

Watershed Emergency Response Team Evaluation
LNU LIGHTNING COMPLEX
HENNESSEY FIRE



CA-LNU-013407

October 8, 2020



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LIST OF ACRONYMS

BAER	Burned Area Emergency Response
CAL FIRE	California Department of Forestry and Fire Protection
Cal OES	California Office of Emergency Services
Caltrans	California Department of Transportation
CAM-17	California Administrative Manual Title-22 Metals
CEG	Certified Engineering Geologist
CFM	Certified Floodplain Manager
cfs	Cubic Feet per Second
CGS	California Geological Survey
DOC	California Department of Conservation
DWR	California Department of Water Resources
EAS	Emergency Alert System
EPM	Emergency Protection Measure
ERMiT	Erosion Risk Management Tool
FCC	Federal Communications Commission
FEMA	Federal Emergency Management Agency
GIS	Geographic Information System
GIT	Geologist-in-Training
IPAWS	Integrated Public Alert and Warning System
LiDAR	Light Detection and Ranging
LNU	CAL FIRE Sonoma-Lake-Napa Unit
NOAA	National Oceanographic and Atmospheric Administration
NRCS	USDA Natural Resources Conservation Service
NWS	NOAA National Weather Service
OES	Office of Emergency Services
OHV	Off-Highway Vehicle
PE	Professional Engineer
PG	Professional Geologist
PH	Professional Hydrologist
RCD	Resource Conservation District
RI	Return Interval
RPF	Registered Professional Forester
SBS	Soil Burn Severity
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USFS	USDA United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VARs	Values-at-Risk
WEA	Wireless Emergency Alerts
WERT	Watershed Emergency Response Team

LNU LIGHTNING COMPLEX (HENNESSEY FIRE)
Watershed Emergency Response Team EVALUATION
October 8, 2020

EXECUTIVE SUMMARY

State of California

Watershed Emergency Response Team (WERT)

LNU LIGHTNING COMPLEX (HENNESSEY FIRE) – WERT ASSESMENT EXECUTIVE SUMMARY

CA-LNU-013407 WERT Evaluation

Mission Statement: The California Watershed Emergency Response Team (WERT) helps communities prepare after wildfire by rapidly documenting and communicating post-fire risks to life and property posed by debris flow, flood, and rockfall hazards.

It should be noted that the findings included in this report are not intended to be fully comprehensive or conclusive, but rather to serve as a preliminary tool to assist the counties of Napa, Solano, Yolo, Colusa and Lake – and their local department of emergency services, various agencies within each respective county, Caltrans, the California Governor’s Office of Emergency Services, the USDA Natural Resource Conservation Service, utility companies, and other responsible agencies in the development of more detailed post-fire emergency response plans. It is intended that the agencies/entities identified above will use the information presented in this report as a preliminary guide to complete their own more detailed evaluations, and to develop detailed emergency response plans and mitigations. This report should also be made available to local districts, residents, businesses, and property managers so that they may understand their proximity to hazard areas, and to guide their planning for precautionary measures as recommended and detailed in this document.

The Hennessey Fire started on August 17, 2020 ignited by lightning caused by a tropical storm in the Pacific Ocean following a heatwave. Lightning struck California approximately 14,000 times over a three-day period and started more than 650 fires. Once started, the fires grew quickly in response to low humidity and high winds. The Hennessey Fire started as two separate fires, the Hennessey and the Gamble fires. One fire originated near Lake Hennessey and the other in a remote area north of Lake Berryessa. The Hennessey Fire is part of the larger 363,220-acre LNU Lightning Complex. The overall Complex was 98% contained as of September 30, 2020. The Hennessey portion of the LNU Lightning Complex is within Colusa, Lake, Napa, Solano and Yolo counties. Other fires within the overall LNU Lightning Complex include the Walbridge, Meyers, 15-10, Spanish, Markley, 13-14, and 11-16 fires. Most of these became subsumed by the larger named fires, such as the Gamble Fire being incorporated into the Hennessey Fire after they combined. This report presents the WERT results for the Hennessey portion of the LNU Complex which occurred within Napa,

Solano, Yolo, Colusa and Lake counties. The Walbridge and Meyers portion of the LNU Complex is presented in a separate, but associated, report.

Hennessey	
Acres	305,920
Containment	98%
Structures destroyed (Structures damaged)	1,193 (207)
Fatalities	6
Injuries	5

Summary of the Key WERT Findings

- The degree of fire-induced damage to soil is called “soil burn severity” and is a primary influence on increased runoff generation and the occurrence of post-fire watershed hazards (e.g., rockfall, debris flows and flooding). Moderate and high soil burn severity typically create the most impacts.
- Twenty-two (22) percent of the fire burned at moderate to high soil burn severity, whereas the remaining portion of the fire (78%) burned at low or very low/unburned soil burn severity. Past discussions with Soil Scientists from the United States Forest Service have indicated that soils with higher clay content tend to have less heat penetration than sandier soils (*personal communication*, Brad Rust and Dave Young, USFS Soil Scientists). This may play a part in the lower soil burn severities observed in the Hennessey Fire, as soils in these areas generally have a relatively high clay content.
- Ninety-six (96) Values-at-Risk (VARs) were identified within and downslope/downstream of the fire. Fifty (50) of the VARs are polygons that encompass several individual structures or extended alignments of road. In general, the majority of VARs are likely to be subject to localized flooding and/or localized potential for debris flows.
- Twenty (21) VARs were determined to have a high threat to life-safety. Two (2) are located in Pope Creek, one (1) in Lower Cache Creek, two (2) in Napa Valley, seven (7) in Middle Putah Creek, three (3) in Lower Putah Creek, and six (6) in Ulatis Creek - Alamo Creek. Fifty-two (52) VARs were determined to have a moderate threat to life-safety.
- Twenty-three (23) VARs were determined to have a low threat to life-safety but a moderate risk to property. These VARs are generally associated with an elevated risk of flooding.
- Some risk to water supply infrastructure located downslope of the burned area may exist from elevated flows, sediment, and both suspended and transported organic material. Lake Hennessey, Lake Berryessa, Lake Curry, Lake Solano, and other reservoirs are within or downstream of the fire perimeter. These reservoirs are part of

the systems that provide drinking water to Napa and Solano counties and local municipalities.

- Observations within and downslope/downstream of the burned area indicate that classic debris flow hazards (i.e., rapidly transported flows with suspended boulder-sized material) may be present in some portions of the burned area. It is unclear, however, whether post-fire debris flows are a major contributor to the geomorphology of the area. Franciscan Assemblage bedrock is well known for its instability, where both large and small landslide occurrences are fairly common. Areas of shallow- and deep-seated landsliding observed in available LiDAR imagery confirm active rain driven hillslope processes even without fire effects.
- USGS debris flow model results are presented in terms of “predicted probability”, “potential volume” and “combined debris flow hazard”, which reflects both the likelihood of debris flow occurrence and the magnitude of potential debris volume. For example, basins with a high likelihood of debris flow occurrence and/or relatively high magnitude of debris production have a “high combined hazard”, whereas basins with a low likelihood of debris flow occurrence and/or a relatively low magnitude of debris production have a “low combined hazard.”
 - Based on review of the USGS debris flow model for the Hennessey Fire, a storm scenario of approximately 0.35 inches in 15-minutes (i.e., 1.54 in hr⁻¹ or 36 mm hr⁻¹ for the 15-minute duration) represents a 50-percent chance that a debris flow may initiate within 50-percent of the modeled basins. Basins that are modeled as high in the USGS debris flow model may be susceptible to debris flow initiation at lower thresholds.
- Twenty-one (21) sub-watersheds (i.e., pour points) were specifically analyzed for increased post-fire sediment-laden flood hazards. Various rapid analytical methods were used to predict runoff increases utilizing 2- and 10-year recurrence interval 30-minute rainstorms. Results are variable depending upon modeling assumptions (i.e., assuming flood versus debris flows). The range of increase is predicted at 10% to 170%, with the lowest increase at the pour point on Putah Creek, and the highest increase at the pour point on Cold Canyon. The Cold Canyon and Ulatis Creek pour points have the largest potential post-fire flood response, with the 10-year rainfall event modeled as capable of producing a bulked peak flow with a 500-year recurrence interval.
- The ERMiT post-fire surface erosion model predicts mostly a minimal to moderate increase in the rate of surface erosion across the burned area due to the preponderance of low and very low soil burn severity.

General Recommendations

The WERT’s objectives for the burned area were to quickly identify potential post-fire life-safety and property threats, including those from debris flows, flooding, rockfall, and erosion. General recommendations include:

- Utilize early warning systems available to homeowners, particularly those located in debris flow and flood-prone areas. The WERT recommends the use of Napa, Solano,

Colusa, Lake and Yolo county-recommended emergency alert notification systems; see the following websites:

Colusa County

<https://www.countyofcolusa.org/64/Emergency-Alert>

Lake County

<http://www.lakesheriff.com/About/OES/LakeCoAlerts.htm>

Napa County

<https://www.countyofnapa.org/353/Emergency-Services>

Solano County

<https://www.solanocounty.com/depts/oes/alertsolano/information.asp>

Yolo County

<https://www.yolocounty.org/residents/emergency-alerts-health-alerts>

- Have the various county emergency services centers assist in clearly communicating the high potential and high risk/consequences of post-fire watershed hazards to the agencies responsible for emergency planning and response.
- Develop emergency response and evacuation plans based upon the identified post-fire hazards.
- Increase the situational awareness of affected residents and the communities regarding the hazards and risks associated with living downstream/downslope of burned areas.
- Perform monitoring and maintenance of road drainage and storm drain infrastructure. Drainage facilities were noted to be undersized for larger storm events in many locations, and the post-fire environment can create conditions that quickly overwhelm even drainage facilities normally considered to be adequately sized.
- Utilize temporary flood control and structure protection (sand bags, K-rails, Muscle Wall) where appropriate.
- Place temporary signage and consider road closure in areas of potential post-fire rockfall, debris flow, and flooding hazards.
- City and counties with municipal water supply reservoirs should consider conducting detailed hydrologic evaluations of the potential post-fire impacts, including evaluating possible mitigation measures designed to minimize the potential for debris and ash to impact the water supply.

1. Introduction

Background

This report presents the results of a rapid evaluation of post-fire geologic and hydrologic hazards to life-safety and property (i.e., collectively known as “Values-at-Risk”) for private lands, state lands, non-profit ownerships, and a limited portion of federal ownership affected by the Hennessey Fire of the greater 2020 LNU Lightning Complex Fire (Figure 1). The Hennessey portion of the burned area is located within Napa, Solano, Yolo, Colusa and Lake counties. Due to the size of the fire within the overall LNU Lightning Complex, the Walbridge and Meyers portions of the Complex are described in a separate report. The Walbridge and Meyers fires are located within Sonoma County, which does not have any land within the fire perimeter of the Hennessey Fire. The WERT arrived on-site September 4, 2020, and the full team completed field work on September 13, 2020. Two local team members reviewed a few site-specific areas within the Hennessey Fire after the full team returned to their respective home units to write the report. Team members are listed in Table 1.

A primary concern for burned watersheds is the increased potential for damaging flood flows, debris flow occurrence, rockfall from steep slopes, and hillslope erosion. As winter approaches, it is critical that people who live in and downstream from large wildfires implement emergency protection measures (EPMs) where appropriate, remain alert of weather conditions, and be ready to evacuate if necessary during large and high intensity storms.

This document summarizes downslope/downstream Values-at-Risk (VARs) and makes specific and general recommendations to reduce life-safety and property exposure to post-fire hazards on private lands. Area and proportion of the Hennessey Fire by ownership group is shown in Figure 2 and Table 2. Other WERT/United States Geological Survey (USGS) products associated with this report include GIS data in the form of shapefiles and raster files. Clear communication of life-safety and property hazards is an objective of the WERT process, and the use of these spatial data is a critical component for communicating hazards in a planning and operational context. These data have been shared with federal, state, and local responsible agencies.

Table 1. Hennessey Fire WERT members.

Name	Position	Agency	Expertise-Position
John Ramaley; RPF 2504	Team Lead	CAL FIRE	Forestry
Kevin Doherty; PG 7824; CEG 2666	Co-Team Leader	CGS	Engineering Geology
Thembi Borrás; RPF 2700	Team Member	CAL FIRE	Forestry
Patrick Brand; PG 8693; CEG 2542	Team Member	CGS	Engineering Geology
Stefani Lukashov; GIT 898	Team Member	CGS	Geology
Trevor Morgan; PE 79967	Team Member	DWR	Hydrology/Engineering
Adjunct Team			
Janine Bird	Adjunct Member	CGS	GIS
Sol McCrea; CFM 3527	Adjunct Member	CGS	GIS
Will Olsen	Adjunct Member	CAL FIRE	GIS/GIS Analysis
Pete Cafferata; PH 1676; RPF 2174	Adjunct Member	CAL FIRE	Hydrology/Forestry
Pete Roffers; PG 9100	Adjunct Member	CGS	GIS/Geology
Francesca Rohr	Adjunct Member	CAL FIRE	GIS

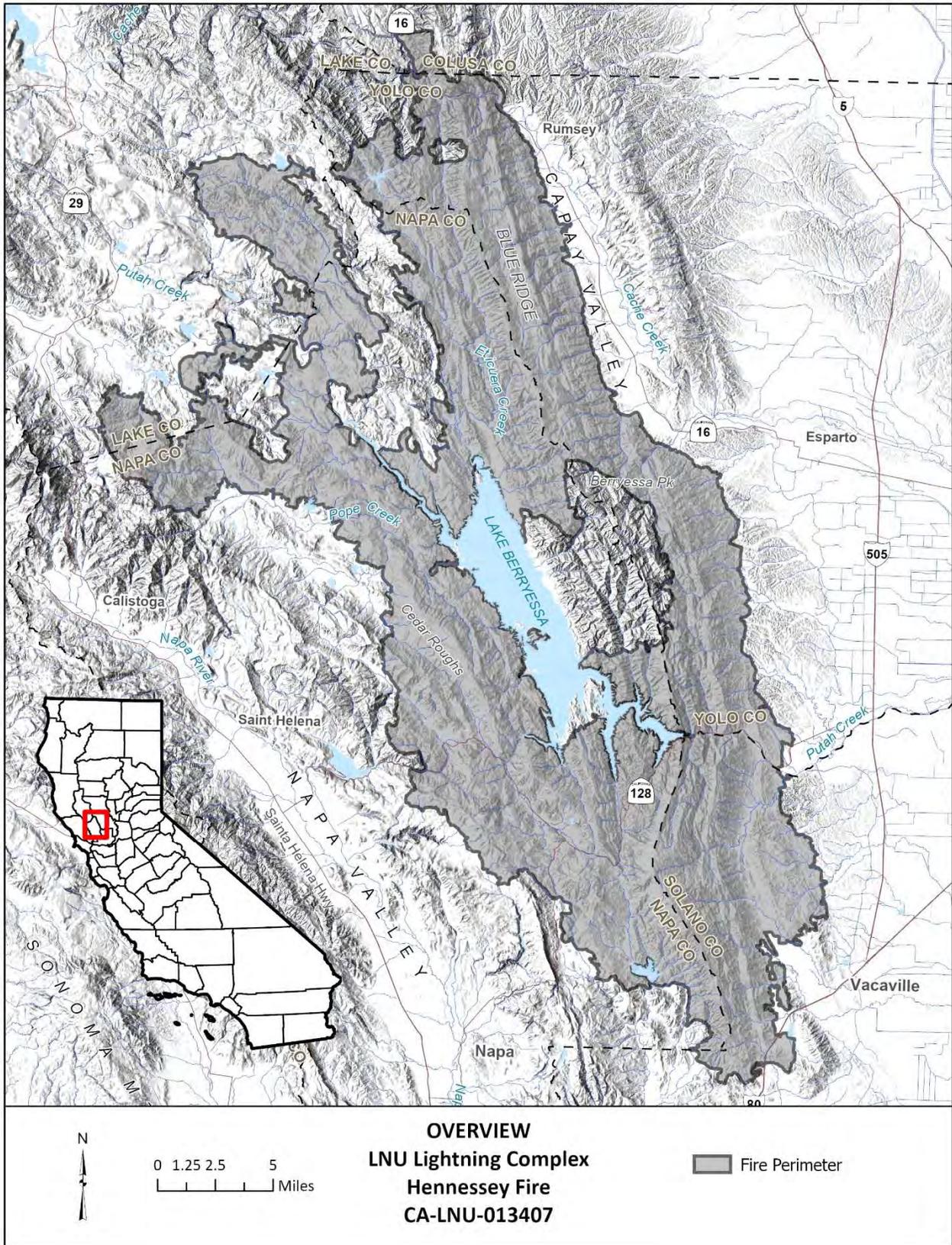


Figure 1. Overview map of the Hennessey Fire.

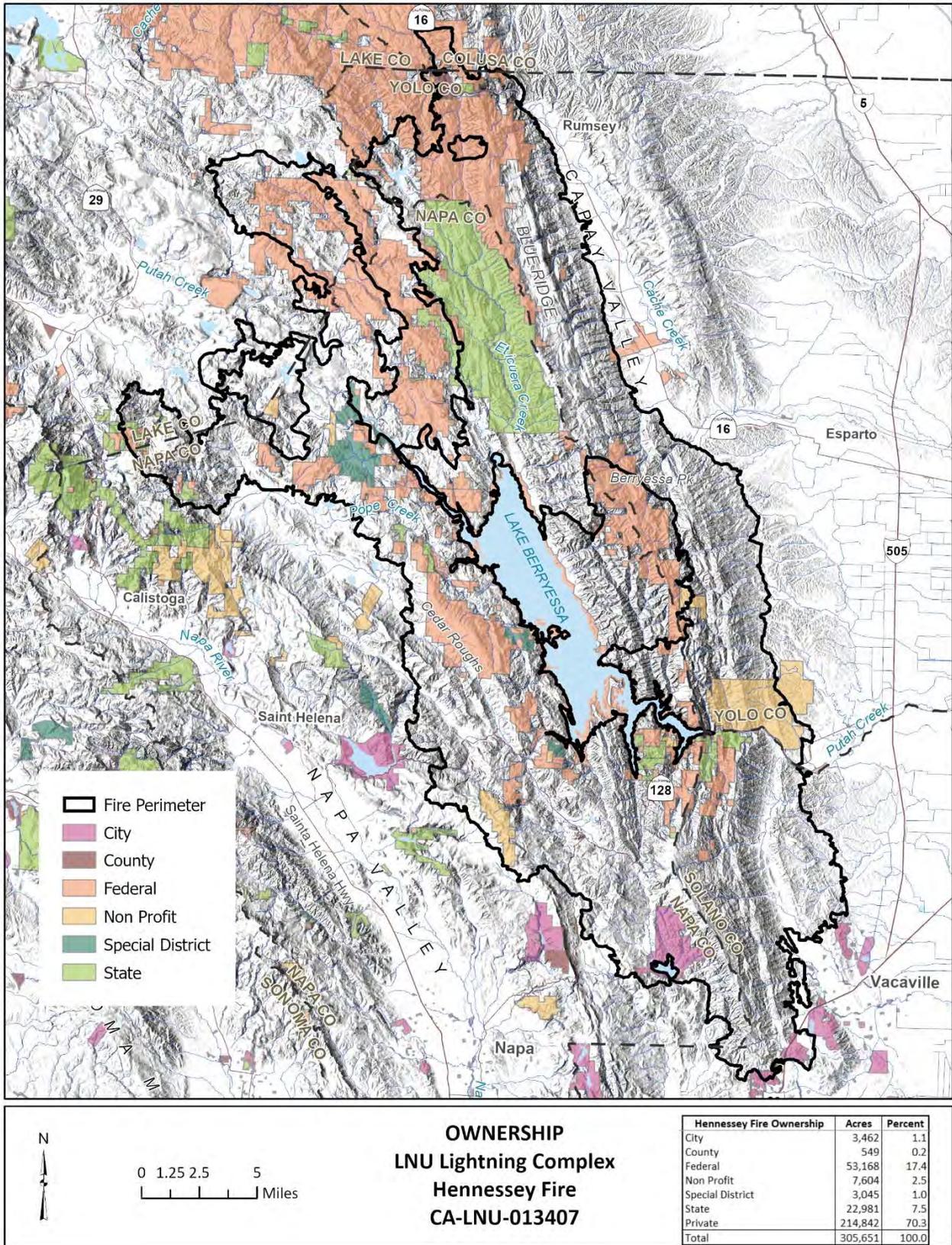


Figure 2. Location and ownership map of the Hennessey Fire.

Table 2. Area and proportion of the Hennessey Fire burn area by ownership group.

Hennessey Fire Ownership	Acres	Percent
City	3,462	1.1
County	549	0.2
Federal	53,168	17.4
Non Profit	7,604	2.5
Special District	3,045	1.0
State	22,981	7.5
Private	214,842	70.3
Total	305,651	100.0

Objectives and Scope

Primary objectives for the WERT are to conduct a rapid preliminary assessment to:

- Identify types and locations of on-site and downstream threats to life-safety, property, and critical infrastructure (i.e., Values-at-Risk [VARs]) from post-fire flooding, debris flows, rockfall, erosion, and other geologic hazards that are elevated due to post-fire conditions.
- Determine relative risk to these values using a combination of state-of-the-art analytical tools (e.g., post-fire debris flow probability model, erosion model, burn severity model) and the professional judgement of licensed geohazard professionals (i.e., Professional Geologists; Certified Engineering Geologists; Professional Engineers).
- Develop preliminary emergency protection measures necessary to avoid or minimize life-safety and property threats.
- Communicate findings to responsible entities and affected parties.

It is important to emphasize that the WERT performs a rapid evaluation of post-fire hazards and risk. A complete characterization of post-fire hazards and/or in-depth design of protection measures is beyond the scope of the WERT evaluation. However, findings from the WERT evaluation can potentially be used to leverage emergency funds for emergency treatment implementation and more detailed site investigation and/or treatment design.

2. Physical Setting

Topography, Climate, and Vegetation

The Hennessey Fire burned area is east of the Napa Valley communities/cities of Calistoga, Angwin, St. Helena, Yountville and Napa; north of the city of Fairfield; northwest of the city of Vacaville; west of the communities of Winters, the Rumsey Rancheria and Guinda; and south of Steinhart Lakes. The northern and northeastern portions of the fire area are very remote. The northwestern area near James Creek was mostly used for mining operations in the past. The topography within the burned area is predominately low to moderately steep in the foothills and valleys to very steep in the southeastern portions near Rocky Ridge and Blue

Ridge. Elevations range from approximately 140 feet in the lower reaches of Putah Creek below Monticello Dam, to the higher areas of Rocky Ridge and the Cedar Bluffs, which reach an elevation of 3,057 feet at Berryessa Peak.

Figure 3 shows the distribution of slope gradients within the burned area. Due to the size of the fire, many different major streams receive drainage from the fire area, most notably the Napa River, Cache Creek, and Putah Creek. All catchments within the Hennessey Fire burned area ultimately drain into San Pablo Bay via the Sacramento River and Suisun Bay.

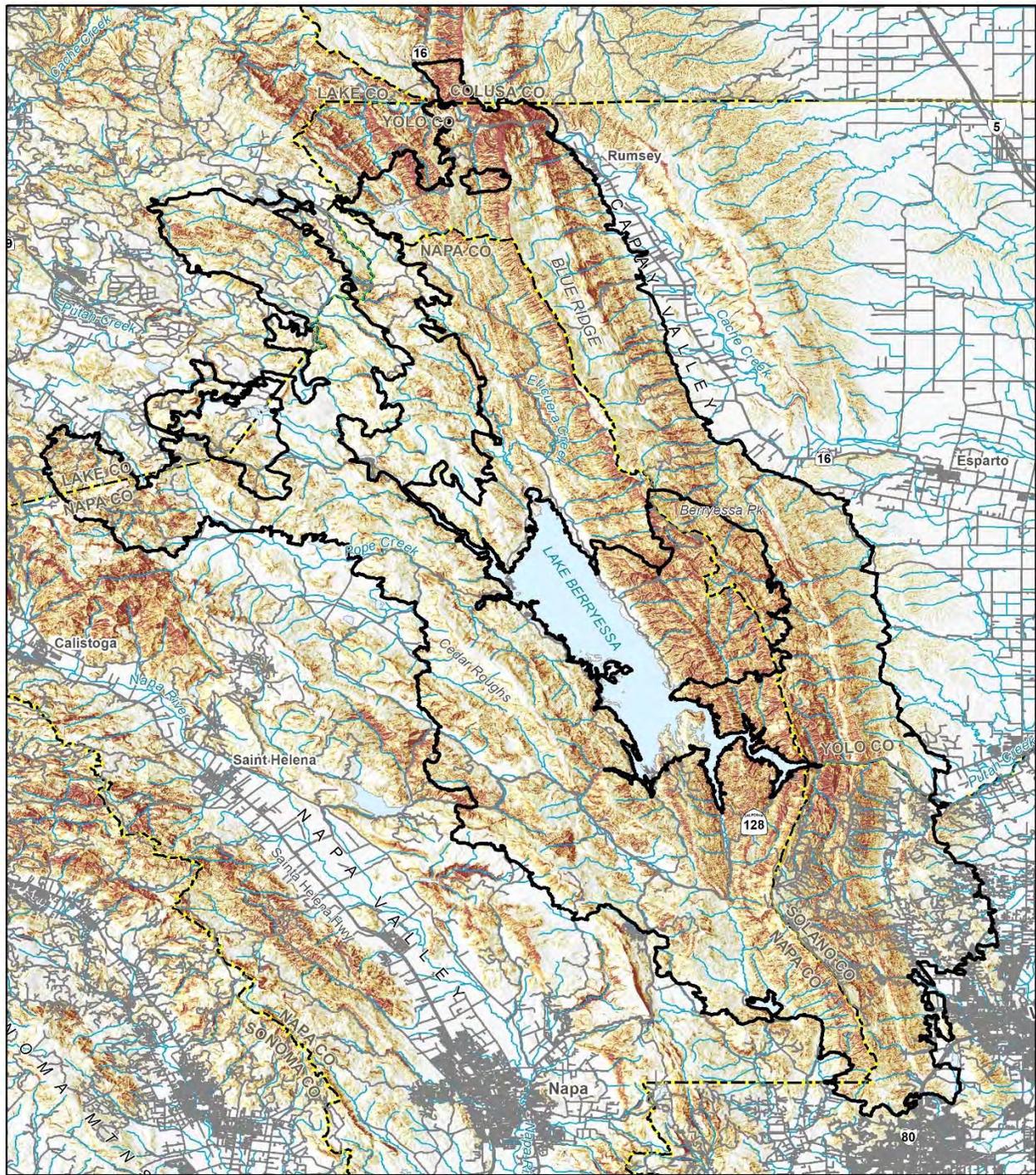
The burned area has a California Mediterranean climate with mild winters and hot, dry summers. The area is located along the leeward side of the Coast Ranges, which receive most of the precipitation before east-moving storms reach the fire area and rain amounts drop significantly. Rain events are very rare during the summer months. Widely varying amounts of precipitation occur from year to year during the winter months. Precipitation throughout the burned areas occurs almost entirely as rain and snowfall is extremely rare. Portions of the burned area rarely reach 40 inches of precipitation during a rain year. An approximate mid-point of the Hennessey Fire, in the middle of Lake Berryessa had a low of 5.21 inches of precipitation in the 2013 rain year and a high of 38.83 inches of precipitation in the 2019 rain year. Average annual rainfall in the burned area for the last 30 years (1981-2010) is approximately 25 inches. Most of the annual precipitation occurs from November through March (OSU PRISM site; <http://prism.oregonstate.edu/explorer/>) and the highest temperatures are from June through September. Annual precipitation totals are highly variable from year to year and can be much higher during wet El Niño years.

The NOAA National Weather Service Hydrometeorological Design Studies Center, Atlas 14 Point Precipitation Frequency Estimates website was utilized to provide statistical data for rainfall intensities that may be expected at four locations of the Hennessey Fire burned area (Table 3). The NOAA website is located at the following web address:

<https://hdsc.nws.noaa.gov/hdsc/pfds/>

Table 3. NOAA Atlas 14 rainfall intensities (in/hr) by recurrence interval for the 15-minute storm duration.

Recurrence Interval (yrs)	Butts Creek – Berryessa Confluence	Cold Canyon – Putah Creek Confluence	Lake Curry	Hole Creek - Jericho Creek Confluence	Average of Stations
2	1.16	1.2	1.17	1.09	1.16
5	1.44	1.51	1.48	1.38	1.45
10	1.68	1.76	1.73	1.63	1.70
25	2.02	2.10	2.07	1.98	2.04
50	2.29	2.35	2.34	2.25	2.31
100	2.58	2.60	2.61	2.54	2.58



Elevation source: 2005 NEXTMap InSAR

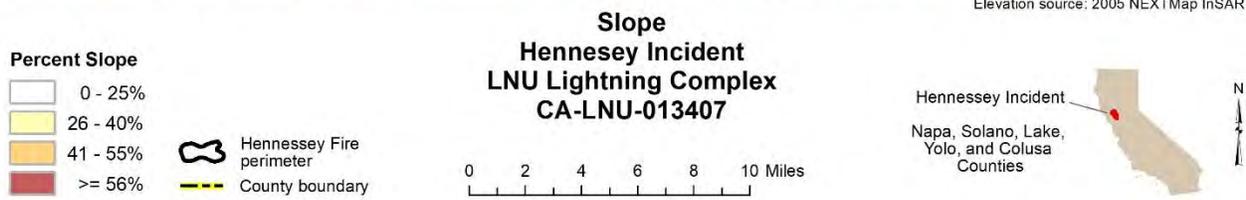


Figure 3. Shaded relief map for the Hennessey Fire. Areas over 60 percent slope (i.e., red shading) have a higher likelihood of landsliding, erosion, and dry ravel.

Vegetation and Fire History

The vegetation communities within the Hennessey Fire are highly variable. However, all vegetation communities are much dryer than the western portions of the LNU Lightning Complex in western Sonoma County.

Communities encountered within the Hennessey Fire:

1. Oak woodland
2. Hardwood
3. Chaparral
4. Grasslands
5. Agricultural lands
6. Douglas-fir / pine
7. Montane hardwood-conifer

CAL FIRE records show that a substantial portion of the Hennessey Fire has burned recently, including a portion as recently as 2018 during the County Fire (Figure 4). The Rocky, Jerusalem, Valley, Atlas, and County fires all at least partly overlie the Hennessey Fire perimeter footprint, and all occurred from 2015 through 2019. The arid nature of the area and the composition of the vegetative communities suggest fire reoccurs fairly frequently in the general area, and has throughout history, either through intentional manipulation by Native Americans and settlers, or through less frequent lightning events. In modern times, human caused fires are a significant portion of CAL FIRE's incidents and can quickly accelerate into larger fires with wind events.

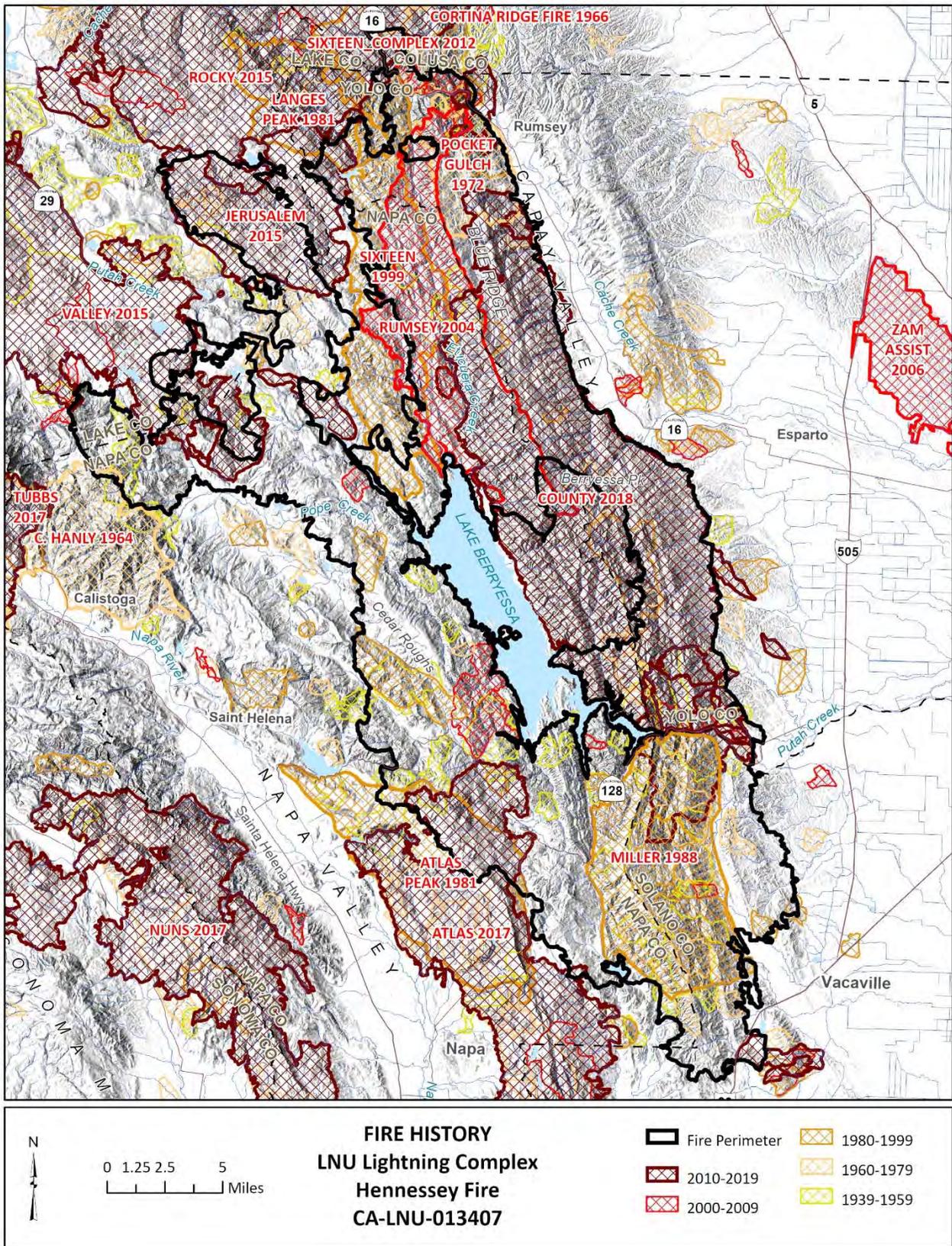


Figure 4. Fire history map for the Hennessey Fire.

Hydrology/Flood History

Hennessey Fire - Flood History

Flooding events occur in the Northern Coast Ranges when atmospheric rivers tap into tropical moisture creating warm, long duration storm events with periods of intense rainfall. Long-term, unregulated stream gaging records are not found within the fire perimeter, but long-term flow data are available from USGS gaging stations in Lake County. A 70-year record (missing 1977 to 1998) for unregulated Putah Creek near Guenoc, CA (USGS 11453500), just to the north of the fire perimeter, shows major floods occurred in December 1937 and December 1955. Historic flood events on unregulated segments of Cache Creek (USGS 11467002) also provide a good representation of large flood events within the general fire area. Prior to the construction of Indian Valley Reservoir in 1975, North Fork Cache Creek near Lower Lake, CA (USGS 11451500) had major flood events in December 1937, February 1940, and December 1964. After the construction of the reservoir, North Fork Cache Creek at Hough Spring near Clearlake Oaks, CA (USGS 11451100, above the lake) had its largest peak flow during January 1997 (New Year's Day Flood), approximately a 40-year recurrence interval flood.

The hazard mitigation plans for the five counties affected by this fire address flooding. Flood problems for Lake County are stated as being north of the burned area: (1) along Cache Creek downstream from Clear Lake largely confined to the main stem reach near Lower Lake, (2) along the lower reaches of North Fork Cache Creek, and (3) in the Putah Creek basin, in Coyote and Collayami Valleys and in Middletown (Lake County, 2018). The Napa County plan states that there remains a significant threat of flooding along the many feeder streams in the Napa River watershed, including Conn Creek, Rector Creek, and Milliken Creek on the east side, even with reservoirs such as Lake Hennessy in place (Napa County, 2018). The Solano County plan (Solano County, 2012) states that flooding is a significant problem, and that it has occurred both within the 100-year floodplain and in other localized areas. The Yolo County plan (Yolo County, 2018) states that since the completion of Monticello Dam on Putah Creek (Lake Berryessa), flooding from Putah Creek and Cache Creek occurs from Cache Creek overflow in the Capay Valley and south of Cache Creek near the City of Woodland, and north of Cache Creek in the lowlands of the Hungry Hollow watershed, a tributary of Cache Creek. Finally, Colusa County has experienced flooding most recently in 1970, 1985, 1997, and 1998. Key areas include farmland and a residential area off State Route 20 west of the City of Colusa (Colusa County, 2005).

Mapped gaging station locations can be found at the following website:

<https://maps.waterdata.usgs.gov/mapper/index.html>

Geology and Landslides

Regional geologic mapping at 1:250,000 scale by Wagner and Bortugno (1982) and Wagner et al. (1981) and at 1:100,000 scale by Graymer et al. (2007) indicates that the Hennessey Fire occurs within the southern portion of the northern California Coast Ranges geomorphic province, just west of the transition to the Great Valley geomorphic province (CGS, 2002) (Figure 5). The Coast Ranges geomorphic province is a series of steep, northwest-trending

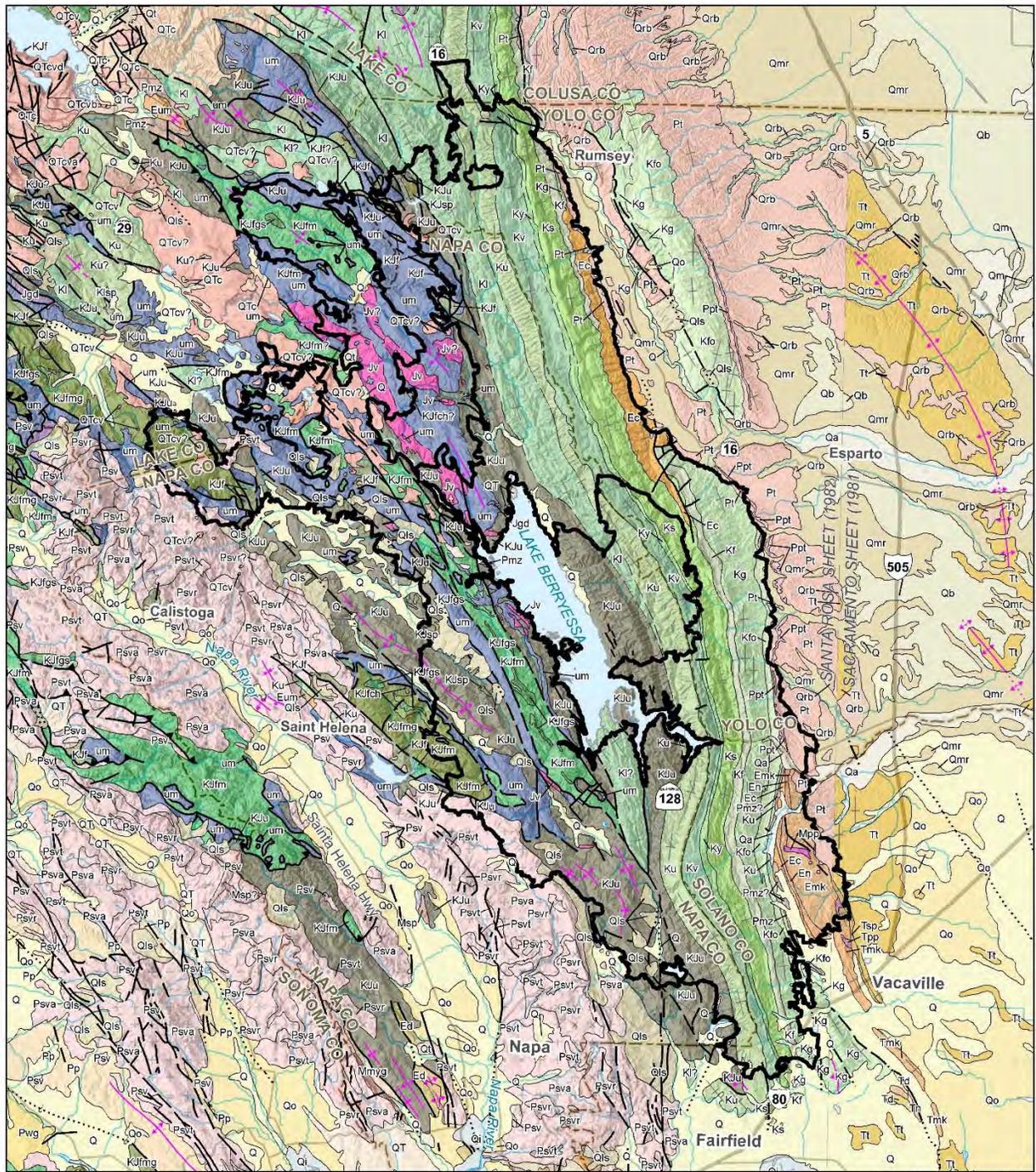
mountain ranges and valleys extending from the Oregon border to the north, Transverse Ranges to the south, and the Great Valley province to the east. The western edge of the province along the Pacific Ocean is uplifted, terraced and wave-cut. The Coast Ranges run subparallel to the active San Andreas Fault, which runs approximately 600-miles from Point Arena to the Gulf of California. The province is divided into northern and southern sections separated by a depression containing the San Francisco Bay. Within the geomorphic province, the bedrock is generally comprised of Mesozoic and Cenozoic era (65 million years to 250 million years) sedimentary rocks which are overlain in areas by Tertiary and Quaternary (Pleistocene)-age (120,000 years to 65 million years) volcanic rocks (Sonoma and Clear Lake Volcanics).

Bedrock underlying the Hennessey Fire burned area are reportedly comprised of the Jurassic to Cretaceous-age Central Belt Franciscan Complex, Jurassic to Cretaceous-age Great Valley Sequence, Eocene to Pleistocene-age fluvial and marine sedimentary rocks, and Miocene to Pleistocene-age volcanic rocks. Upper Jurassic to Cretaceous-aged marine sedimentary rocks of the Great Valley Sequence underlie most of the burned area. In the western portion of the burned area, small bands of Jurassic-aged ultramafic rock and deformed marine rocks of the Franciscan Complex bisect the larger unit of Great Valley Sequence rocks. The Great Valley Sequence is described as marine mudstone, siltstone, sandstone, and conglomerate (Wagner and Bortugno, 1982). In the northwestern portion of the burned area, the Great Valley Sequence and Franciscan Complex are unconformably overlain by Cenozoic-aged Sonoma and Clear Lake volcanics, as well as fluvial deposits of the Tehama Formation and the Glen Ellen Formation. To the east, bedrock within the burned area gradually transitions to younger strata, from marine rocks of the Great Valley Sequence, to Paleocene-age marine sandstone of the Martinez Formation, various Eocene-age marine sandstones, and Pliocene-age Tehama Formation. However, an unconformity exists north of Highway 128 up to Berryessa Peak, where the Great Valley sequence is overlain by the nonmarine sand, silt, and volcanoclastic rocks of the Pliocene-age Tehama Formation. Nonmarine clayey gravel of the Pleistocene-age Red Bluff Formation overlies the Tehama Formation, along with alluvial deposits from the Pleistocene-age Modesto Riverbank Formations. Small blocks of early-Miocene-age Putnam Peak Basalt are mapped within the watersheds of Putah Creek and Miller Canyon Creek.

The deep-seated landslides mapped as Quaternary landslide deposits in the geology map (Figure 5) represent a small portion of mapped large, deep-seated landslides within the burned areas. The landslide map of the burned areas (Figure 6) consists of numerous sources compiled within the California Geological Survey internal landslide inventory (Wills et al., 2011). The inventory includes regional mapping by Dwyer et al. (1976) within the southern and western portions of the map, by Manson (1989) within the Highway 16 corridor in the northeastern portion of the map, and by Majmunder (1987, 1989) within the southernmost edge of the burned area. It should be noted that regional landslide mapping is not available for the north-northeastern portion of the burned area; however, this does not imply that landslides are not present within these areas. As part of our evaluation of the burned area, we did not validate the landslide mapping but used it as a tool to help guide our evaluation of the burned area and focus on areas of potential hazard. The absence of landslides in the eastern portion of the map is representative of the absence of mapping in

the area, rather than the absence of landslide activity. Generally based on field observations and review of available LiDAR imagery, landsliding appears to be prevalent across the burned area, primarily as shallow debris flows or rock slides. Extreme short-term and long-term rainfall events are a primary trigger for initiating both shallow and deep-seated landslides, respectively, in the area, while ground shaking from nearby active faults is an important process in preparing slopes for landsliding and initiating landslides (Keefer, 1984). These landslide prone materials can add to the increased erosion and runoff expected because of post-fire soil hydrology changes.

There are numerous active earthquake fault systems in and adjacent to the Hennessey Fire burned area. Northwest-trending folds and faults run through the burned area and are part of the Lake Berryessa section of the Hunting Creek-Berryessa Fault Zone. The Lake Berryessa section exhibits late Quaternary-age fault movement and has a right-lateral slip rate of 1.0-5.0 mm/yr (Bryant, 2000). There are numerous other regional seismic sources that are capable of producing strong ground motions in the burned area. Earthquakes and subsequent landsliding during the 3- to 5-year recovery period that burned slopes are susceptible to post-fire response flood flows can be further increased by bulking with sediment and debris delivered to the channel networks by coseismic landsliding. The material delivered to streams can also be mobilized in sediment laden flood and debris flow events increasing their magnitude and destructive power.



Sources: Geologic map of California, 1:250,000, Sacramento Sheet, D.L. Wagner, C.W. Jennings, T.L. Bedrossian, E. J. Bortugno, California Division of Mines and Geology, 1981, and Santa Rosa Sheet, D.L. Wagner, E. J. Bortugno, California Division of Mines and Geology, 1982.

Elevation source: 2005 NEXTMap InSAR

Geology
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 Hennessey Fire perimeter

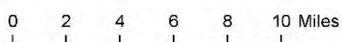


Figure 5. Geologic map and legend for the Hennessey Fire.

Geologic Map Units - Hennessey Burn Area

CENOZOIC

Quaternary

Q	Alluvium	Qm	Modesto Formation (alluvium)
Qa	Natural levee and channel deposits	Qmr	Modesto-Riverbank Formations (arkosic alluvium)
Qb	Basin deposits (alluvium)	Qt	Terrace deposits
Qls	Landslide deposits	Qrb	Red Bluff Formation (gravel in silty or sandy matrix)
Qi	Intertidal deposits (peaty mud)	Qmz	Montezuma Formation (clayey sand)
Qo	Older alluvium		

Tertiary

Pleistocene

QT	Huichica and Glen Ellen Fms. (gravel, silt, sand, clay)	Tt	Tehama Formation (sand, silt, volcanoclastic rocks)
QTc	Cache Fm. (sandstone, conglomerate, siltstone, tuff)	Tsp	San Pablo Group (marine sandstone and shale)
QTcv	Clear Lake Volcanics	Tmk	Markley Sandstone (marine)
QTcva QTcvb QTcvd QTcwr	(andesite, basalt, dacite, rhyolite)	Tn	Nortonville Shale (marine)
		Td	Domengine Sandstone (marine)
		Tpp	Putnam Peak Basalt (Sacramento map sheet)

Miocene - Pliocene

Pt	Tehama Formation (sand, silt, and volcanoclastic rocks)
Ppt	Putah Tuff Member
Pwg	Wilson Grove Fm. (sandstone, siltstone, conglomerate)
Pp	Petaluma Fm. (claystone, siltstone, mudstone)
Psv	Sonoma Volcanics
Psva Psvi Psvi	(andesite, rhyolite, tuff)
Msp	San Pablo Group (marine sandstone and shale)
Mmyg	Monterey Group (shale, sandstone)
Mpp	Putnam Peak basalt (Santa Rosa map sheet)

Paleocene - Eocene

Emk	Markley Sandstone (marine)
En	Nortonville Shale (marine)
Ed	Domengine Sandstone (marine)
Ec	Capay Formation (marine sandstone)
Eum	Unnamed Eocene marine rocks
Pmz	Martinez Formation (marine quartzose sandstone)

Map Symbols

	Contact – Solid where accurately located; long dash where approximately located; short dash where inferred
	Fault – Solid where accurately located; long dash where approximately located; short dash where inferred; dotted where concealed; queried where uncertain
	Anticline – Dashed where approximately located
	Syncline – Dashed where approximately located; dotted where concealed
	Bedding

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MESOZOIC

Cretaceous

Ku	Upper Cretaceous (undifferentiated marine rocks)
Kfo	Forbes Formation (marine shale and siltstone)
Kg	Guinda Formation (marine sandstone)
Kf	Funks Formation (marine shale and sandstone)
Ks	Sites Formation (marine sandstone)
Ky	Yolo Formation (marine shale and sandstone)
Kv	Venado Formation (marine shale and sandstone)
Kl	Lower Cretaceous Great Valley Sequence
Klsp	(detrital serpentine)
KJu	Lower Cretaceous-Upper Jurassic Great Valley Sequence
KJsp	(detrital serpentine)

Cretaceous - Jurassic

KJt	Franciscan Complex
KJfch KJfgs	(chert, greenstone, metagraywacke, sandstone)
KJfmg KJfss	(melange)
KJfm	(melange)
Jv	Volcanic rocks (mainly basalt)
Jgd	Gabbro and diabase
um	Serpentinized ultramafic rocks

Figure 5. (Continued)

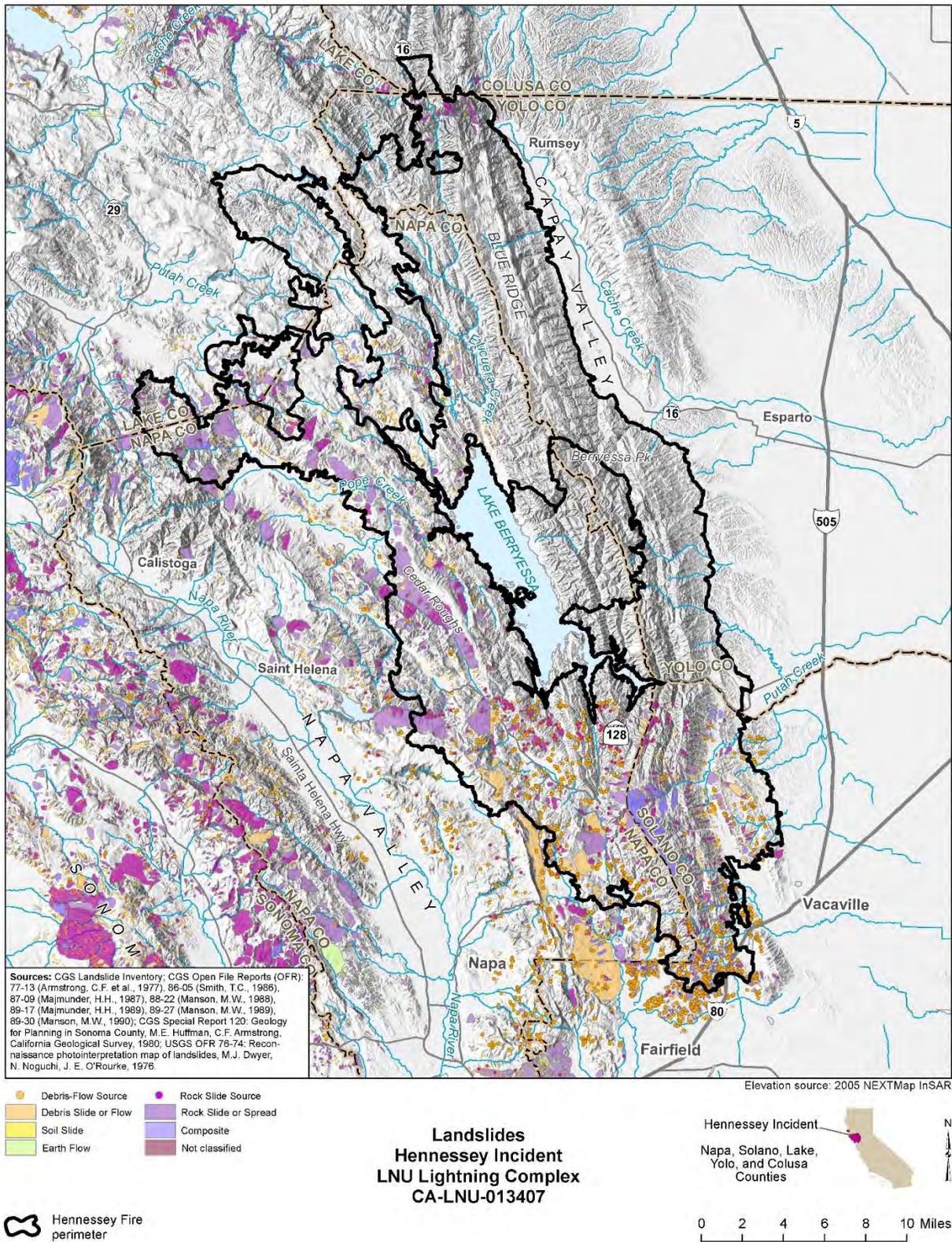


Figure 6. Landslide map for the Hennessey Fire.

Hazardous Minerals

Hazardous minerals in the Coast Ranges province are often associated asbestos, mercury, and other heavy metals. Regional geologic mapping (Wagner and Bortugno, 1982) identifies serpentinite and other ultramafic rock units within the western and northern portion of the Hennessey Fire burned area that may contain asbestiform minerals. Asbestos is classified as a known human carcinogen by state, federal and international agencies and is regulated under Title 8 Section 1529 of the California Code of Regulations. State and federal health officials consider all types of asbestos to be hazardous. There is no agreed-upon “safe” level of asbestos exposure because there is insufficient scientific information to support the identification of an exposure level at which there would be zero risk of cancer. Asbestos can be entrained with increased runoff and brought into areas that when disturbed could cause potential hazards. Based on our field observations, outcrops and road cuts of serpentinite were observed within the burned area.

Figure 5 shows the distribution of Jurassic to Tertiary-age Coastal Belt and Central Belt Franciscan Formation, that have potential for locally elevated levels of CAM-17 metals. These hazardous minerals, including mercury, copper, chromium and manganese, may be entrained with increased surface runoff and impair water quality downslope. There are numerous historic mining operations within and adjacent to the western and northern portion of the burned area that may contain potentially harmful concentrations of heavy metals. Primary and secondary mined minerals contain mercury, copper, chromium, manganese, and chrysotile (<https://www.mindat.org/>). Mine tailings and mine waste may contain minerals with harmful concentrations of hazardous elements, including arsenic, cadmium, lead, zinc, mercury, silver and other CA Title-22 (CAM-17) metals. These hazardous minerals may be entrained with increased surface runoff and impair water quality downslope, notable to the Lake Berryessa and its tributaries.

The historic Aetna Mining District is a series of former mercury and manganese mines located along the flanks of Oat Hill within the northwest Hennessey Fire burned area. Operations within the mining district are located upslope of James Creek, a tributary to Pope Creek. Pope Creek drains to Lake Berryessa, which provides drinking water to residents in Solano and Napa counties. Mining operations are no longer ongoing, but tailings, equipment and open adits remain. According to information provided by Napa County, methylmercury levels in Lake Berryessa have resulted in state warnings recommending limits of fish consumption. Increased runoff associated with the low and moderate soil burn severities observed within the headwaters of James Creek and Pope Creek may result in higher flows within the drainages, potentially increasing runoff or inundating the mine areas during large rain events, increasing the potential for mercury delivery to Lake Berryessa.

The McLaughlin Mine gold and silver mining operation is located along the northern Hennessey Fire boundary. The open pit mine was operated between 1985 and 2002, and mining operations are no longer ongoing. Secondary and tertiary minerals associated with the gold and silver extraction include mercury, lead, iron, copper, thallium, arsenic, antimony, and zinc. Tailings piles and two ponds, totaling approximately 90-acres, are located upstream of the Davis Creek Reservoir and Eticuera Creek, a tributary to Lake Berryessa. The mining

operation was not visited during the WERT evaluation, so it is unclear how much storage capacity remains in the ponds. While mining infrastructure is located along the ridgeline and likely not in a position to be inundated by post-fire debris and flood flows, increased post-fire runoff into the ponds may overwhelm the ponds' capacity. Evaluation of the ponds' capacity is prudent to minimize the potential for the ponds to overtop.

Based on our review of California Department of Conservation online well finder, there are five idle and numerous plugged oil and gas wells mapped within and downstream of the Hennessey Fire burned area. The idle wells appear located within mapped drainages or within Lake Berryessa, suggesting that they may be in a position to be inundated by increased post-fire flood flows. Further evaluation of the location of the idle wells appears warranted.

Geothermal wells are mapped within and downstream of the northwestern portion of the Hennessey Fire burned area. Very little infrastructure associated with the geothermal wells was observed during our field review, as much of the area was difficult to access due to locked gates and poor roads. Our field evaluations were conducted over a relatively short period and should not be considered comprehensive and/or conclusive. Low and moderate soil burn severities observed within the northwestern Hennessey Fire boundary will likely result in increased runoff into the mapped drainages. Geothermal well infrastructure located within the drainages may be at risk of inundation from higher flows in the drainages during large storm events.

The locations of potential mineralogical hazards, including the CAM-17 mines and ultramafic minerals, are shown below in the Mineral Hazard Map (Figure 7).

Information regarding the hazardous minerals discussed above can be found at the California Office of Environmental Health Hazard Assessment (<https://oehha.ca.gov/chemicals/>).

For additional information, see:

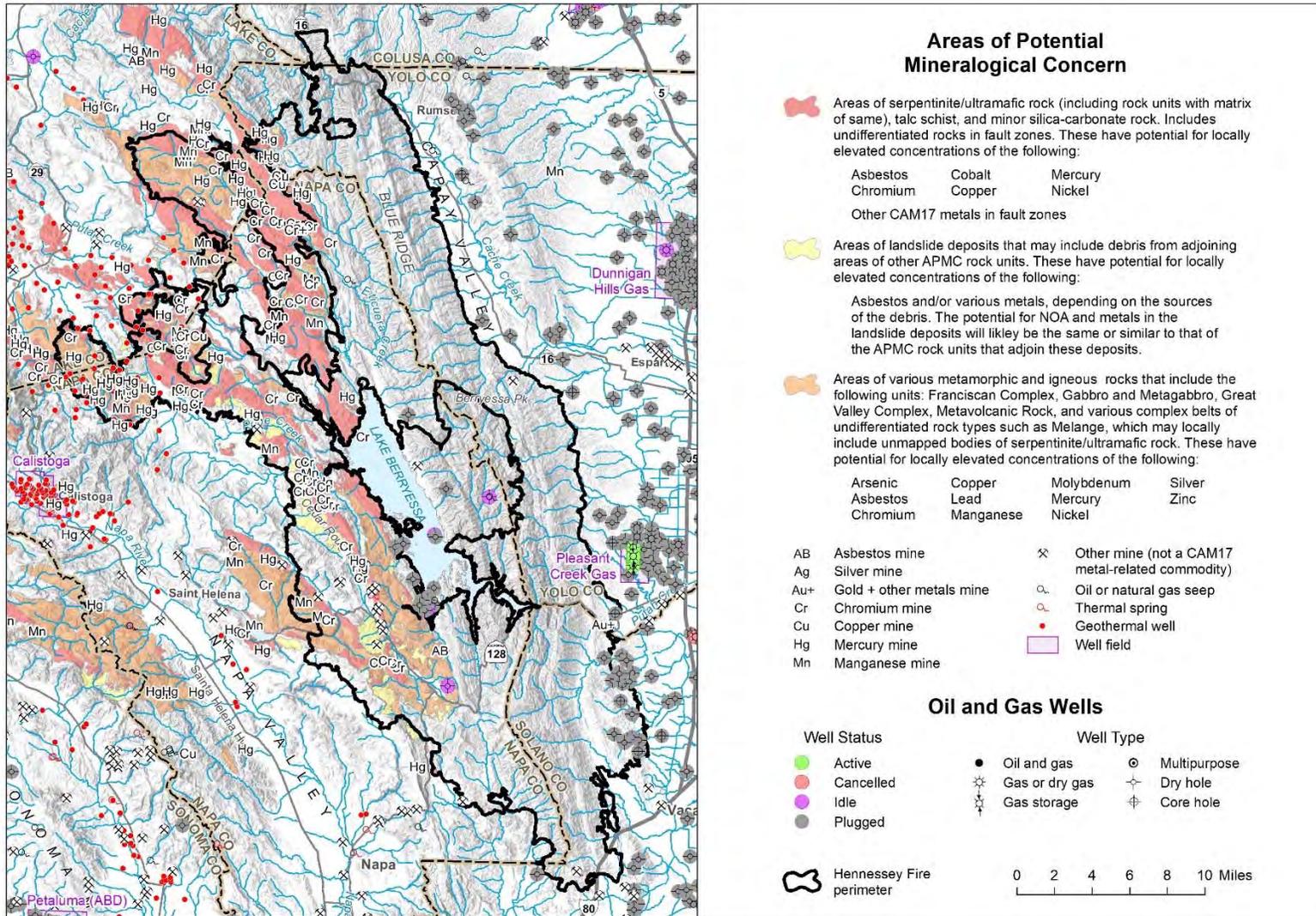
<http://pubs.usgs.gov/fs/2005/3014/>

<http://www.who.int/mediacentre/factsheets/fs361/en/>

<https://ww2.arb.ca.gov/resources/documents/naturally-occurring-asbestos-publications-maps>

https://westernmininghistory.com/mine_detail/10310645/

<https://www.mindat.org/feature-5373266.html>



Sources: Minerals, oil and natural gas seeps, thermal springs, and geothermal wells: Higgins, C.T. and Churchill, R.K., 2019, 2014, and 2010 (multiple reports). Preliminary Assessment of Potential for Mineral Hazards in California Department of Transportation Districts 1, 3, and 4 (respectively). California Geological Survey, internal technical reports prepared for the California Department of Transportation under Interagency Agreements Nos. 43A0311 and 43A0261. Mines: U.S. Geological Survey Mineral Resources Data System (MRDS). Oil and gas wells and well fields: CalGEM.

**Areas of Potential Mineralogical Concern
and Distribution of Oil and Gas Wells
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Figure 7. Mineral hazards map for the Hennessey Fire.

3. Development and Key Infrastructure

The Hennessey Fire burned on developed and undeveloped land within the Northern California Coast Ranges in Napa, Solano, Yolo, Lake, and Colusa counties. The burned area is located between the communities of Vacaville and Fairfield to the south and southeast, Winters and Guinda to the east, Middletown to the northwest, and Angwin and Napa to the west and southwest. Intermixed private, local, state and federally owned lands, including water supply reservoirs at Lake Berryessa, Lake Hennessey, Lake Solano, Rector Reservoir, Milliken Reservoir, and Lake Curry, are located within or downstream of the burned area. The entire Hennessey Fire burned area is surrounded by residential, commercial, agricultural, and recreational developments. Additional affected areas include various federal, state and regional parks, non-profit conservancies, and open space areas. Developments located downslope of and within moderate to steep, burned canyons and were a primary focus of the WERT.

Transportation Corridors

Interstate 80 (I-80) provides a major transportation route from the San Francisco Bay Area to the Nevada border, continuing east to New Jersey. The freeway was originally designated US 40 in 1926 and redesignated as part of the interstate system in 1964 during state highway renumbering. The northeast-southwest trending freeway alignment bisects Solano County between Fairfield and Vacaville. The freeway alignment crosses the southeastern Hennessey Fire burned area through the Cherry Glen and Lagoon Valley communities within the City of Vacaville. Major south and southeast-flowing drainages, including Suisun Creek, Soda Springs Creek, Laurel Creek, Laguna Creek, Alamo Creek, Ulatis Creek, and Gibson Canyon Creek flow under I-80 southeast of the Hennessey Fire boundary. Several other drainages appear to flow from the eastern portion of the burned area to I-80 within constructed channels, including Sweaney Creek and the Putah South Canal. Portions of the highway near the watercourse crossings are within areas designated as Zones A, AE and AO-Special Flood Hazard Areas by FEMA, which identifies areas subject to inundation by the 1-percent annual chance flood event (100-year flood) (<https://msc.fema.gov/portal/home>). Moderate and high soil burn severities observed within the headwaters of several of the drainages may result in higher than normal flows experienced at the highway crossings.

State Route 128 (SR 128) connects State Route 1 near the Mendocino coast to Interstate 505 near the Town of Winters in Yolo County. The alignment was originally State Route 28 and was redesignated as SR 128 in 1952. The SR 128 alignment bisects the Hennessey Fire burned area along the southern end of Lake Berryessa. The highway alignment is approximately perpendicular to the northwest-southeast trending ridgelines within the central and eastern fire boundary and appears to cross numerous burned drainages, including Wragg Creek, Cold Canyon, and Bray Canyon. Topography is generally moderate to the west, where the highway alignment follows portions of the Capell, Soda Creek, and Sage Creek valleys before travelling through Sage Canyon along the western Hennessey Fire boundary. Topographic relief increases to the east and rockfall hazards were observed where SR 128 traverses below steep slopes and near-vertical bedrock outcrops near Monticello Dam. The eastern alignment and portions of the western alignment of SR 128 within the

Hennessey Fire burned area are within areas designated as Zone A-Special Flood Hazard Areas by FEMA, which identifies areas subject to inundation by the 1-percent annual chance flood event (100-year flood). Monticello Dam along the southeastern corner of Lake Berryessa regulates water released into Putah Creek, minimizing flooding along the eastern alignment of SR 128. Low, moderate and high soil burn severities observed within catchments draining to SR 128 may result in higher than normal flows at the highway crossings.

The western alignment of State Route 16 (SR 16) connects State Route 20 (SR 20) near Rumsey to Interstate 5 near the Town of Woodland in Yolo County. The alignment was originally State Route 50 and was redesignated as SR 16 in 1964. The SR 16 alignment bisects the Capay Valley along the northeastern Hennessey Fire boundary and enters the northern tip of the Hennessey Fire burned area. Much of the highway alignment is located between burned northwest-southeast trending ridgelines to the west and Cache Creek to the east and appears to cross numerous burned drainages, including Rumsey Canyon, Hamilton Canyon, Palmer Canyon, Brooks Creek, and Salt Arroyo. Where SR 16 enters the northern tip of the burned area, it crosses Cache Creek and several tributary drainages. Steep slopes and near-vertical bedrock outcrops observed above SR 16 within the northern Hennessey Fire burned area indicate a pre-existing rockfall hazard. Portions of SR 16 within and downslope of the Hennessey Fire burned area are within areas designated as Zone A-Special Flood Hazard Areas by FEMA, which identifies areas subject to inundation by the 1-percent annual chance flood event (100-year flood). Low, moderate, and high soil burn severities observed within catchments draining to SR 16 may result in higher than normal flows at the highway crossings.

Interstate 505 (I-505) is a north-south oriented auxiliary freeway connecting Interstate 80 in Vacaville, Solano County, and Interstate 5 near Dunnigan in Yolo County. It was constructed to bypass the Sacramento metropolitan area and was designated in 1977. The I-505 alignment approximately parallels the eastern Hennessey Fire boundary through Winters. The freeway alignment crosses several large burned drainages, including Gibson Canyon Creek, Sweaney Creek, Putah Creek, Cottonwood Slough, Cache Creek, and numerous smaller drainages. Portions of I-505 downslope of the Hennessey Fire burned area are within areas designated as Zone A, AE and AO-Special Flood Hazard Areas by FEMA, which identifies areas subject to inundation by the 1-percent annual chance flood event (100-year flood). The primarily low soil burn severity, with patches of moderate and high soil burn severities, observed within catchments draining to I-505 may result in moderately higher than normal flows at the highway crossings. Flow along Putah Creek is regulated at Lake Solano upstream of the I-505 crossing, potentially minimizing flooding along the eastern alignment of SR 128 and I-505.

State Route 121 (SR 121) connects SR 128 near Lake Berryessa to State Route 37 near Novato in Marin County. The alignment was designated as SR 121 in 1963. The north-south SR 121 alignment bisects the western Hennessey Fire burned area southwest of Lake Berryessa. Topography is generally moderate along the alignment, where the highway alignment follows the Capell Creek Valley. Portions of SR 121 within the Hennessey Fire burned area are within areas designated as Zone A-Special Flood Hazard Areas by FEMA,

which identifies areas subject to inundation by the 1-percent annual chance flood event (100-year flood). Low and moderate soil burn severities observed within catchments draining to SR 121 may result in higher than normal flows at the highway crossings.

For more information about I-80, SR 128, SR 16, I-505 and SR 121 see:

<https://dot.ca.gov/>

Lake Curry

Lake Curry and associated critical water supply infrastructure for the City of Vallejo is located within the southern Hennessey Fire burned area. The lake was created in the mid-1920's by constructing a concrete dam at the confluence of Suisun Creek, Seven Acre Canyon, and Bull Canyon. The lake is owned the City of Vallejo and provides water to residents in rural Solano and Napa counties. The infrastructure includes the dam, a concrete and gated spillway and a system of pipes. During our review, it appeared between approximately 20 to 40-feet of freeboard was observed below the dam spillway. The observed low, moderate and high soil burn severities observed within the headwaters that drain to Lake Curry suggest that the lake and associated infrastructure are likely susceptible to increased sediment, debris, ash and flood flows. Although there appears to be significant available freeboard below the dam, evaluation of the potential for the dam to overtop appears prudent.

For more information about Lake Curry see:

https://www.cityofvallejo.net/city_hall/departments_divisions/finance/water_services

https://napavalleyregister.com/news/local/vallejo-reservoir-could-provide-recreation-water-for-napa-county/article_4083bbff-8662-5324-a80d-e91bba4941d8.html

<https://www.federalregister.gov/documents/2003/08/14/03-20708/lake-curry-water-supply-project-napa-and-solano-counties-ca>

Lake Hennessey

Lake Hennessey is located downstream of the western Hennessey Fire boundary and is the major water source for the City of Napa. It was formed in 1946 after completion of Conn Dam at the confluence of Conn Creek, Moore Creek, and Sage Canyon. The lake has a storage capacity of approximately 31,000 acre-feet and a watershed of approximately 35,000-acres. Critical infrastructure within the lake include Conn Dam, a concrete intake, a 36-inch diameter transmission line, a system of distribution pipes, and the Hennessey Water Treatment Plant. The observed low, moderate and high soil burn severities observed within the headwaters that drain to Lake Hennessey suggest that the lake and associated infrastructure is likely susceptible to increased sediment, ash and flood flows. Evaluation of the potential for the dam to overtop appears prudent.

For more information about Lake Hennessey see:

<https://www.cityofnapa.org/888/Lake-Hennessey>

<https://www.cityofnapa.org/580/Lake-Hennessey-Boating-Fishing>

Solano Project and Lake Berryessa

The Solano Project was developed in the 1940's and 1950's to deliver water stored in Lake Berryessa to 400,000 residents of Solano County. According to the Napa County water

resources web page, water is also provided to Napa County. Critical water supply infrastructure associated with the Solano Project that are located within the Hennessey Fire burned area include Monticello Dam (Lake Berryessa), a circular spillway (Glory Hole), Putah Diversion Dam (Lake Solano), and Putah South Canal. The construction of the Monticello Dam in 1958 along Putah Creek resulted in the formation of Lake Berryessa, which has a maximum storage capacity of approximately 1,600,000 acre-feet. Water is released from the dam into lower Putah Creek and into Lake Solano, where much of it is diverted into the Putah South Canal. The entire northern, western and southern portions of the lake are within the Hennessey Fire burned area. An approximately 6-mile stretch of the approximately 16-mile long eastern shore, from Scribner Mountain south to Dardon Canyon, is located outside of the Hennessey Fire boundary and is unburned. Several large burned drainages, including Putah Creek, Eticuera Creek, Butts Creek, Pope Creek, Capell Creek, and Wragg Creek, drain to Lake Berryessa. Lower Putah Creek below the dam is regulated, but at least two large burned catchments, Cold Canyon and Pleasants Creek, drain to lower Putah Creek and Lake Solano. Increased runoff resulting from low, moderate and high soil burn severities observed within the headwaters of burned catchments that drain to Lake Berryessa and the Solano Project area may result in higher than normal flows, including sediment, debris and ash, into Lake Berryessa and Lake Solano.

For more information about the Solano Water Project and Lake Berryessa see:

<https://www.scwa2.com/>

<https://www.scwa2.com/putah-creek/>

<https://www.scwa2.com/solano-project/>

<https://www.usbr.gov/projects/index.php?id=421>

<https://www.usbr.gov/mp/cca0/berryessa/>

<https://www.countyofnapa.org/1190/Water-Resources>

PG&E Substation

The Vaca-Dixon PG&E substation is located along Interstate 80 in Vacaville, downstream of the southeastern Hennessey Fire boundary. The substation was constructed in 1922 and was the largest substation at the time, and currently provides power statewide. The substation is located directly adjacent to Gibson Canyon Creek, which drains the southeastern Hennessey Fire burned area. According to Solano County staff, flood flows in December 2005 nearly inundated the substation. Concern was raised that increased runoff from the Hennessey Fire burned area would be enough to inundate the substation during large rain events. Based on the relatively low soil burn severity observed in the Gibson Canyon Creek headwaters within the southeastern Hennessey Fire boundary, moderate to large flow increases along Gibson Canyon Creek are not expected.

For more information about the Vaca-Dixon PG&E Substation see:

<https://www.pge.com/>

<http://wikimapia.org/11878066/Vaca-Dixon-Substation>

Milliken Reservoir

Milliken Dam was constructed along Milliken Creek, a tributary to the Napa River, in the 1920s. The resulting Milliken Reservoir is located approximately 5-miles northeast of the City

of Napa. The reservoir is a seasonal water source for the city, used during periods of high demand. The storage capacity of the reservoir is limited to 1,390 acre-feet due to a seismic evaluation by the state. Only approximately 800-acres (approximately 13-percent) of the 6,000-acre watershed above the reservoir is located within the southwestern Hennessey Fire burned area. Low and moderate soil burn severities observed within the tributary catchments may result in slightly higher than normal flows, including sediment and ash into the Milliken Reservoir. Evaluation of the potential for the dam to overtop appears prudent.

For more information about the Milliken Reservoir see:

<https://www.cityofnapa.org/924/Milliken-Reservoir>

Rector Reservoir

Rector Reservoir was formed by the construction of Rector Dam at the mouth of Rector Canyon, a tributary to the Napa River. The reservoir is located approximately 2 to 3-miles northeast of the Town of Yountville and is the primary water source for the town. A water treatment facility at the reservoir is owned and operated by the State of California Department of Veterans Affairs. Approximately 1600-acres (approximately 25-percent) of the approximately 6,500-acre watershed above the reservoir is located within the southwestern Hennessey Fire burned area. Low and moderate soil burn severities observed within the tributary catchments may result in moderately higher than normal flows, including sediment, debris and ash, into the Rector Reservoir. The reservoir is located just upstream of the Silverado Trail, a major thoroughfare through rural Napa Valley. Evaluation of the potential for the dam to overtop appears prudent.

For more information about the Rector Reservoir see:

<https://www.townofyountville.com/departments-services/public-works/water>

4. Modeling results

Soil Burn Severity

The Hennessey Fire burned area is characterized by a high proportion of very low to low soil burn severity (Table 4, Figure 8). Forty-three percent (43%) of the Hennessey burned area is composed of low soil burn severity, and thirty-six percent (36%) is very low/unburned. Twenty-one percent (21%) of the area burned at moderate severity and less than one percent (<1%) burned at high severity. Moderate and high soil burn severities indicate a high potential for post-fire watershed response. The highest portion of high and moderate soil burn severity is within the steep terrane of the Vaca Mountains in the southern portion of the burned area. Concentrations of moderate soil burn severity are in the northeastern and western portions of the burned area. The lowest soil burn severity, with virtually no identifiable moderate soil burn severity, is in the slopes above the southern Capay Valley and Lamb Valley on the eastern side of the burned area. Past discussions with Soil Scientists from the United States Forest Service have indicated that soils with higher clay content tend to have less heat penetration than sandier soils (*personal communication*, Brad Rust and Dave Young, USFS Soil Scientists). This may play a part in the lower soil burn severities observed in the Hennessey Fire, as soils in these areas generally have a relatively high clay content.

Table 4. Soil burn severity for the Hennessey Fire.

Hennessey Soil Burn Severity	Percent of Fire
High	0.5
Moderate	21.2
Low	42.7
Very Low/Unburned	35.6

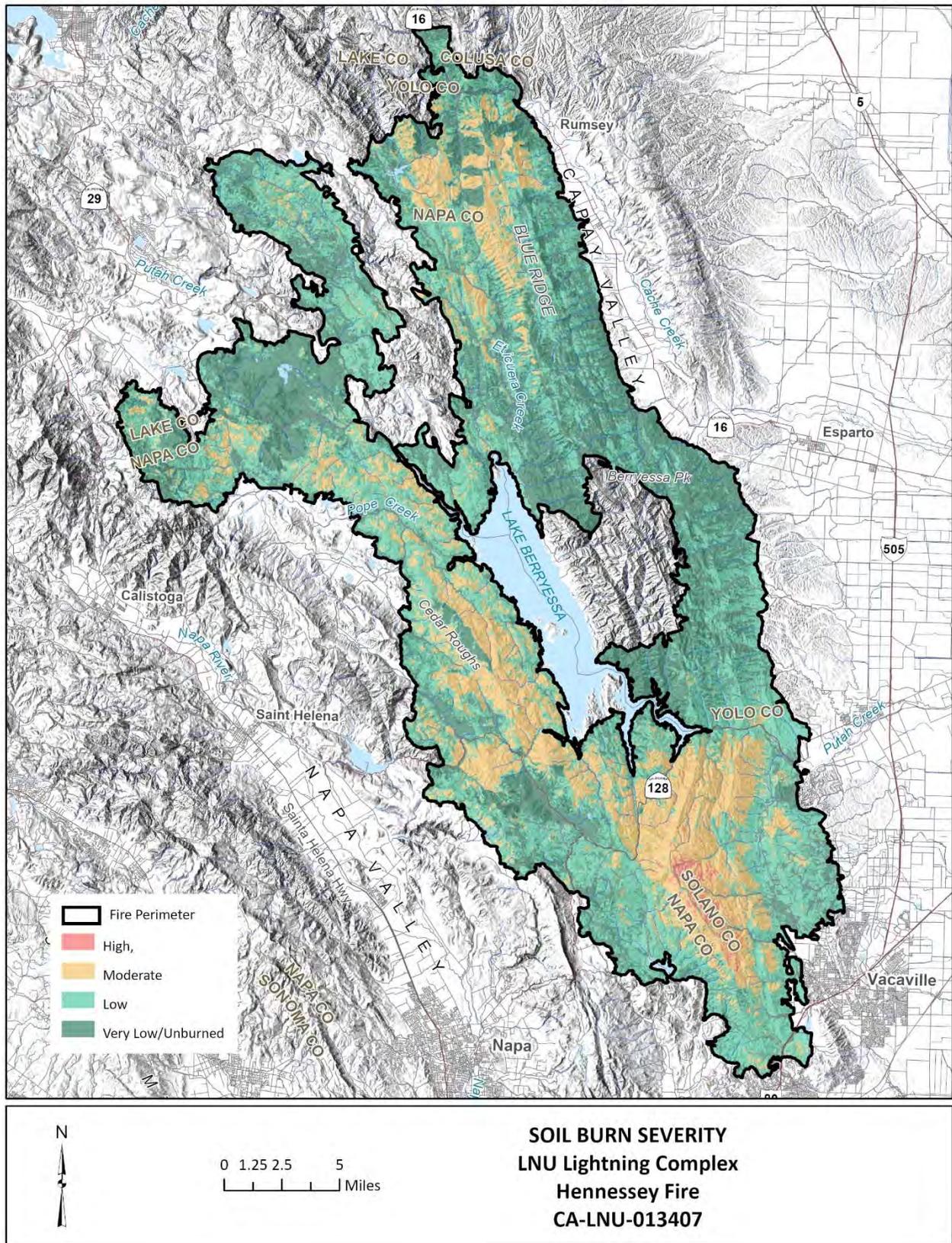


Figure 8. Soil burn severity map for the Hennessey Fire.

Post-Fire Hydrology

Twenty-one watersheds, or “pour points”, were selected to estimate potential post-fire peak flow increases to Values-at-Risk from flooding and sediment-laden flood hazards. Not all watersheds in the burned area are modeled for post-fire peak flow. Pour point locations are selected based on field and office observations to better understand post-fire flood response in areas that may have higher flood hazards to life, property, and infrastructure. Additional pour points can be modeled using the equations and methods in the 2020 WERT Draft Procedural Guide (CAL FIRE and CGS, 2020). Due to modeling uncertainties, absolute changes in flow volumes or peak magnitude from the Hennessey Fire are not provided; rather an estimate of peak flow response is displayed in Table 5 to make a more informed determination on flood hazards. Relative increases in peak flows from one drainage basin to another were judged to be most important for this rapid assessment, not estimated absolute values of the peak flows.

Pre-fire peak flow estimates were first produced for the 21 pour point watersheds by using the North Coast USGS Regional Regression Equation for a range of recurrence interval discharges (USGS StreamStats; Gotvald et al., 2012). Post-fire flow modifiers for the 21 pour point locations are provided in Table 5 and locations shown in Figure 9. Post-fire estimates were generated using a flow modifier method (Foltz et al., 2009). The modifier assumes a 100% flow increase (doubling of flows) for high and moderate soil burn severity and no change for low and very low/unburned soil burn severity. The modifier is then multiplied by a sediment bulking factor that is proportional to soil burn severity (Gusman, 2011) to produce a combined multiplier for that pour point watershed. The post-fire multiplier was then multiplied with a pre-fire 2 and 10-year recurrence interval discharge and compared with a range of pre-fire flows using the USGS Regional Regression Equation (i.e., 2, 5, 10, 25, 50, 100, 200, 500 recurrence intervals) to determine the predicted recurrence interval during a post-fire storm event. The Foltz et al. (2009) and Gusman (2011) methods are described in greater detail in the 2020 WERT Draft Procedural Guide (CALFIRE and CGS, 2020).

Generation of post-fire flow multipliers for the Hennessey Fire ranged from 1.0 to 2.7 (increase of 0% and 170%). The watersheds with the highest increase were Ulatis Creek and Cold Canyon, with a modifier calculated at 2.6 and 2.7, respectively (increase of 160% and 170%). These two watersheds have a higher percentage of moderate and high soil burn severity at 81% and 84.4%, respectively. It is estimated that a post-fire 10-year event in the Ulatis and Cold Canyon drainage would produce a 500-year pre-fire peak flow. The watershed with the lowest increase is Putah Creek where it enters Lake Berryessa. A modifier was calculated at 1.0 (very little increase) for Putah Creek. The Putah Creek watershed has the lowest percentage of moderate and high soil burn severity at 1.0%, and only 10.5% of the watershed was burned at low or very low/unburned soil burn severity.

Predictions of post-fire flood recurrence interval should be viewed in a relative sense, as the predicted recurrence interval may be underestimated and/or overestimated due to the use of the USGS Regional Regression Equations rather than local hydrologic analysis. In general, all post-fire peak flow predictions are subject to considerable uncertainty due the limited data available for post-fire hydrology at the watershed scale. These estimates are intended for

emergency response planning purposes only and are not to be used for design. Moreover, they are most appropriately applied to flows within the first year following the fire, or until ground cover within the burned area is well established.

Table 5. Estimated bulked post-fire flow multipliers and peak flow return interval based on a 2-year and 10-year recurrence interval storm for pour point watersheds shown in Figure 9.

Pour Point No.	Pour Point Watershed Name	Drainage Area (mi ²)	Percent Burned	Low, Very Low/Unburned SBS	Mod SBS	High SBS	Post-Fire Bulk Multiplier	Predicted 2-Year Recurrence Interval Peak Flow	Predicted 10-Year Recurrence Interval Peak Flow
1	Soda Springs Creek	3.7	65.5%	61.7%	3.8%	0.0%	1.2	2 - 5	10 - 25
2	Laguna Creek	2.7	89.9%	81.3%	8.6%	0.0%	1.3	2 - 5	10 - 25
3	Alamo Creek	5.7	91.3%	25.3%	56.4%	9.6%	2.3	5 - 10	200 - 500
4	Ulatis Creek	4.7	98.8%	17.8%	69.4%	11.6%	2.6	5 - 10	500
5	Miller Canyon Creek	7.7	99.1%	27.8%	58.7%	12.6%	2.5	5 - 10	200 - 500
6	Pleasants Creek	16.5	90.3%	37.0%	47.4%	5.9%	2.1	5	100 - 200
7	Dry Creek	16.1	27.4%	27.4%	0.0%	0.0%	1.1	2	10 - 25
8	Hamilton Creek	5.8	61.1%	41.0%	19.9%	0.2%	1.4	2 - 5	25 - 50
9	Lake Curry	15.9	89.7%	57.8%	30.8%	1.1%	1.7	2 - 5	50 - 100
10	Lake Hennessey	14.1	64.8%	36.4%	28.4%	0.0%	1.6	2 - 5	25 - 50
11	Eticuera Creek	54.0	50.9%	36.9%	14.1%	0.0%	1.3	2 - 5	10 - 25
12	Putah Creek	234.0	10.5%	9.5%	1.0%	0.0%	1.0	2 - 5	10
13	Pope Creek	78.2	32.6%	23.5%	9.1%	0.0%	1.2	2 - 5	10 - 25
14	Capell Creek	29.7	58.1%	38.1%	19.9%	0.1%	1.4	2 - 5	25 - 50
15	Encinosa Creek	2.8	89.1%	50.1%	38.8%	0.2%	1.8	2 - 5	50 - 100
16	Alamo Creek	19.0	66.7%	38.2%	25.6%	2.9%	1.6	2 - 5	25 - 50
17	Gibson Canyon Creek	0.7	60.1%	60.1%	0.0%	0.0%	1.1	2	10 - 25
18	Sweany Creek	3.2	79.8%	72.4%	7.4%	0.0%	1.3	2 - 5	10 - 25
19	English Creek	6.2	72.7%	68.4%	4.3%	0.0%	1.2	2 - 5	10 - 25
20	Pleasant Creek	2.2	81.8%	54.3%	27.5%	0.0%	1.6	2 - 5	25 - 50
21	Cold Canyon	6.3	99.4%	15.1%	82.6%	1.8%	2.7	5 - 10	500

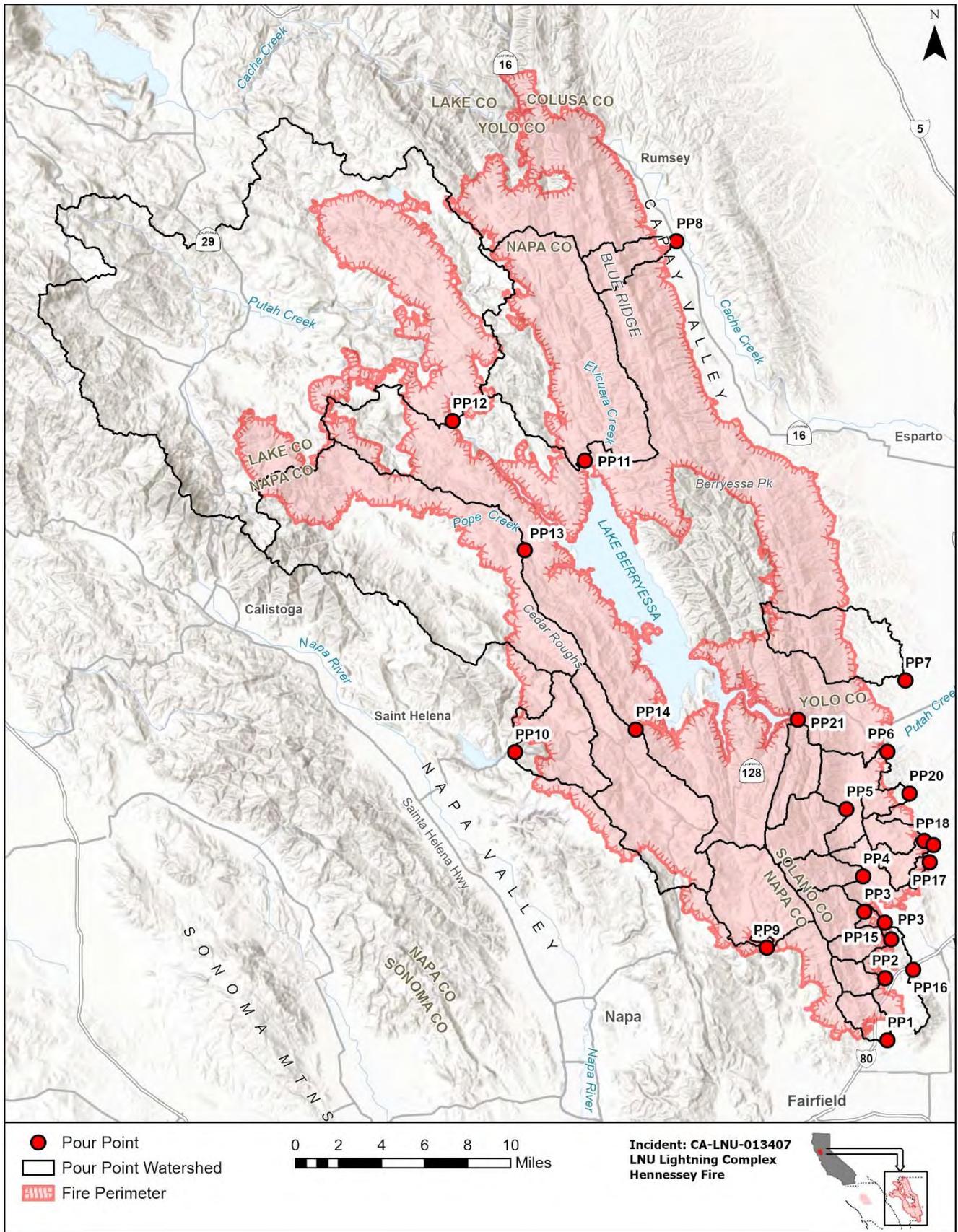


Figure 9. Hennessey Fire pour point watersheds.

Sedimentation and Potential Water Quality Impacts

Pre-fire sedimentation rates were investigated using the U.S. Department of Agriculture Soil Conservation Service's (now known as Natural Resource Conservation Service, NRCS) Sedimentation Data Summary, data sheet 72-14 for Catacoula Reservoir (USGS, n.d.). The small Catacoula Reservoir is located along Chiles Pope Valley Road and is the drainage to Maxwell Creek. Data from the NRCS revealed that approximately 1.6 acre-feet (2,581 yd³) of sediment accumulated over a 5-year period. Assuming a conversion factor of 0.81 short tons per cubic yard (Minear and Kondolf, 2009), this equates to 727 yd³/mi²/yr or 611 t/mi²/yr (0.95 t/ac/yr). This sedimentation rate for Catacoula Reservoir matches well with Minear and Kondolf's (2009) mean estimated sediment yield for reservoirs found in the California coastal region of 1.1 t/ac/yr.¹

Post-fire erosion rates for the Hennessey Fire area were calculated using the Erosion Risk Management Tool (ERMiT). See pages 35 through 37 for a description of the ERMiT modeling method and results. Based on the ERMiT modeling, the mean post-fire erosion rate is 5.5 t/ac for the first winter, assuming a 2-year storm event. First year post-fire surface erosion rates for the Hennessey Fire burned area are expected to be at least five times higher than pre-fire rates for this component of the LNU Lightning Complex.

Past post-fire studies in the California Coast Ranges suggest a considerable level of increased sedimentation for watersheds burned at higher severities. For example, Ritter and Brown (1972) reported that sediment yields increased significantly in Williams Reservoir following a 1961 wildfire that burned in the Los Gatos Creek watershed. Warrick et al. (2015) state that average sediment yields can increase by an order of magnitude within watersheds the first year following a wildfire in the Santa Ynez Mountain region, located to the south of this fire complex. Additionally, a post-fire sediment study conducted on Boggs Mountain Demonstration State Forest following the 2015 Valley Fire, primarily located in Lake County, has revealed sediment rates the first winter of 0.3 t/acre for low soil burn severity, 0.9 t/acre for moderate soil burn severity, and 6.2 t/acre for high soil burn severity for first order catchments in volcanic-derived soils (Olsen, 2016). Rates were higher the second year, but the relative differences between soil burn severities remained the same. Due to the lower level of soil burn severity for the watersheds draining to multiple reservoirs in the LNU Lightning Complex, post-fire surface erosion rates are expected to be lower.

Concerns regarding post-fire impacts to water quality and its effect on water treatment facilities are best addressed by further specific analysis by the responsible entity. Potential post-fire impacts to the reservoirs within and downstream of the Hennessey Fire can include elevated sediment and debris loading and turbidity, and increased concentrations in nitrates,

¹ Sedimentation rates were also investigated for Lake Berryessa. A detailed bathymetric survey conducted by the Solano County Water Agency in 2007 found 50,708 AF less than previously calculated. While the total calculated rate (2,839 yd³/mi²/yr or 3.6 t/ac/yr) appears to be relatively high over 50 years, the difference between the present and former area capacity curves was attributed to both a combination of sedimentation and the difference in technology used to derive the new curve. In general, the sedimentation was found to be minimal, but the new capacity curves did show a reduction in Lake Berryessa capacity due to more precise measurements (Kilkus, 2017). Minear (2010) lists a suspended sediment rate of 252 m³/km²/yr for upper Putah Creek upstream of Monticello Dam (data from 1962-1968), which is approximately 1.1 t/ac/yr.

phosphates, organic carbon, and trace metals that could place an added demand on water treatment systems. Previous data from the 1981 Atlas Peak Fire and its effect on water quality on the Milliken Reservoir water system (Cohen, 1982) can be used as a basis for determining the relative risk to water quality and water treatment facilities. For instance, the study indicated that turbidity increased by more than a factor of twenty (20) when discharge in upper Milliken Creek increased from approximately 100 to 700 cfs. Data from the thesis also indicated that turbidity in Milliken Reservoir and the reservoir outlet remained elevated, even after upper Milliken Creek turbidity recovered. This basic pattern was consistent for other water quality constituents, such as nitrate and nitrite (Cohen, 1982). Intense wildfire has been found to significantly increase nitrogen loads in stream water in southern California, where post-wildfire concentrations of nitrogen in streams as soluble nitrate have been found to exceed drinking water standards (Meixner and Wohlgemuth 2004), but that was not the case for Milliken Reservoir after the 1981 Atlas Peak Fire (Cohen 1982).

More recently, Uzun et al. (2020) reported that the watersheds burned in the 2015 Rocky and Wragg fires showed rapid water quality degradation from elevated levels of turbidity, color, and suspended solids, with greater degradation in the more extensively burned watershed. During the first year's initial flushes, concentrations of dissolved organic carbon (DOC), dissolved organic nitrogen (DON), ammonium ($\text{NH}_4^+/\text{NH}_3$), and specific ultraviolet absorbance (SUVA₂₅₄) were significantly higher in the more extensively burned watershed compared to the reference watershed. These elevated values gradually declined and finally returned to levels like the reference watershed in the second year.

Impacts to Lake Hennessey, located approximately 1.5 miles downstream and outside of the western boundary of the fire, are expected to be minimal, since less than 30 percent of the watershed upstream of the reservoir burned, and the Conn Creek watershed, a major tributary, was unburned. However, the City of Napa should consider conducting a detailed hydrologic evaluation of the potential post-fire impacts, including evaluating possible mitigation measures designed to minimize the potential for debris and ash to impact the water supply. For example, a floating containment system was installed in Milliken Reservoir to limit the entry of organic debris resulting from the 2017 Atlas Fire, as well as to lessen the chance of damage to the dam from large floating debris. Evaluation by the City of Napa as to whether a similar barrier system or other measures are appropriate for the Lake Hennessey watershed appears prudent.

As noted above, a number of water supply reservoirs have the potential to be affected by post fire impacts including elevated flows, sediment, and debris including ash and organic byproducts that may negatively affect water supply and reservoir operations. Evaluation of measures to limit impacts to these water supply reservoirs is prudent.

Post-Fire Debris Flows and Volumes

The USGS post-fire debris flow hazard model estimates the likelihood, potential volume, and combined hazard of debris flows at both the drainage basin scale and along stream segments within each basin. The combined hazard is considered as the combination of both probability and volume. This concept is illustrated in Figure 10, which shows how the likelihood of a debris flow and the predicted debris flow volume are used to assign an ordinal combined hazard ranking of either low, moderate, or high.

Combined Hazard Matrix		Debris Volume (m ³)			
		<1,000	1,000 - 10,000	10,000-100,000	>100,000
Likelihood of Debris Flow	0-20%	Low		Moderate	
	20-40%				
	40-60%			High	
	60-80%				
	80-100%				

Figure 10. The combined debris flow hazard classification as a function of predicted debris flow probability and debris volume production. Colors in yellow, orange, and red represent a combined debris flow hazard of low, moderate, and high, respectively.

The model estimated the 15-minute threshold rainfall intensity for triggering post-fire debris flows for the Hennessey Fire to be 37 mm hr⁻¹ (1.46 in hr⁻¹) at the basin scale. This threshold represents the median rainfall intensity at which there is a 50 percent probability of debris flow initiation. For reporting purposes, we utilized model outputs from a 15-minute rainfall intensity of 36 mm hr⁻¹ (1.42 in hr⁻¹) because model outputs for an intensity of 37 mm hr⁻¹ were not provided. For most of the Hennessey Fire area, The 36 mm hr⁻¹ storm generally represents a 2-year to 5-year recurrence interval 15-minute storm event using data from the NOAA Atlas 14 website (https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html); however, within portions of the northernmost burn (roughly north of Lake Berryessa), the 36 mm hr⁻¹ storm generally represents a 5-year to 10-year recurrence interval 15-minute storm event using the NOAA Atlas 14 website.

Figures 11, 12, and 13 show the estimated likelihood, potential volume, and combined debris flow hazard for the 36 mm hr⁻¹ (1.46 in hr⁻¹) storm, respectively. These maps indicate that the combined debris flow hazard is primarily moderate to high for the selected rainfall intensity along Blue Ridge in the northernmost and southern portions of the burned area, near Wragg Ridge in the southern burned area, and the Cedar Roughs in the western portion of the burned area. Elsewhere, these maps generally show that the combined debris flow hazard is moderate to low for the selected rainfall intensity. The VAR maps in Appendix C show combined debris flow hazard in response to the 36 mm hr⁻¹ (1.46 in hr⁻¹) storm event.

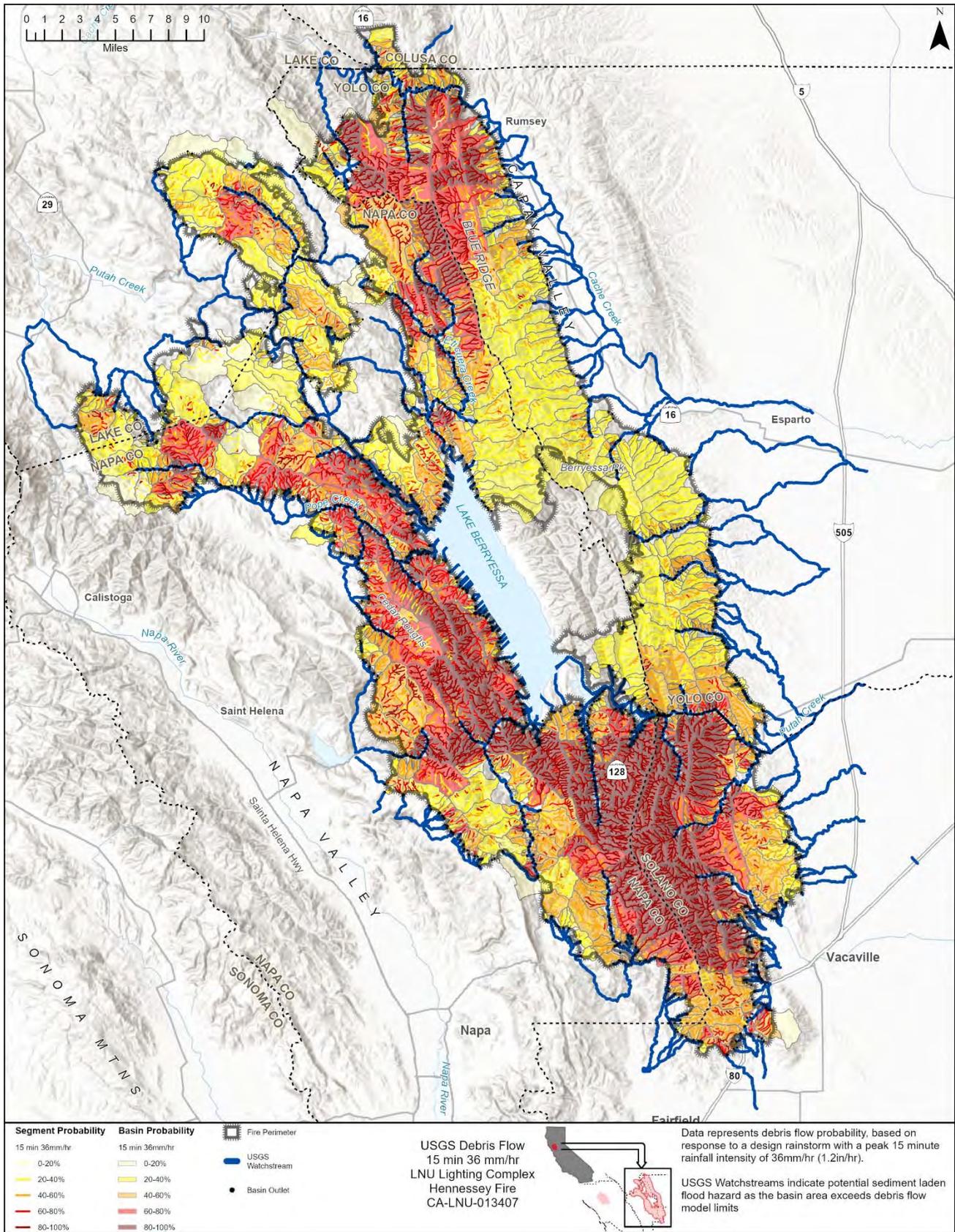


Figure 11. USGS debris flow model results for the Hennessey Fire. Debris flow probability, 36 mm/hr storm event.

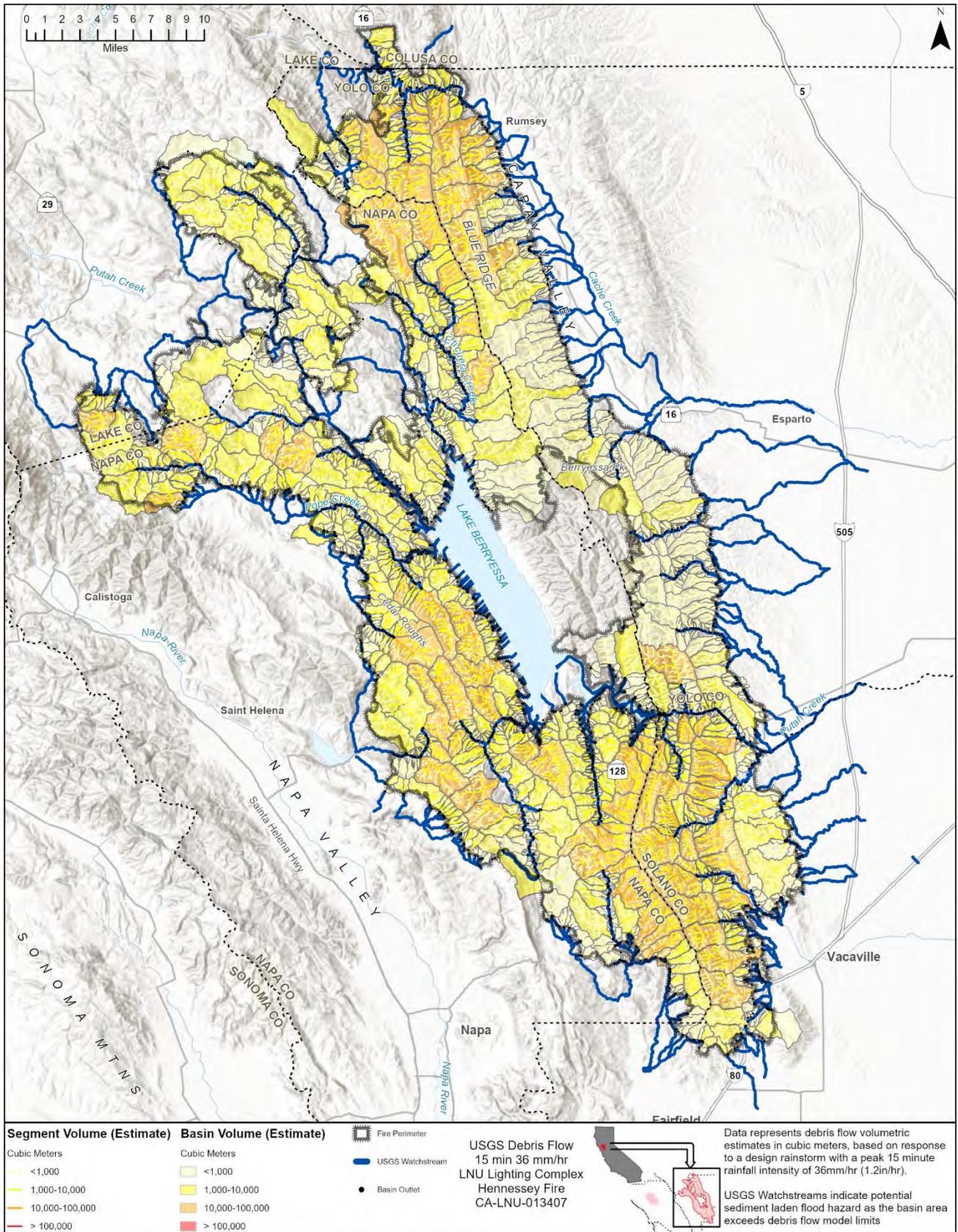


Figure 12. USGS debris flow model results for the Hennessey Fire. Debris flow volume, 36 mm/hr storm event.

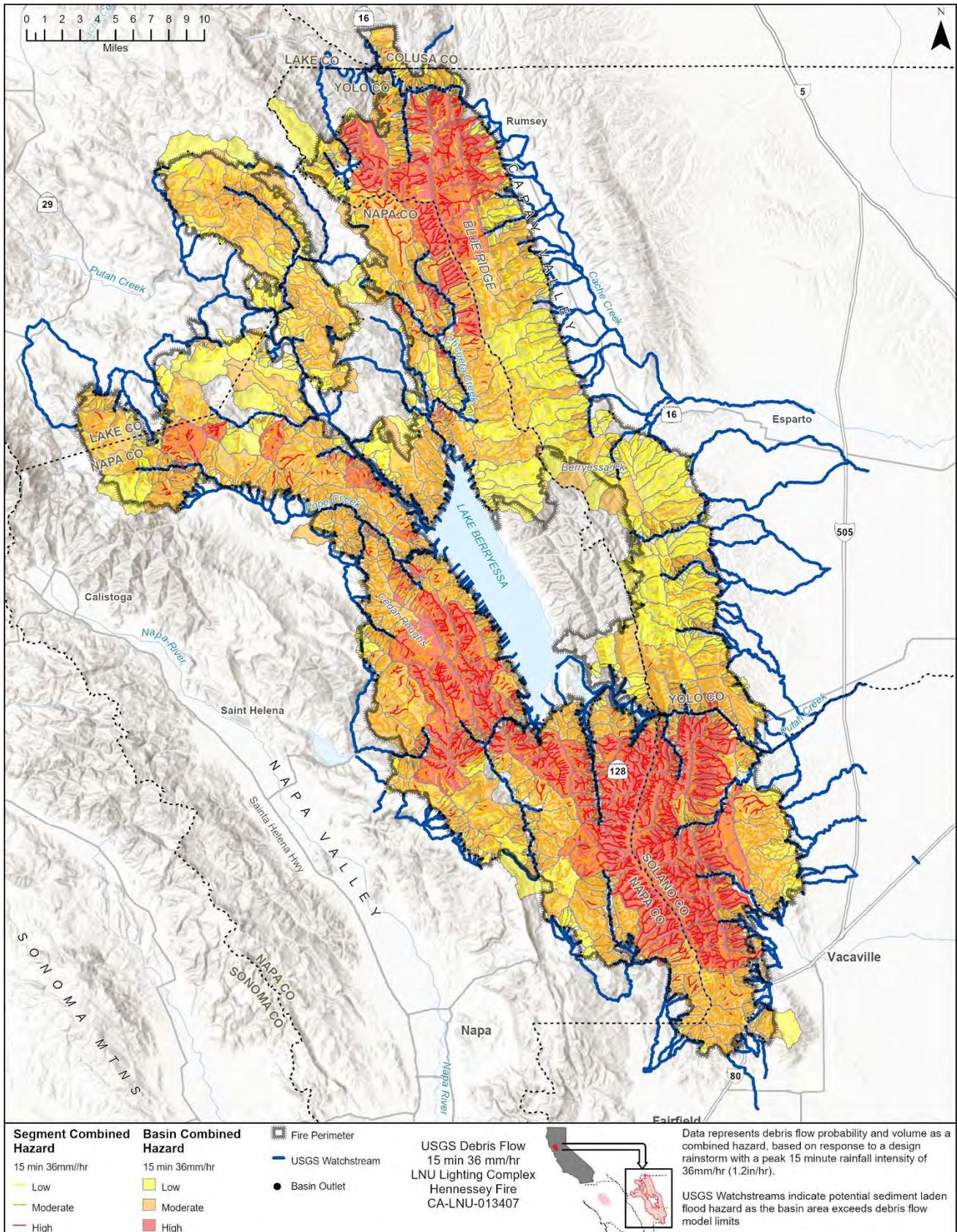


Figure 13. USGS debris flow model results for the Hennessey Fire. Combined hazard, 36 mm/hr storm event.

Post-Fire Surface Erosion

Post-fire erosion rates for the Hennessey Fire area were calculated using the ERMiT (Erosion Risk Management Tool). The ERMiT model predicts primarily minor increases in post-fire surface erosion rates for the 50-percent exceedance (2-year) probability storm event during the first wet season following the fire (Figure 14). Localized moderate and high surface erosion rates generally consist of hillslopes with steeper slopes and/or areas burned at moderate to high soil burn severity, and are associated with slopes along Blue Ridge in the northernmost and southern portions of the burned area, slopes draining to Chiles Valley, and south facing slopes above Pope Valley. The lowest predicted post-fire surface erosion rates are associated with portions of the lower Eticuera Creek, upper Butts Creek, and eastern Lake Berryessa watersheds. Areas of highly erodible soils that were unmapped in the Soil Survey Map Unit may exhibit elevated erosion rates due to fire impacts and the loss of surface cover, and may not be captured by modeling.

Model Uncertainties

The models do not consider in-stream storage of material available to be mobilized in a debris flow or existing loose material on slopes that can contribute to bulking flows. The bulked peak flows discussed could significantly underestimate stream response if significant amounts of sediment are available for transport during high flow conditions.

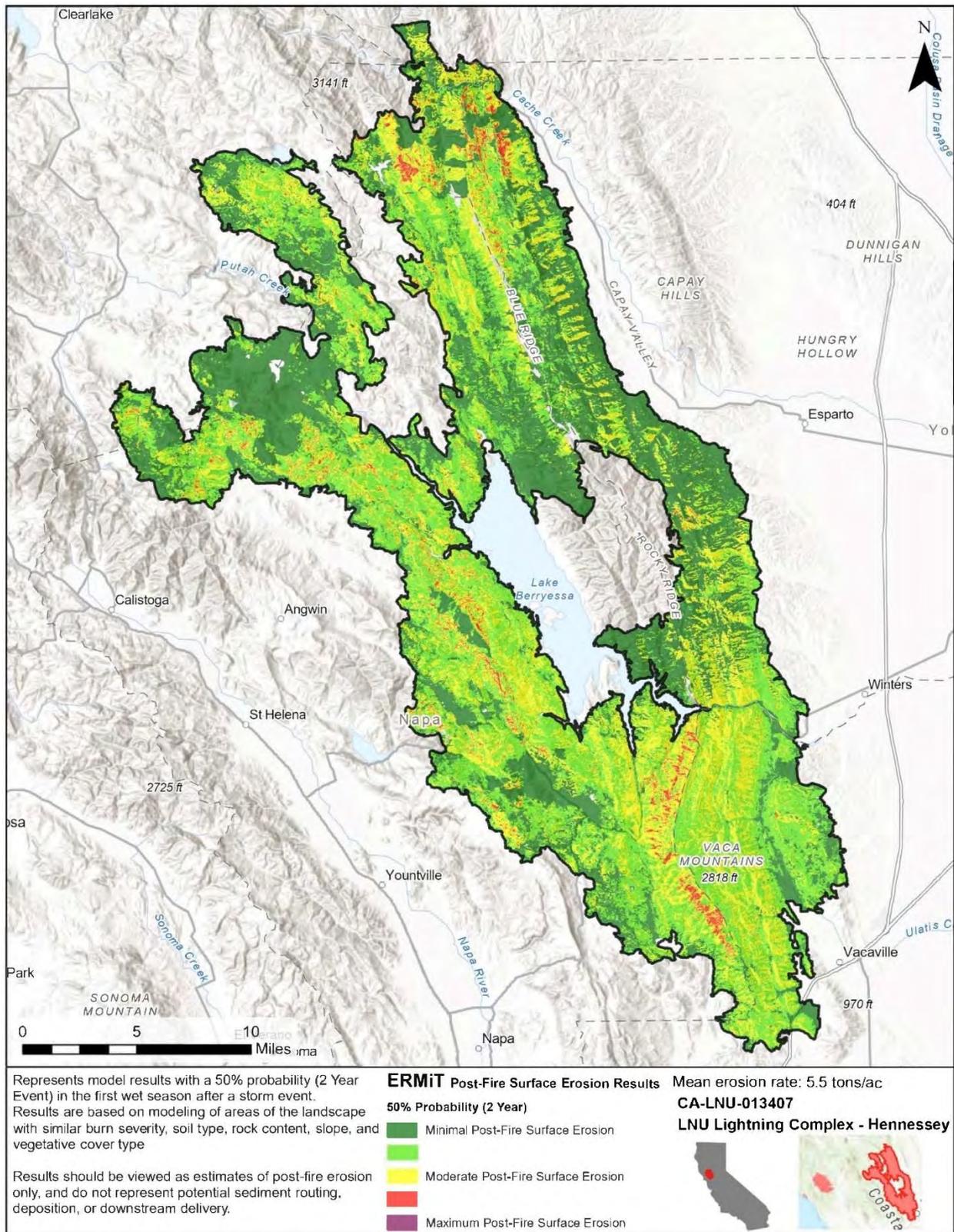


Figure 14. Hennessey Fire predicted surface erosion rates for the 2-year recurrence interval storm event using the Erosion Risk Management Tool (ERMIT).

5. VAR Observations and Recommendations

Potential Values-at-Risk (VARs) are grouped into eleven areas defined by geographical communities, watershed boundaries, and facilities and critical infrastructure (Figure 15). General observations and recommendations for each of these areas are provided below. More detailed observations are provided in the VAR summary table (Appendix B) and VAR locations are displayed in Appendix C. VAR-specific maps and information are provided on information sheets in Appendix D. Furthermore, spatial data of Values-at-Risk can be requested in the form of shapefiles from the WERT team lead.

This evaluation is not intended to be comprehensive and/or conclusive, and additional VARs may be identified through more detailed evaluation by responsible agencies.

Several limitations include:

- Flood hazard mapping was not complete or non-existent in several areas.
- Not all roadway culverts and bridges in and adjacent to the burned area were evaluated.
- Some potential VARs were not evaluated, or evaluated from a distance, because of the lack of access.
- Hazards on alluvial fans could not be represented as single-points given the potential for avulsion and flow-path uncertainty. Alluvial fan VARs are generally presented as polygons or included in FEMA and DWR flood and awareness zones. FEMA and DWR flood maps do not exist for all drainages or alluvial fans.
- VAR evaluation was not conducted within all mapped flood hazard areas that are downstream of the burn perimeter. Risk of flooding in these areas is preexisting and is anticipated to be increased by post-fire runoff. As such, local agencies should consider these mapped hazard areas in addition to the VARs identified in this report.

This report serves as a preliminary tool to assist emergency responding agencies (e.g., Napa, Solano, Yolo, Colusa, and Lake counties, Cities of Napa, Fairfield, Vacaville, and Vallejo, Town of Yountville, local fire departments, Caltrans, Office of Emergency Services, water supply agencies, utility companies, and other responsible agencies) in the development of more detailed post-fire emergency response plans and assessments.

It is intended that the responsible agencies will use the information presented in this report as a preliminary guide to complete their own more detailed evaluations and develop detailed emergency response plans and mitigations. These agencies may identify additional VARs through their more detailed evaluations.

General Discussion

Unstable slope conditions are apparent within the Hennessey Fire burned areas upslope of residential, commercial, agricultural, and recreational developments within the eleven geographical communities. Teams observed post-fire dry ravel and existing areas of

alluvial/colluvial deposits within and below the mouths of steep drainages, along the steep canyon headwalls, and on side slopes upstream of the residential, commercial, agricultural and recreational areas. While material observed within the communities and agricultural areas downstream of the Hennessey Fire burned area generally appeared fine-grained, alluvial deposits of cobble- to boulder-sized rocks are present within and at the outlets of steep canyons, including Gates Canyon, Mix Canyon, Miller Canyon, Cold Canyon, Wragg Canyon and numerous smaller tributary drainages. These observations suggest the presence of preexisting flood, hyperconcentrated flow, and debris flow hazards. We observed recent deep-seated landslides, as well as small-scale rock fall, shallow landslides in steep headwalls and along steep streamside slopes that further confirm active slope instability within the burned area. These landslides also provide material to stream channels during heavy precipitation that can be mobilized by subsequent flood and debris flows. The northwest-southeast trending Bartlett Springs Fault Zone and several smaller associated faults bisect the Hennessey Fire burned area along the western bank of Lake Berryessa (Jennings and Bryant, 2010). The northern splay of the Bartlett Springs Fault Zone is considered active by the State of California. In addition to storm events, landsliding and rockfall may also be triggered by strong ground shaking associated with earthquakes on nearby faults, providing another source of material in channels to be mobilized during flood, hyperconcentrated flow and debris flow events.

The drainage channels downslope of the Hennessey Fire burned area are heavily modified by infrastructure, including roads, drainage structures, basins and dams in adjacent communities, including the Cities of Napa, Fairfield, Vacaville, and Vallejo, and the Town of Yountville. This report characterizes the potential Values-at-Risk observed within each of the communities and/or geographical areas and adjacent to critical infrastructure.

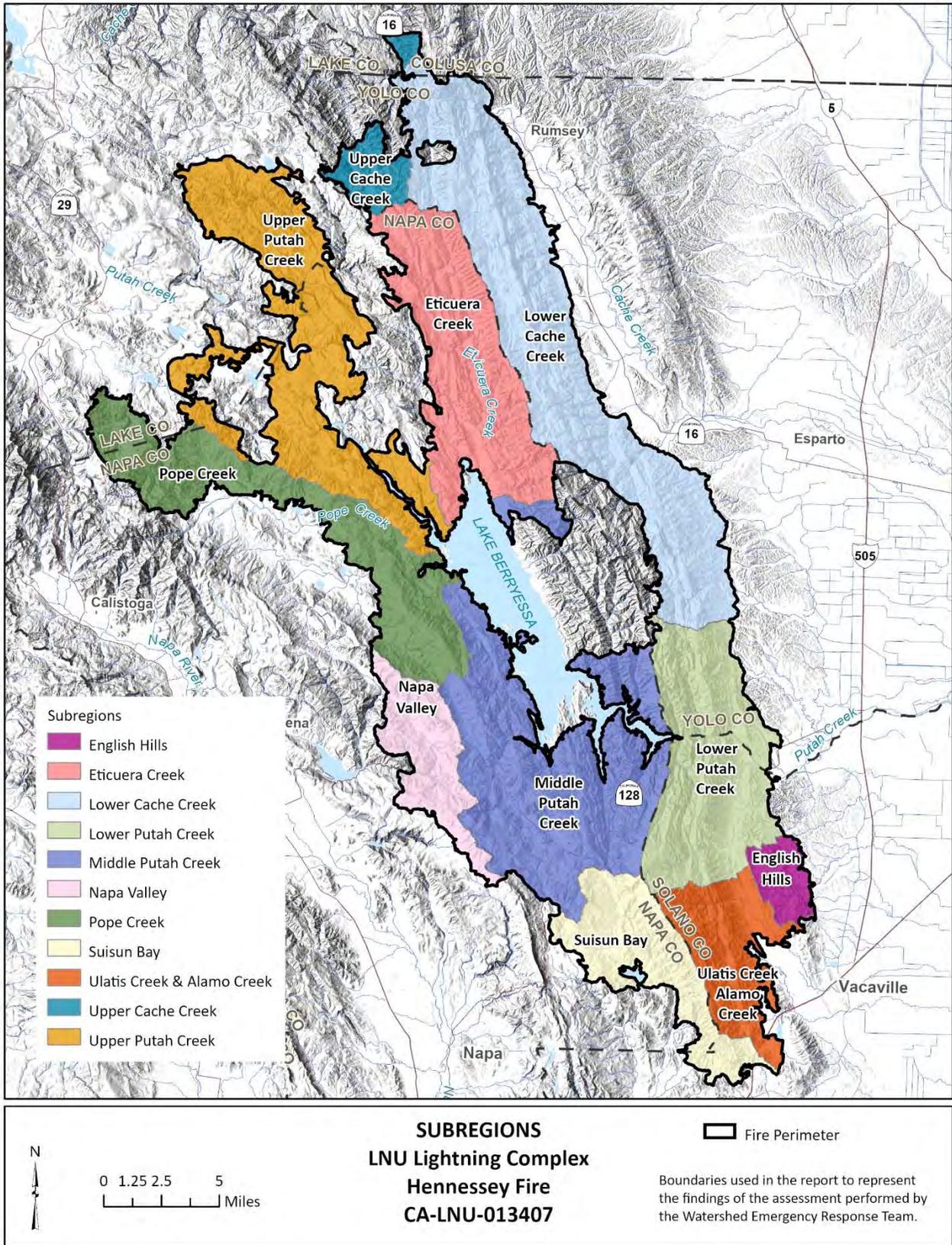


Figure 15. Boundaries used to define areas for more detailed descriptions of Values-at-Risk.

English Hills

Observations

The area within and downslope of the Hennessey Fire burned area within the English Hills assessment area is a source of potential hazards to downslope residents, property, and infrastructure. The Dry Arroyo, Sweany Creek, English Creek, and Gibson Canyon Creek catchments drain the burned area eastward into developed and/or modified waterways in the Central Valley geomorphic province downslope of the burned area. The Pleasant Creek watershed, which appears similar to the English Hills basin based on landscape characteristics, was evaluated separately as part of the Lower Putah Creek subregion. Slopes within the English Hills assessment area primarily burned at very low to low soil burn severity, with an isolated patch of moderate soil burn severity within the Sweany Creek catchment.

Regional geologic mapping (Wagner and Bortugno, 1982; Wagner et al., 1981) characterizes the geologic units underlying the western portions of the English Hills assessment area as Eocene-age Markley Sandstone, which consists of marine sandstone; while the eastern portions are underlain by Pliocene-age Tehama Formation, which is described as sand, silt, and volcanoclastic rocks. Northwest-trending lenses of the Putah Tuff member are mapped within the Tehama Formation. Near the eastern boundary of the burned area, Sweany Creek, English Creek, and Gibson Canyon Creek open into broad, flat alluvial plains where the Tehama Formation is mantled with surficial deposits of Quaternary alluvium. Additionally, regional landslide mapping by Majmunder (1989) and Dwyer et al. (1976) identifies several relatively large rockslides and numerous small landslides within the English Hills portion of the burned area.

The slopes in the English Hills assessment area are generally gentle to moderate, with lower relief than many other portions of the burned area. However, locally steep slopes are generally associated with unstable slope conditions that are apparent within the assessment area. Review of LiDAR imagery shows probable relatively large earthflows and smaller debris slides scattered throughout the assessment area, which suggests active hillslope processes in the area in the absence of fire. These processes can provide material to stream channels that can be mobilized by subsequent flood flows, hyperconcentrated flows, and debris flows. USGS debris flow modeling on the slopes within the English Hills assessment area indicates that 4 of the 20 modeled drainage basins exhibit debris flow probabilities of 40 to 60-percent or greater (using a threshold of a 15-minute duration at 36 mm hr⁻¹ rainfall rate) within the burned portions of these drainages (Figure 11).

The English Hills drain eastward into relatively flat, moderately developed portions of the Central Valley geomorphic province. We noted mapped FEMA Special Flood Hazard Areas downstream of the burned area along Sweany Creek, Gibson Canyon Creek, and Dry Arroyo. Additionally, DWR Awareness Floodplains are mapped extending further upstream into or near the burned area along Dry Arroyo, Sweany Creek, English Creek, Gibson Canyon Creek, and several unnamed tributaries. Solano County Water Agency (SCWA) staff report that Sweany Creek is a flood prone watershed that routinely floods rural residents in the Allendale area downstream of the burned area. As well, SCWA staff report that Gibson

Canyon Creek nearly flooded the PG&E Vaca-Dixon electrical substation (located downstream of the burned area) in December 2005. These observations support the presence of a preexisting flood hazard in the absence of fire.

Numerous residential and agricultural structures are located within and downstream of the English Hills subregion of the burned area. Within and immediately downstream of the burned area, these structures are primarily located along ridgelines and away from watercourses; however, several structures are located within or near DWR Awareness Floodplains. Additionally, numerous structures appear to be located within the FEMA Special Flood Hazard Area more than 1¼ mile downstream of the burned area. We did not specifically evaluate the risks associated with flooding in the built environment downstream of the burned area.

No Values-at-Risk were identified within and downslope of the English Hills assessment area; however, structures located within or near mapped DWR Awareness floodplains and FEMA Special Flood Hazard Areas may be at increased flood risk. Given the relatively small catchment areas and generally low soil burn severities in the English Hills assessment area, though, we anticipate relatively low increases to rock fall and post-fire flood flows due to the fire.

Recommendations

- Cleanout and monitor culverts, basins, and drainage structures prior to, during and after large rain events where they cross residential streets.
- Monitor areas downslope of the English Hills subregion burned area, including but not limited to residential and agricultural developments along Gibson Canyon Creek, English Creek, Sweany Creek, and Dry Arroyo, which may be subject to increased inundation during significant storm events.
- Evaluate the potential for installing diversion stormwater control structures, including sand bags and/or concrete K-rails, along stream banks and around residences where high flood flows are predicted along drainages.
- Utilize existing early warning systems, linked to up-to-date storm information.
- Consider the use of temporary signage in areas of increased flood and rockfall hazards.
- Consider the use of appropriate professionals to review and design additional engineered mitigations not provided in this report.
- Consider the applicability of constructing diversion structures where flood flow channels may adversely impact residential and agricultural development or restrict residential access roads where flooding is anticipated during predicted high intensity rain events. Site specific mitigations and containment and diversion structures should be designed by licensed professionals specializing in geotechnical engineering, soil erosion, and engineering geology.
- Provide English Hills assessment area residents and businesses with this information so they may understand their proximity to hazard areas and take appropriate actions.

Eticuera Creek

Observations

The area within and downslope of the Hennessey Fire burned area within the Eticuera Creek assessment area is largely undeveloped but is a source of potential hazards to downslope property and infrastructure. Small unnamed catchments drain into Eticuera Creek which ultimately drains south into Lake Berryessa. Slopes in the northern area of the Eticuera Creek watershed burned at primarily low to moderate soil burn severity while slopes in the southern half of the watershed generally burned at very low to low severity. Slopes southwest of Berryessa Knoxville Road have areas of moderate soil burn severity within steeper slopes near the top of catchments. Recreational and residential developments and infrastructure within and downslope of the Eticuera Creek portion of the burn are accessed from SR 128 via Berryessa Knoxville Road, East Side Road, and unnamed native surfaced roads.

Regional geologic mapping (Wagner and Bortugno, 1982; Wagner et al., 1981) characterizes the geologic units underlying the Eticuera Creek portion of the burned area as Mesozoic- to early Tertiary-age marine, fluvial, and volcanic rocks. Marine sandstone, shale, mudstone, siltstone, and conglomerate of the Lower Cretaceous-Upper Jurassic to Upper Cretaceous-age Great Valley Sequence underlie the majority of the Eticuera Creek area. The westernmost extent of the Eticuera Creek watershed is underlain by the Jurassic-age Coast Range Ophiolite, which includes serpentized ultramafic rocks with lenses of gabbro and basalt. Small deposits of Tertiary-age Clear Lake Volcanics exist in the northwestern portion of the Eticuera Creek watershed. Continental fluvial deposits of the Tertiary-age Glen Ellen formation and undifferentiated alluvial deposits line the shores of Lake Berryessa within the assessment area. Field observations and remote reconnaissance support regional landslide mapping by Dwyer et al. (1976) within the Eticuera Creek burned area.

USGS debris flow modeling on the slopes within the Eticuera Creek assessment area indicates that 176 of 249 modeled drainage basins exhibit debris flow probabilities greater than 40 percent (using a threshold of a 15-minute duration at 36 mm hr⁻¹ rainfall rate) within the burned portions of these drainages (Figure 11).

Berryessa-Knoxville Road and portions of the Knoxville Wildlife and Recreational Areas within the Eticuera Creek area of the Hennessey burned area are designated as Zone A-Special Flood Hazard Areas by FEMA. Structures located within these areas are subject to inundation by the 1-percent annual chance flood event. The same structures may also be subject to increased potential for inundation because of the post-fire soil effects of the low, moderate and high burn severity in the watersheds draining to Eticuera Creek. The magnitude of the hillslope response will be increased by the post-fire changes to hydrology and soil properties. Overnight and day-use access to Knoxville Wildlife and Recreational Areas should be restricted during predicted significant storms events. The Knoxville Wildlife headquarters (VAR-05) are comprised of several structures adjacent to FEMA designated flood zones and constitute a moderate risk to property, as post-fire runoff will likely be increased for the next 3-5 years.

Portions of the residential development downslope of the burned area is located on stream alluvium, stream terrace and alluvial fan deposits within the catchments or along wide gently

sloping alluvial fans downslope. Alluvial fans are gently sloping and convex radial depositional landforms located below the mouths of confined canyons. A channel avulsion is the process by which flow is diverted out of an established channel into a new course on the alluvial surface. Many of the fan surfaces observed within the Hennessey Fire boundary are graded and developed, partly disguising the shape of the fan surfaces and making the evaluation of potential avulsion paths unpredictable. This includes areas outside of active channel network delineated by FEMA 100-year flood zones. Debris flows and hyperconcentrated flows originating in watersheds upslope of residential and agricultural areas can flow downslope across roads and through the communities and impact the low-lying residential areas as sediment and debris laden floods. Unmaintained drainage structures in residential developments, including low bridges, culverts, debris basins, confined constructed channels and at-grade, low water road crossings, can become overwhelmed and trigger in-channel avulsion (i.e., the rapid shifting of channel location) and overbank flooding during storm events. Unmaintained drainage structures near residential developments, including low bridges, culverts, debris basins, confined constructed channels and at-grade, low water road crossings, can become overwhelmed and trigger in-channel avulsion (i.e., the rapid shifting of channel location) and overbank flooding during storm events.

Recreational structures and infrastructure observed downslope of the steep slopes and debris flow drainages were identified as Values-at-Risk. One VAR (VAR 05) was found within and downslope of the Eticuera Creek portion of the burned area, including a polygon encompassing several individual structures. The VAR was determined to constitute a moderate risk to property resulting from the structures being located downstream of the mouths of flood flow-prone catchments.

Recommendations

- Cleanout and monitor culverts, basins, and drainage structures prior to, during and after large rain events where they cross residential streets.
- Perform storm infrastructure monitoring during large rain events to ensure drainage structures are functioning along commercial and residential roads, including but not limited to SR 128, Berryessa-Knoxville Road, East Side Road, and residential side streets.
- Monitor areas downslope of the Eticuera Creek burned area, including but not limited to, residential and recreational developments along Berryessa-Knoxville Road, East Side Road, and local side streets subject to increased inundation during significant storm events.
- Evaluate the potential for installing stormwater control structures, including sand bags and/or concrete K-rails, along stream banks and around properties where high flood flows and debris flows are predicted along drainages.
- Utilize existing early warning systems, linked to up-to-date storm information.
- Consider the use of temporary signage in areas of increased flood and rockfall hazards.
- Consider closure of recreational areas, including trails, day-use areas and campgrounds, prior to and during predicted intense storms located within flood-prone

areas, and at the base of steep canyons and steep side slopes that may be subject to hyperconcentrated or debris flows, floods and/or rockfall hazards, including but not limited to Knoxville Recreation Area (VAR 05) and public parks located within identified flood zones by FEMA.

- Consider the use of appropriate professionals to review and design additional engineered mitigations not provided in this report.
- Consider the applicability of constructing diversion structures where debris and flood flow channels may adversely impact residential and agricultural development or restrict residential access roads where flooding is anticipated during predicted high intensity rain events. Site specific mitigations and containment and diversion structures should be designed by licensed professionals specializing in geotechnical engineering, soil erosion, and engineering geology.
- Provide Eticuera Creek burned area subregion residents, open space personnel and/or property managers with this VAR information so they may understand their proximity to hazard areas and take appropriate actions.

Upper and Lower Cache Creek

Observations

The area within and downslope of the Hennessey Fire burned area within the Upper and Lower Cache Creek assessment area, is a source of potential hazards to downslope property and infrastructure. The main catchments draining into Cache Creek include Bear Creek, Fiske Creek, Hamilton Creek, Brooks Creek, Willow Creek, Salt Creek, and Pine Creek. Slopes within the burned area upstream of the developed areas within the Capay Valley are primarily burned at low soil burn severity, with moderate soil burn severity noted at the northern portion of the watershed along Blue Ridge. Upslope areas of the southern portion of Capay Valley, between the towns of Guinda and Brooks, are primarily unburned with low soil burn severity occurring on southern facing slopes. Agricultural, commercial, recreational, and residential developments and infrastructure within and downslope of the Upper and Lower Cache Creek portion of the burn are accessed from SR 16 via county roads and numerous local side streets and native surfaced roads.

Regional geologic mapping (Wagner and Bortugno, 1982; Wagner et al., 1981) characterizes the geologic units underlying the Upper and Lower Cache Creek portion of the burned area as Mesozoic- to early Tertiary-age marine sedimentary rocks. Sandstone, shale, mudstone, siltstone, and conglomerate of the Upper Cretaceous-age Great Valley Sequence underlie the majority of the Upper and Lower Cache Creek area. A fault-bound band of marine sandstone of the Eocene-age Capay Formation dissects the Great Valley Sequence in the north. Non-marine sand silt, and volcanoclastic rocks of the Pliocene-age Tehama Formation are mapped downstream of eastern burn perimeter. Alluvium and alluvial deposits of the Pleistocene-age Modesto-Riverbank Formations fill topographic depressions within the Capay Valley. Field observations support landslides mapped within the SR 16 corridor north of Rumsey by Manson (1989). In 1906, a large landslide along SR 16 had temporarily dammed Cache Creek and caused one of the largest historic flooding events in Capay Valley when the dam failed several days later (Manson, 1989). The rest of the Upper and Lower

Cache Creek burned area lacks regional landslide history or mapping, but brief reconnaissance suggests slope failures are common across the area.

USGS debris flow modeling on the slopes within the Upper and Lower Cache Creek assessment area indicates that 188 of 391 modeled drainage basins exhibit debris flow probabilities greater than 40 percent (using a threshold of a 15-minute duration at 36 mm hr⁻¹ rainfall rate) within the burned portions of these drainages (Figure 11).

Portions of residential, agricultural, and commercial developments along Lower Cache Creek downstream of the northeastern Hennessey burned area are designated as Zone A-Special Flood Hazard Areas by FEMA. Residences and structures located within these areas are subject to inundation by the 1-percent annual chance flood event. Commercial, residential and recreational structures located within these areas may be subject to increased potential for inundation because of the post-fire soil effects of the low, moderate and high burn severity in the watersheds draining to Lower Cache Creek. The magnitude of the hillslope response will be increased by the post-fire changes to hydrology and soil properties. Residential and commercial areas at potential risk include, but are not limited to, the towns of Rumsey, Guinda, and Brooks, and to recreational areas along SR 16, including the Cache Creek Canyon Regional Park. Portions of SR 16 in the corridor north of Rumsey may also be subject to increased rockfall hazards (VAR 01).

Portions of the residential and agricultural development downslope of the burned area are located on stream alluvium, stream terrace and alluvial fan deposits within the catchments or along wide gently sloping alluvial fans downslope. Alluvial fans are gently sloping and convex radial depositional landforms located below the mouths of confined canyons. A channel avulsion is the process by which flow is diverted out of an established channel into a new course on the alluvial surface. Many of the fan surfaces observed within the Hennessey Fire boundary are graded and developed, partly disguising the shape of the fan surfaces and making the evaluation of potential avulsion paths unpredictable. This includes areas outside of active channel network delineated by FEMA 100-year flood zones. Debris flows and hyperconcentrated flows originating in watersheds upslope of residential and agricultural areas can flow downslope across roads and through the communities and impact the low-lying residential areas as sediment and debris laden floods. Unmaintained drainage structures in residential developments, including low bridges, culverts, debris basins, confined constructed channels and at-grade, low water road crossings, can become overwhelmed and trigger in-channel avulsion (i.e., the rapid shifting of channel location) and overbank flooding during storm events.

Residential, agricultural, commercial, and recreational structures downstream of the Lower Cache Creek portion of the burned area are primarily located along ridgelines and away from watercourses. One residence (VAR 04) was noted within the burned area, downstream of a low to moderately burned steep watershed with potential to produce debris flow and flood hazards. The primary structure appears downstream of possible retention basins of unknown status (access to region limited). Near Rumsey, several structures adjacent to watercourses draining the burned area were mapped as Values-at-Risk (VAR 02 and 03) and are determined to constitute a moderate risk to public safety, and/or property. In the Upper Cache Creek portion of the watershed, potential increased runoff from the low and moderately

burned slopes above Davis Creek Reservoir pose a potential risk to day-use and overnight visitors, and access should be restricted during predicted significant storm events.

Recommendations

- Cleanout and monitor culverts, basins, and drainage structures prior to, during and after large rain events where they cross residential streets.
- Perform storm infrastructure monitoring during large rain events to ensure drainage structures are functioning along commercial and residential roads, including but not limited to SR 16, county roads and residential side streets.
- Monitor areas downslope of the Upper and Lower Cache Creek burned area, including but not limited to residential, commercial and recreational developments along SR-16, county roads and local side streets subject to increased inundation during significant storm events.
- Evaluate the potential for installing stormwater control structures, including sand bags and/or concrete K-rails, along stream banks and around properties where high flood flows and debris flows are predicted along drainages.
- Utilize existing early warning systems, linked to up-to-date storm information.
- Consider closure of public parks, trails and campgrounds prior to and during predicted intense storms located within flood-prone areas, and at the base of steep canyons and steep side slopes that may be subject to hyperconcentrated or debris flows, floods and/or rockfall hazards, including but not limited to Cache Creek Canyon Recreation Area, Davis Creek Reservoir, and public parks located within identified flood zones by FEMA.
- Consider the use of appropriate professionals to review and design additional engineered mitigations not provided in this report.
- Consider mitigation measures, including signage and/or road closure, along SR 16 designed to minimize the potential for public safety hazards related to rockfall.
- Consider the applicability of constructing diversion structures where debris and flood flow channels may adversely impact residential and agricultural development or restrict residential access roads where flooding is anticipated during predicted high intensity rain events. Site specific mitigations and containment and diversion structures should be designed by licensed professionals specializing in geotechnical engineering, soil erosion, and engineering geology.
- Provide Upper and Lower Cache Creek burned area subregion residents and/or commercial business owners with this VAR information so they may understand their proximity to hazard areas and take appropriate actions.

Lower Putah Creek

Observations

The area within and downslope of the Lower Putah Creek assessment area is a source of potential hazards to downslope residents, property, and infrastructure. The subregion consists of the portion of the burned area that drains to Putah Creek downstream of Monticello Dam (Lake Berryessa). This segment of Putah Creek flows eastward from the burned area into the Central Valley geomorphic province. This subregion includes the 5-mile

long “interdam reach” of Putah Creek between Monticello Dam and the Putah Diversion Dam (Lake Solano), which reportedly provides the municipal water supply to 400,000 Solano County residents. Solano County Water Agency (SCWA) staff report that the drainages in this reach are major sources of sediment, particularly Pleasants Creek.

To the south of Putah Creek, the Cold Canyon, Pleasants Creek, and McCune Creek catchments drain the burned area to Putah Creek. The Cold Canyon catchment primarily burned at moderate soil burn severity. The headwaters of the Pleasants Creek catchment burned at moderate to high soil burn severity, while the lower reaches primarily burned at very low to low soil burn severity. The McCune Creek catchment primarily burned at low to moderate soil burn severity. To the north of Putah Creek, the catchments of Thompson Canyon, Bray Canyon, Dry Creek, and Enos Creek drain to Putah Creek. These watersheds primarily burned at very low to low soil burn severity. The confluence of Enos Creek/Dry Creek with Putah Creek is more than three miles downstream of the burned area near the community of Winters.

Regional geologic mapping (Wagner and Bortugno, 1982) shows that the Lower Putah Creek assessment area is primarily underlain by marine sandstone, siltstone, mudstone, shale, and conglomerate comprising multiple formations within the Upper Cretaceous-age Great Valley Sequence. These units are generally dipping moderately steeply eastward with differential erosion of more resistant sandstones and conglomerates forming ridgelines. The easternmost portion of the subregion within the burned area is underlain by marine sandstone of the Eocene Markley Sandstone and sand, silt, and volcanoclastic rocks of the Pliocene Tehama Formation.

Regional landslide mapping by Majmundar (1989) and Dwyer et al. (1976) identify numerous relatively large rockslides and numerous small landslides within the portion of the Lower Putah Creek subregion south of Putah Creek. Regional landslide mapping is not available for the portion of the subregion north of Putah Creek; however, unstable slope conditions are apparent throughout much of the Lower Putah Creek subregion area. Review of LiDAR imagery shows probable large rockslides and earthflows and smaller debris slides throughout the assessment area, which suggests active hillslope processes in the area in the absence of fire. These processes can provide material to stream channels that can be mobilized by subsequent flood flows, hyperconcentrated flows, and debris flows. We observed relatively small alluvial fan deposits at the mouths of some of the steep tributary channels and larger apparent alluvial fans at the mouths of larger drainages that have been altered by grading and human activity (e.g., Thompson Canyon, Bray Canyon, Cold Canyon), confirming preexisting hyperconcentrated flow and debris flow hazards in these areas.

USGS debris flow modeling on the slopes within the Lower Putah Creek assessment area indicates that 194 of 239 modeled drainage basins exhibit debris flow probabilities of 40 to 60-percent or greater (using a threshold of a 15-minute duration at 36 mm hr⁻¹ rainfall rate) within the burned portions of these drainages (Figure 11).

FEMA Special Flood Hazard Areas are mapped along Putah Creek, Enos Creek, and Pleasants Creek. Additionally, mapped DWR Awareness Floodplains extend further upstream into the Vaca Mountains along Pleasants Creek, Cold Canyon, and several unnamed

tributaries. These observations support the presence of a preexisting flood hazard in the absence of fire.

To the north of Putah Creek, residential and agricultural structures are sparse and are generally located along ridgelines and away from watercourses. A significant portion of the area consists of the 6,800-acre Bobcat Ranch owned by Audubon California. The ranch is reportedly only accessible with permission (<https://ca.audubon.org/about-us/bobcat-ranch>) and we are not aware of specific trail, day use, or camping locations.

To the south of Putah Creek, much of the Vaca Mountains area is also sparsely developed. Significant portions of this area consist of publicly owned parcels including the Putah Creek Wildlife Area, the UC Davis Natural Reserve System Stebbin Cold Canyon Reserve, and Bureau of Land Management (BLM) property. Residential and agricultural structures in this area are concentrated in and around Pleasant Valley. These structures are primarily located along ridgelines and away from watercourses. However, during our assessment we observed a few residential and/or agricultural structures that are located at the mouth of steep tributary watersheds that could potentially be impacted by post-fire debris flows and/or flooding.

The “interdam reach” of Putah Creek corridor is mostly public property that is utilized for recreation, including the California Department of Fish and Wildlife “Putah Creek Fish Access” parcel, Lake Solano County Park, and various BLM holdings. Various day use facilities and a campground (Lake Solano) are located in these areas. We also noted a private resort facility in this area, just downstream of Monticello Dam. These areas are generally accessed via SR 128, which is constructed in the Putah Creek valley along the “interdam reach.” Portions of SR 128 are constructed with very steep, high cutbanks exposing bedrock outcrops, and it appears that rockfall is a hazard along these segments.

Residences and infrastructure observed downslope of the steep slopes and debris flow drainages were identified as Values-at-Risk. A total of 13 VARs (VARs 6 through 13, 86 through 90) were identified within and immediately downslope of the Lower Putah Creek assessment area, including polygons encompassing several individual structures and/or public recreation facilities. Generally, the VARs identified within and downslope of the burned area are determined to constitute a low to moderate risk to public safety or property, or both, resulting from residential/agricultural structures and recreational facilities located downstream of the mouths of debris and flood flow-prone catchments. However, a recreational facility (VAR 86) and RV resort area (VAR 87) downstream of Cold Canyon was determined to constitute a high risk to public safety.

Downstream of the burned area and Lake Solano, Putah Creek flows eastward toward the community of Winters. We noted scattered structures within or near the mapped FEMA Special Flood Hazard Area along Putah Creek in this area. We did not specifically evaluate the risks associated with flooding downstream of the burned area and we did not identify Values-at-Risk in these areas downstream of the burned area. However, these structures along Putah Creek appear to have a pre-existing flood hazard regardless of post-fire conditions, and we do anticipate an increased flooding hazard within or near mapped FEMA Special Flood Hazard Areas downstream of the burned area due to increased post-fire peak flows.

Recommendations

- Monitor areas within and downslope of the Lower Putah Creek subregion burned area, including but not limited to residential and agricultural developments along Pleasants Creek and Putah Creek, which are subject to increased inundation during significant storm events.
- Evaluate the potential for installing diversion stormwater control structures, including sand bags and/or concrete K-rails, along stream banks and around residences where high flood flows and debris flows are predicted along drainages.
- Utilize existing early warning systems, linked to up-to-date storm information.
- Consider signage along areas where rockfall and flood hazards may be present along public roadways, including but not limited to SR 128 (VAR 06).
- Consider closing the recreational facilities within and downstream of the burned area, such as day-use facilities, trails and campgrounds, prior to and during predicted large rain events.
- Cleanout culverts and drainage structures prior to large rain events along residential access roads, including but not limited to Pleasants Valley Road and Quail Canyon Road.
- Perform storm infrastructure monitoring along residential access roads, including but not limited to Pleasants Valley Road and Quail Canyon Road.
- Consider the use of appropriate professionals to review and design additional engineered mitigations not provided in this report.
- Consider the applicability of constructing diversion structures where debris and flood flow channels may adversely impact residential and agricultural development or restrict residential access roads where flooding is anticipated during predicted high intensity rain events. Site specific mitigations and containment and diversion structures should be designed by licensed professionals specializing in geotechnical engineering, soil erosion, and engineering geology.
- Provide Lower Putah Creek assessment area residents with this VAR information so they may understand their proximity to hazard areas and take appropriate actions.

Middle Putah Creek

Observations

The area within the Middle Putah Creek portion of the burned area within the south-central Hennessey Fire burned area is a source of potential hazards to downslope residents, property, and infrastructure. Southwest, west, north and east-facing slopes within the burned area upstream of the developed areas are primarily burned at low and moderate soil burn severity, with patches of high soil burn severity along the eastern ridgeline and northwestern burned area. The two main catchments, Capell Creek and Wragg Creek, and numerous small catchments drain the burned area to the north through commercial and residential development areas in the Capell Valley, Soda Valley, Steel Canyon, Wragg Canyon and Markley Canyon. All of the drainages are tributary to Lake Berryessa. Drainage infrastructure (culverts, bridges, drop inlets, stormwater and flood control drains/channels, basins) were observed at several locations along the drainages adjacent to and upstream of residential,

agricultural and commercial developments and public roads. These structures are designed to convey floodwaters and reduce the potential for downstream flooding. Commercial and residential developments within and downslope of the Middle Putah Creek portion of the burned area are accessed from I-80 via SR 128 and numerous local side streets.

Regional geologic mapping (Wagner and Bortugno, 1982; Delattre and Sowers, 2006; Wiegers et al., 2007) characterizes the major geologic units underlying the Middle Putah Creek portion of the burned area and area downslope as Cretaceous to Jurassic-age Great Valley Sequence and Cretaceous to Jurassic-age Franciscan Formation. The Great Valley Sequence is described as primarily interbedded sandstone, shale, mudstone and occasional conglomerate. Large northwest-southeast trending lenses of serpentinite are mapped within the Great Valley Sequence. The Franciscan is described as a massive and foliated metagraywacke with interbedded sandstone and shale with inclusions of altered volcanic rock and serpentinite. Quaternary-aged fluvial, alluvial fan, alluvial terrace and landslide deposits overlie the older bedrock within elevated valleys and the mouths of tributary drainages to Lake Berryessa, including Capell Valley, Adams Flat, Cherry Valley, Markley Canyon, Steel Canyon and Little Valley. Residential, agricultural and commercial developments are constructed on fluvial, alluvial fan and alluvial terrace deposits (Bezore et al., 1998a and b, Bezore, 2004; Wiegers, 2006) in these areas and may experience a higher risk of flooding because of their location. Where extensive grading has occurred, the drainages disappear and reappear as they extend through the built environment on gently sloping alluvial deposits. Field observations and review of available LiDAR imagery identify areas of shallow- and deep-seated landsliding, consistent with regional geologic mapping (Delattre and Sowers, 2006; Wiegers et al., 2007), confirming active hillslope processes. These processes can provide material to stream channels that can be mobilized by subsequent flood flows, hyperconcentrated flows, and debris flows. Northwest-southeast trending Quaternary-age and PreQuaternary faulting is mapped as bisecting the Middle Putah Creek portion of the burned area.

USGS debris flow modeling on the slopes within the Middle Putah Creek portion of the burned area indicates that 290 of 355 modeled drainage basins exhibit debris flow probabilities between 40 to 60-percent or greater (using a threshold of a 15-minute duration at 36 mm hr⁻¹ rainfall rate) within the burned portions of these drainages (Figure 11).

At the request of Napa County, we evaluated a fill failure along an existing native surfaced access road near the top of a steep burned catchment in Berryessa Highlands. The road provides access from Rimrock Drive to an existing Napa County water tank. The outer road fill prism appears unconsolidated and appears to be failing in several locations. The road is drained via an existing ditch relief culvert which outlets onto the fill failure and likely contributed to the failure. The burned catchment drains to residential structures along Arroyo Lindo Court (VAR 69), approximately 2,500-feet downstream. The potential hazard to the residences downstream from saturation and mobilization of the unconsolidated road fill during large rain appears preexisting. Increases in runoff resulting from the low soil burn severity within the catchment may increase the potential for residences along Arroyo Lindo Court to experience post-fire debris, hyperconcentrated and sediment laden flood flows. Further

evaluation of the failed road appears warranted. Napa County was notified of our findings via email.

Residential, commercial, agricultural and recreational developments within the Middle Putah Creek portion of the burned area, particularly along SR 128, SR 121, Wragg Canyon Road and local side streets, are designated as Zone A-Special Flood Hazard Areas by FEMA and as Awareness Floodplains by the California Department of Water Resources (DWR). Residences and structures located within these areas are subject to inundation by the 1-percent annual chance flood event. Commercial, residential, agricultural and recreational structures located within these areas may be subject to increased potential for inundation because of the post-fire soil effects of the low, moderate and high burn severity in the Middle Putah Creek portion of the burned area. The magnitude of the hillslope response will be increased by the post-fire changes to hydrology and soil properties.

Day use areas and campgrounds adjacent to Lake Berryessa, including Steele Canyon and Pleasure Cove campgrounds, appear located within low-lying areas and near the mouths of debris flow canyons. Recreation area access roads appear to cross potential debris flow drainages at several locations. The soil burn severities observed upslope of the day use areas and campgrounds may result in higher flows that may inundate the recreational areas during large rain events.

Portions of the residential and agricultural development downslope of the burned area is located on stream alluvium, stream terrace and alluvial fan deposits within the catchments or along wide gently sloping alluvial fans downslope. Alluvial fans are gently sloping and convex radial depositional landforms located below the mouths of confined canyons. A channel avulsion is the process by which flow is diverted out of an established channel into a new course on the alluvial surface. Many of the fan surfaces observed within the Hennessey Fire boundary are graded and developed, partly disguising the shape of the fan surfaces and making the evaluation of potential avulsion paths unpredictable. This includes areas outside of active channel network delineated by FEMA 100-year flood zones. Debris flows and hyperconcentrated flows originating in watersheds upslope of residential and agricultural areas can flow downslope across roads and through the communities and impact the low-lying residential and agricultural areas as sediment and debris laden floods. Unmaintained drainage structures in residential developments, including low bridges, culverts, debris basins, confined constructed channels and at-grade, low water road crossings, can become overwhelmed and trigger in-channel avulsion (i.e., the rapid shifting of channel location) and overbank flooding during storm events.

Residential communities and infrastructure observed downslope of the steep slopes and debris flow drainages were identified as Values-at-Risk. A total of 36 VARs (VARs 53 through 85) were found within and downslope of the Middle Putah Creek portion of the burned area, including polygons encompassing several individual structures. Seven of the 36 VARs (VARs 59, 61, 62, 66, 75, 75, 77) observed within and downslope of the Middle Putah Creek portion of the burned area are determined to constitute a high risk to life-safety, property, or both, resulting from residential, agricultural and recreational structures being located downstream of the mouths of debris and flood flow-prone catchments (Photographs E03, E04, E05).

Recommendations

- Cleanout culverts, basins, stormwater and flood channels and drainage structures prior to, during and after large rain events where they cross residential streets.
- Consider the use of temporary signage in areas of increased flood and rockfall hazards.
- Perform storm infrastructure monitoring during large rain events to ensure drainage structures are functioning along commercial and residential roads, including but not limited to Berryessa-Knoxville Road, Steele Canyon Road, Wragg Canyon Road, SR 128, SR 121, and local side streets.
- Monitor areas within and downslope of the Middle Putah Creek portion of the burned area, including but not limited to low-lying residential, commercial, agricultural and recreational developments along Berryessa-Knoxville Road, Steele Canyon Road, Wragg Canyon Road, SR 128, SR 121, and local side streets subject to increased inundation during significant storm events.
- Evaluate the potential for installing stormwater control structures, including sand bags and/or concrete K-rails, along stream banks and around residences where high flood flows and debris flows are predicted along drainages.
- Utilize existing early warning systems, linked to up-to-date storm information. Residents of structures located within and directly adjacent to delineated FEMA Flood Zones and DWR Awareness Floodplains should be notified prior to large rain events to expect an increased potential for inundation, including along Wragg Canyon Road, SR 128, SR 121 and local side streets.
- Consider closure of public parks, trails, campgrounds, boat ramps, day use areas and recreational areas adjacent to Lake Berryessa, including Steele Canyon and Pleasure Cove campgrounds (VAR 63), prior to and during predicted intense storms located within flood-prone areas, and at the base of steep canyons and steep side slopes that may be subject to hyperconcentrated or debris flows, floods and/or rockfall hazards.
- Consider the use of appropriate professionals to review and design additional engineered mitigations not provided in this report.
- Consider the applicability of constructing diversion structures where debris and flood flow channels may adversely impact residential development or restrict residential access roads where flooding is anticipated during predicted high intensity rain events. Site specific mitigations and containment and diversion structures should be designed by licensed professionals specializing in geotechnical engineering, soil erosion, and engineering geology.
- Provide Middle Putah Creek burned area subregion residents, recreational area personnel and commercial business owners with this VAR information so they may understand their proximity to hazard areas and take appropriate actions.

Upper Putah Creek

Observations

The area within and downslope of the Hennessey Fire burned area within the Upper Putah Creek assessment area is a source of potential hazards to downslope property and

infrastructure. The main catchments draining into Upper Putah Creek include Bucksnot Creek, Hole Creek, Jericho Creek, Jerusalem Creek, and Hunting Creek, which ultimately drains to Lake Berryessa. The southeastern portion of the Upper Putah Creek watershed drains into Butts Creek which drains eastward to northwestern Lake Berryessa. A portion of the western Upper Putah Creek assessment area did not burn and is reflected as a hole within the fire perimeter. The Upper Putah Creek watershed primarily has low to moderate soil burn severity, with higher concentrations of moderate burn severity to the west. The northeast-facing slopes in the eastern half of the watershed also tend to have a higher concentration of moderate burn severity relative to the surrounding area. The soil burn severity at the confluence of Jerusalem Creek and Hunting Creek is anomaly lower than the rest of the watershed. Recreational, industrial, and residential developments and infrastructure within and downslope of the Upper Putah Creek portion of the burn are accessed from SR 128 and SR 29 via Pope Canyon Road, Butts Canyon Road, Berryessa Knoxville Road, residential side streets, and unnamed native surfaced roads.

Regional geologic mapping (Wagner and Bortugno, 1982; Wagner et al., 1981) characterizes the geologic units underlying the Upper Putah Creek portion of the burned area as Mesozoic-to early Tertiary-age oceanic, marine, fluvial, and volcanic rocks. Faulted bands of deformed marine rocks of the Jurassic-age Franciscan Complex and Coast Range Ophiolite underlie the general assessment area, the most prominent units being ultramafic and volcanic rocks. A small band of marine sandstone, mudstone, and conglomerate of the Lower Cretaceous- and Upper Jurassic-age Great Valley Sequence is wedged between a large unit of ultramafic and volcanic rocks in the center of the watershed. Scattered deposits of late Tertiary-age Clear Lake volcanics exist across the Upper Putah Creek area and decrease in concentration moving towards Lake Berryessa. Continental fluvial deposits of the Tertiary-age Glen Ellen formation exist along the shores of Lake Berryessa within the assessment area. Field observations and remote reconnaissance support regional landslide mapping by Dwyer et al. (1976) within the Upper Putah Creek burned area.

USGS debris flow modeling on the slopes within the Upper Putah Creek assessment area indicates that 170 of 328 modeled drainage basins exhibit debris flow probabilities greater than 40 percent (using a threshold of a 15-minute duration at 36 mm hr⁻¹ rainfall rate) within the burned portions of these drainages (Figure 11).

Portions of Butts Creek and Putah Creek within the Upper Putah Creek area of the Hennessey burned area are designated as Zone A-Special Flood Hazard Areas by FEMA. Structures located within these areas are subject to inundation by the 1-percent annual chance flood event. The same structures may also be subject to increased potential for inundation because of the post-fire soil effects of the low and moderate burn severity in the watersheds draining to Butts Creek and Putah Creek. The magnitude of the hillslope response will be increased by the post-fire changes to hydrology and soil properties. Overnight and day-use access to outdoor recreational activities within the Knoxville Wildlife and Recreational Areas, and at golf courses should be restricted during predicted significant storms events.

Day use areas and campgrounds within the Upper Putah Creek burned area, including Hunting Creek campground, appear located within low-lying areas and near the mouths of

debris flow canyons. Recreation area access roads appear to cross potential debris flow drainages at several locations. The soil burn severities observed upslope of the day use areas and campgrounds may result in higher flows that may inundate the recreational areas during large rain events.

Residential, recreational, and industrial structures within the Upper Putah Creek portion of the burned area are primarily located along ridgelines and away from watercourses. One Value-At-Risk (VAR 51) polygon was noted downstream of the burned area within an existing FEMA flood zone. The polygon consists of several structures constructed in a flat-lying area adjacent to Lake Berryessa with drainage structures that may be overwhelmed from potential increased post-fire runoff from Butts Creek and from the immediate upslope area. One property (VAR 52) is immediately downslope of a small, lightly burned catchment above Lake Berryessa and may be subject to debris flow hazards. Another Value-At-Risk (VAR 50) polygon exists along a catchment to Butts Canyon and consists of rockfall, debris flow, and flood hazards. The homes within the polygon are below steep slopes burned at low to moderate severity and constitute increased rockfall hazards. The other structures within the polygon, including a workshop and garage, are adjacent to the watercourse channel and will potentially be subject to debris flow and flood hazards.

Recommendations

- Cleanout and monitor culverts, basins, and drainage structures prior to, during and after large rain events where they cross residential streets.
- Consider the use of temporary signage in areas of increased flood and rockfall hazards.
- Perform storm infrastructure monitoring during large rain events to ensure drainage structures are functioning along commercial and residential roads, including but not limited to SR 128, SR 29, Pope Canyon Road, Butts Canyon Road, Berryessa-Knoxville Road, and residential side streets.
- Monitor areas downslope of the Upper Putah Creek burned area, including but not limited to residential and recreational developments along Pope Canyon Road, Butts Canyon Road, and local side streets subject to increased inundation during significant storm events.
- Evaluate the potential for installing stormwater control structures, including sand bags and/or concrete K-rails, along stream banks and around properties where high flood flows and debris flows are predicted along drainages.
- Utilize existing early warning systems, linked to up-to-date storm information.
- Consider closure of recreational areas, trails and campgrounds, including Hunting Creek Campground and Knoxville OHV Park, prior to and during predicted intense storms located within flood-prone areas, and at the base of steep canyons and steep side slopes that may be subject to hyperconcentrated or debris flows, floods and/or rockfall hazards, including but not limited to Knoxville Recreation Area, public parks, and golf courses located within identified flood zones by FEMA.
- Consider the use of appropriate professionals to review and design additional engineered mitigations not provided in this report.

- Consider the applicability of constructing diversion structures where debris and flood flow channels may adversely impact residential and agricultural development or restrict residential access roads where flooding is anticipated during predicted high intensity rain events. Site specific mitigations and containment and diversion structures should be designed by licensed professionals specializing in geotechnical engineering, soil erosion, and engineering geology.
- Provide Upper Putah Creek burned area subregion residents, open space and recreation area personnel and/or property managers with this VAR information so they may understand their proximity to hazard areas and take appropriate actions.

Napa Valley

Observations

The area within the Napa Valley portion of the burned area along the western Hennessey Fire burned area is a source of potential hazards to downslope residents, property, and infrastructure. Northeast, southeast and north-facing slopes within the burned area upstream of the developed areas are primarily burned at low and moderate soil burn severity, with patches of high soil burn severity along the ridgelines. The main catchment, Sage Creek, and numerous small catchments generally drain the burned area to the southwest and southeast into Lake Hennessey, Rector Reservoir, and Milliken Reservoir. Drainage infrastructure (culverts, bridges, stormwater and flood control drains/channels, basins) were observed at several locations along the drainages adjacent to and upstream of residential, agricultural and commercial developments and public roads. These structures are designed to convey floodwaters and reduce the potential for downstream flooding. Commercial and residential developments within and downslope of the Napa Valley portion of the burned area are accessed from SR 29 via SR 128, Lower Chiles Valley Road, and numerous local side streets.

Regional geologic mapping (Wagner and Bortugno, 1982; Bezore et al., 2005) characterizes the major geologic units underlying the Napa Valley portion of the burned area and area downslope as Cretaceous to Jurassic-age Great Valley Sequence and Cretaceous to Jurassic-age Franciscan Formation. The Great Valley Sequence is described as weak and moderately weathered sandstone, pebble conglomerate, siltstone and shale. The Franciscan is described as metagraywacke with interbedded sandstone and shale with inclusions of altered volcanic rock and serpentinite. A large northwest-southeast trending lens of serpentinite is mapped between the Great Valley Sequence and Franciscan Formation. Quaternary-aged fluvial, alluvial fan and landslide deposits overlie the older bedrock within elevated valleys and the mouths of tributary drainages to Lake Hennessey, including Lower Chiles Valley, Elder Valley, and Foss Valley. Residential, agricultural and commercial developments are constructed on fluvial, alluvial fan and alluvial terrace deposits (Clahan et al., 2004) in these areas and may experience a higher risk of flooding because of their location. Where extensive grading has occurred the drainages disappear and reappear as they extend through the built environment on gently sloping alluvial deposits. Field observations and review of available LiDAR imagery identify areas of shallow- and deep-seated landsliding, consistent with regional geologic mapping (Wagner and Bortugno, 1982; Bezore et al., 2005), confirming active hillslope processes. The northern extension of the

northwest-southeast trending Quaternary-age Green Valley Fault is mapped along the southwestern the Napa Valley portion of the burned area.

USGS debris flow modeling on the slopes within the Napa Valley portion of the burned area indicates that 57 of 76 modeled drainage basins exhibit debris flow probabilities between 40 to 60-percent or greater (using a threshold of a 15-minute duration at 36 mm hr⁻¹ rainfall rate) within the burned portions of these drainages (Figure 11).

Three dammed water supply reservoirs, Lake Hennessey, Rector Reservoir, and Milliken Reservoir, are located downstream of the western Hennessey Fire burned area. Critical water supply infrastructure, including constructed spillways, piping and associated structures, was observed at all three reservoirs. Lake Hennessey and Milliken Reservoir provide water storage for the City of Napa. Both the Lake Hennessey Recreation Area and Milliken Reservoir are open to the public and allow hiking and fishing. A public boat launch is located along the southeastern bank of Lake Hennessey near the mouth of Sage Canyon. Rector Reservoir, which is the primary water source for the Town of Yountville, is open to the public for hiking and fishing. It is surrounded by the Rector Reservoir Wildlife Area, which is owned by the State of California Department of Veterans Affairs and managed by the California Department of Fish and Wildlife. Portions of the headwaters of all three water supply reservoirs burned at low and moderate soil burn severity, with small patches of high soil burn severity upstream of Lake Hennessey. The soil burn severities observed within the headwaters may result in higher flows within the tributary catchments that drain to Lake Hennessey, Milliken Reservoir and Rector Reservoir during large rain events.

Residential, commercial, agricultural and recreational developments within and downstream of the Napa Valley portion of the burned area, particularly along SR 128, Lower Chiles Valley Road and local side streets, and in Elder Valley and Foss Valley are designated as Zone A-Special Flood Hazard Areas by FEMA and as Awareness Floodplains by the California Department of Water Resources (DWR). Residences and structures located within these areas are subject to inundation by the 1-percent annual chance flood event. Commercial, residential, agricultural and recreational structures located within these areas may be subject to increased potential for inundation because of the post-fire soil effects of the low, moderate and high burn severity in the Napa Valley portion of the burned area. The magnitude of the hillslope response will be increased by the post-fire changes to hydrology and soil properties.

Portions of the residential and agricultural development downslope of the burned area is located on stream alluvium, stream terrace and alluvial fan deposits within the catchments or along wide gently sloping alluvial fans downslope. Alluvial fans are gently sloping and convex radial depositional landforms located below the mouths of confined canyons. A channel avulsion is the process by which flow is diverted out of an established channel into a new course on the alluvial surface. Many of the fan surfaces observed within the Hennessey Fire boundary are graded and developed, partly disguising the shape of the fan surfaces and making the evaluation of potential avulsion paths unpredictable. This includes areas outside of active channel network delineated by FEMA 100-year flood zones. Debris flows and hyperconcentrated flows originating in watersheds upslope of residential and agricultural areas can flow downslope across roads and through the communities and impact the low-lying residential and agricultural areas as sediment and debris laden floods. Unmaintained

drainage structures in residential developments, including low bridges, culverts, debris basins, confined constructed channels, and at-grade, low water road crossings, can become overwhelmed and trigger in-channel avulsion (i.e., the rapid shifting of channel location) and overbank flooding during storm events.

Residential and commercial communities and infrastructure observed downslope of the steep slopes and debris flow drainages were identified as Values-at-Risk. A total of 9 VARs (VARs 40 through 47, 92) were found within and downslope of the Napa Valley portion of the burned area, including polygons encompassing several individual structures. Two of the 10 VARs (VARs 45 and 46) observed within and downslope of the Napa Valley portion of the burned area are determined to constitute a high risk to life-safety, property, or both, resulting from residential and commercial structures located downstream of the mouths of debris and flood flow-prone catchments.

Recommendations

- Cleanout culverts, basins, stormwater and flood channels and drainage structures prior to, during and after large rain events where they cross residential streets.
- Consider the use of temporary signage in areas of increased flood and rockfall hazards.
- Perform storm infrastructure monitoring during large rain events to ensure drainage structures are functioning along commercial and residential roads, including but not limited to Lower Chiles Valley Road, SR 128 and local side streets.
- Monitor areas within and downslope of the Napa Valley portion of the burned area, including but not limited to low-lying residential, commercial, agricultural and recreational developments along Lower Chiles Valley Road, SR 128 and local side streets subject to increased inundation during significant storm events.
- Evaluate the potential for installing stormwater control structures, including sand bags and/or concrete K-rails, along stream banks and around residences where high flood flows and debris flows are predicted along drainages.
- Utilize existing early warning systems, linked to up-to-date storm information. Residents of structures located within and directly adjacent to delineated FEMA Flood Zones and DWR Awareness Floodplains should be notified prior to large rain events to expect an increased potential for inundation, including along Lower Chiles Valley Road, SR 128 and local side streets.
- Consider closure of public parks, trails, campgrounds, boat ramps, day use areas and recreational areas within the burned area and near the mouths of tributaries to Lake Hennessey, Rector Reservoir, and Milliken Reservoir prior to and during predicted intense storms located within flood-prone areas, and at the base of steep canyons and steep side slopes that may be subject to hyperconcentrated or debris flows, floods and/or rockfall hazards.
- Consider the use of appropriate professionals to review and design additional engineered mitigations not provided in this report.
- Consider the applicability of constructing diversion structures where debris and flood flow channels may adversely impact residential development or restrict residential access roads where flooding is anticipated during predicted high intensity rain events.

Site specific mitigations and containment and diversion structures should be designed by licensed professionals specializing in geotechnical engineering, soil erosion, and engineering geology.

- Provide Napa Valley burned area subregion residents, recreation area personnel and commercial business owners with this VAR information so they may understand their proximity to hazard areas and take appropriate actions.

Pope Creek

Observations

The area within the Pope Creek portion of the burned area along the northwestern Hennessey Fire burned area is a source of potential hazards to downslope residents, property, and infrastructure. Northeast, southwest, north and south-facing slopes within the burned area upstream of the developed areas are primarily burned at low and moderate soil burn severity, with a small patch of high soil burn severity along Trout Creek Ridge. The main catchment, Pope Creek, large tributary drainages, James Creek, Burton Creek and Maxwell Creek, and numerous small catchments generally drain the burned area to the east into Lake Berryessa. Drainage infrastructure (culverts, bridges, stormwater and flood control drains/channels, basins) were observed at several locations along the drainages adjacent to and upstream of residential, agricultural and commercial developments and public roads. These structures are designed to convey floodwaters and reduce the potential for downstream flooding. Commercial and residential developments within and downstream of the Pope Creek portion of the burned area are accessed from SR 29 via SR 128, Deer Park Road, Howell Mountain Road, Chiles Pope Valley Road, and numerous local side streets.

Regional geologic mapping (Wagner and Bortugno, 1982) characterizes the major geologic units underlying the Pope Creek portion of the burned area and area downslope as Cretaceous to Jurassic-age Great Valley Sequence and Cretaceous to Jurassic-age Franciscan Formation. The Great Valley Sequence is described as weak and moderately weathered sandstone, pebble conglomerate, siltstone and shale. The Franciscan is described as metagraywacke with interbedded sandstone and shale with inclusions of altered volcanic rock and serpentinite. A large northwest-southeast trending lens of serpentinite is mapped between the Great Valley Sequence and Franciscan Formation. Small blocks of Tertiary-age Sonoma and Clear Lake volcanics are mapped within the western Pope Creek watershed boundary. Quaternary-aged fluvial, alluvial fan and landslide deposits overlie the older bedrock within elevated valleys, including Pope Valley (Wagner and Bortugno, 1982). Residential, agricultural and commercial developments are constructed on fluvial, alluvial fan and alluvial terrace deposits in these areas and may experience a higher risk of flooding because of their location. Where extensive grading has occurred the drainages disappear and reappear as they extend through the built environment on gently sloping alluvial deposits. Field observations and review of available LiDAR imagery identify areas of shallow- and deep-seated landsliding, consistent with regional geologic mapping (Wagner and Bortugno, 1982; Bezore et al., 2005), confirming active hillslope processes. Quaternary-age faulting is mapped along the eastern edge of the Pope Creek portion of the burned area.

USGS debris flow modeling on the slopes within the Pope Creek portion of the burned area indicates that 212 of 236 modeled drainage basins exhibit debris flow probabilities between 40 to 60-percent or greater (using a threshold of a 15-minute duration at 36 mm hr⁻¹ rainfall rate) within the burned portions of these drainages (Figure 11). Twenty-two additional basins, totaling approximately 3700-acres, are included within the Pope Creek subregion of the Hennessey Fire that do not drain to Lake Berryessa via Pope Creek. They are located along the northwest flank of Table Mountain and drain the Pope Creek subregion north to Lake Berryessa via Upper Putah Creek. Twelve of the 22 modeled drainage basins exhibit debris flow probabilities between 40 to 60-percent or greater (using a threshold of a 15-minute duration at 36 mm hr⁻¹ rainfall rate) within the burned portions of north-flowing drainages (Figure 11). No VARs were identified within or downslope of the Upper Putah Creek basins.

The historic Aetna Mining District is a series of former mercury and manganese mines located in Oat Hill within the northwest Hennessey Fire burned area. Operations within the mining district are located upslope of James Creek, a tributary to Pope Creek. Pope Creek drains to Lake Berryessa, which provides drinking water to residents in Solano and Napa counties. Mining operations are no longer ongoing, but tailings, equipment and open adits remain. According to information provided by Napa County, methylmercury levels in Lake Berryessa have resulted in state warnings recommending limits of fish consumption. Increased runoff associated with the low and moderate soil burn severities observed within the headwaters of James and Pope Creeks may result in higher flows within the drainages potentially increasing runoff and inundating the mine areas during large rain events, increasing the potential for mercury delivery to Lake Berryessa.

Day use areas and campgrounds adjacent to Lake Berryessa, including Putah Creek campground, appear located within low-lying areas and near the mouths of debris flow canyons. Recreation area access roads appear to cross potential debris flow drainages at several locations. The soil burn severities observed upslope of the day use areas and campgrounds may result in higher flows that may inundate the recreational areas during large rain events.

Residential, commercial, agricultural and recreational developments within and downstream of the Pope Creek portion of the burned area, particularly along Pope Valley Road, Pope Canyon Road, Dollarhide Road, Aetna Springs Lane and local side streets, are designated as Zone A-Special Flood Hazard Areas by FEMA and as Awareness Floodplains by the California Department of Water Resources (DWR). Residences and structures located within these areas are subject to inundation by the 1-percent annual chance flood event. Commercial, residential and agricultural structures located within these areas may be subject to increased potential for inundation because of the post-fire soil effects of the low, moderate and high burn severity in the Napa Valley portion of the burned area. The magnitude of the hillslope response will be increased by the post-fire changes to hydrology and soil properties.

Portions of the residential, commercial and agricultural development within and downslope of the burned area are located on stream alluvium, stream terrace and alluvial fan deposits within the catchments or along wide gently sloping alluvial fans downslope. Alluvial fans are gently sloping and convex radial depositional landforms located below the mouths of confined canyons. A channel avulsion is the process by which flow is diverted out of an established

channel into a new course on the alluvial surface. Many of the fan surfaces observed within the Hennessey Fire boundary are graded and developed, partly disguising the shape of the fan surfaces and making the evaluation of potential avulsion paths unpredictable. This includes areas outside of active channel network delineated by FEMA 100-year flood zones. Debris flows and hyperconcentrated flows originating in watersheds upslope of residential, commercial and agricultural areas can flow downslope across roads and through the communities and impact the low-lying residential and agricultural areas as sediment and debris laden floods. Unmaintained drainage structures in residential developments, including low bridges, culverts, debris basins, confined constructed channels, and at-grade, low water road crossings, can become overwhelmed and trigger in-channel avulsion (i.e., the rapid shifting of channel location) and overbank flooding during storm events.

Residential and commercial communities and infrastructure observed downslope of the steep slopes and debris flow drainages were identified as Values-at-Risk. A total of 4 VARs (VARs 48, 49, 95, 96) were found within and downslope of the Pope Creek portion of the burned area including polygons encompassing several individual structures. Two of the 4 VARs (VARs 48 and 95) observed within and downslope of the Pope Creek portion of the burned area are determined to constitute a high risk to life-safety, property, or both, resulting from residential, agricultural and commercial structures being located downstream of the mouths of debris and flood flow-prone catchments.

Recommendations

- Cleanout culverts, basins, stormwater and flood channels and drainage structures prior to, during and after large rain events where they cross residential streets.
- Consider the use of temporary signage in areas of increased flood and rockfall hazards.
- Perform storm infrastructure monitoring during large rain events to ensure drainage structures are functioning along commercial and residential roads, including but not limited to Pope Valley Road, Pope Canyon Road, and local side streets.
- Monitor areas within and downslope of the Pope Creek portion of the burned area, including but not limited to low-lying residential, commercial, agricultural and recreational developments along Pope Valley Road, Pope Canyon Road and local side streets subject to increased inundation during significant storm events.
- Evaluate the potential for installing stormwater control structures, including sand bags and/or concrete K-rails, along stream banks and around residences where high flood flows and debris flows are predicted along drainages.
- Utilize existing early warning systems, linked to up-to-date storm information. Residents of structures located within and directly adjacent to delineated FEMA Flood Zones and DWR Awareness Floodplains should be notified prior to large rain events to expect an increased potential for inundation, including along Pope Valley Road, Pope Canyon Road, Dollarhide Road, Aetna Springs Lane and local side streets.
- Consider closure of public parks, campgrounds, trails, boat ramps, day use areas and recreational areas, including Putah Creek campground, within the burned area prior to and during predicted intense storms located within flood-prone areas, and at the base

of steep canyons and steep side slopes that may be subject to hyperconcentrated or debris flows, floods and/or rockfall hazards.

- Evaluate potential mitigation measures at historic mining sites within the Aetna Mining District to minimize the potential for increased post-fire flows to inundate the mine areas and deliver sediment and contaminants to James Creek and tributaries.
- Consider the use of appropriate professionals to review and design additional engineered mitigations not provided in this report.
- Consider the applicability of constructing diversion structures where debris and flood flow channels may adversely impact residential development or restrict residential access roads where flooding is anticipated during predicted high intensity rain events. Site specific mitigations and containment and diversion structures should be designed by licensed professionals specializing in geotechnical engineering, soil erosion, and engineering geology.
- Provide Pope Creek burned area subregion residents, recreation area personnel and commercial business owners with this VAR information so they may understand their proximity to hazard areas and take appropriate actions.

Suisun Bay

Observations

The area within the Suisun Bay portion of the southern Hennessey Fire burned area is a source of potential hazards to downslope residents, property, and infrastructure. Southwest, south and southeast-facing slopes within the burned area upstream of the developed areas are primarily burned at low and moderate soil burn severity, with patches of high soil burn severity along the eastern ridgeline. The three main catchments, Ledgewood Creek, Wooden Valley Creek, and Suisun Creek, and numerous small catchments drain the burned area to the south through commercial and residential development areas in Gordon Valley, Suisun Valley, and the City of Fairfield. All of the drainages are tributary to Grizzly Bay and Suisun Bay and ultimately San Francisco Bay. Drainage infrastructure (culverts, bridges, stormwater and flood control drains/channels, basins) were observed at several locations along the drainages adjacent to and upstream of residential and commercial developments. These structures are designed to convey floodwaters and reduce the potential for downstream flooding. Commercial and residential developments within and downslope of the Suisun Bay portion of the burned area are accessed from I-80 via Suisun Valley Road, Abernathy Road, Mankas Corner Road, and numerous local side streets.

Regional geologic mapping (Bezore et al., 1998a,b; Bezore, 2004; Wieggers, 2006) characterizes the major geologic units underlying the Suisun Bay portion of the burned area and area downslope as Cretaceous to Jurassic and Tertiary-age Great Valley Sequence and Tertiary-age Sonoma Volcanics. The Great Valley Sequence underlies the eastern portion of the Suisun Bay portion of the burned area and is described as primarily thin-bedded sandstone with interbedded siltstone, shale, mudstone and discontinuous conglomerate beds. The Sonoma Volcanics are located within the western portion of the Suisun Bay portion of the burned area and consist of mainly basalt, andesite and dacite. Quaternary-aged fluvial, alluvial fan, alluvial terrace and landslide deposits overlie the older bedrock within and

downslope of the southern Hennessey Fire boundary. Many of the residential and commercial developments are constructed on alluvial fan and alluvial terrace deposits (Bezore et al., 1998a,b; Bezore, 2004; Wiegers, 2006) and may experience a higher risk of flooding because of their location. Where extensive grading has occurred, the drainages disappear and reappear as they extend through the built environment on gently sloping alluvial deposits. Steep slopes below Blue Ridge along the eastern boundary of the Suisun Bay portion of the burned area descend to the west and south to low rolling hills upstream of the City of Fairfield. Field observations and review of available LiDAR imagery identify areas of shallow- and deep-seated landsliding, consistent with regional geologic mapping (Majmunder, 1987; Dwyer et al., 1976), confirming active hillslope processes.

USGS debris flow modeling on the slopes within the Suisun Bay portion of the burned area indicates that 99 of 123 modeled drainage basins exhibit debris flow probabilities between 40 to 60-percent or greater (using a threshold of a 15-minute duration at 36 mm hr⁻¹ rainfall rate) within the burned portions of these drainages (Figure 11).

Lake Curry is a reservoir formed by the damming of Suisun Creek at the confluence with Seven Acre Canyon and Bull Canyon. The lake is owned by the City of Vallejo and supplies water to residents in rural Solano and Napa counties. The lake was observed gated during our review and not open for public access. A small cluster of structures was observed upstream of the northwest corner of the lake within a long and wide (approximately 1,500 to 2,500-feet) gently sloping alluvial valley. Short modeled debris flow drainages drain to the valley from the west and east. Relic channels are evident in the LiDAR imagery, suggesting that Suisun Creek migrates through the valley. The entire Lake Curry watershed is burned. Based on the low, moderate and high soil burn severities within the headwaters, Lake Curry may experience increased sediment, debris, ash and flow during large rain events. Material observed near the structures generally appears fine-grained, suggesting that larger material drops out and the area is more likely to experience hyperconcentrated and sediment laden flood flows than debris flows.

Residential, commercial, agricultural and recreational developments downstream of the southern Hennessey Fire burned area, particularly along Suisun Valley Road, Abernathy Road, Gordon Valley Road, Mankas Corner Road, Interstate 80 and local side streets, are designated as Zone A and AO-Special Flood Hazard Areas by FEMA and as Awareness Floodplains by the California Department of Water Resources (DWR). Residences and structures located within these areas are subject to inundation by the 1-percent annual chance flood event. Commercial, residential, agricultural and recreational structures located within these areas may be subject to increased potential for inundation because of the post-fire soil effects of the low, moderate and high burn severity in the Suisun Creek and LedgeWood Creek watersheds. Residential, commercial, agricultural and recreational areas at potential risk include, but are not limited to, Wooden Valley, Gordon Valley, Suisun Valley, the City of Fairfield, and residential and commercial developments along Suisun Valley Road, Abernathy Road, Gordon Valley Road, Mankas Corner Road and connecting side streets. The magnitude of the hillslope response will be increased by the post-fire changes to hydrology and soil properties.

Much of the residential development downslope of the burned area is located on stream alluvium, stream terrace and alluvial fan deposits within the catchments or along wide gently sloping alluvial fans downslope. Alluvial fans are gently sloping and convex radial depositional landforms located below the mouths of confined canyons. A channel avulsion is the process by which flow is diverted out of an established channel into a new course on the alluvial surface. Many of the fan surfaces observed downslope of the southern Hennessey Fire boundary are graded and developed, partly disguising the shape of the fan surfaces and making the evaluation of potential avulsion paths unpredictable. This includes areas outside of active channel network delineated by FEMA 100-year flood zones. Debris flows and hyperconcentrated flows originating in watersheds upslope of the residential areas can flow downslope across roads and through the communities and impact the low-lying residential areas as sediment and debris laden floods. Unmaintained drainage structures in residential developments, including low bridges, culverts, debris basins, confined constructed channels and at-grade, low water road crossings, can become overwhelmed and trigger in-channel avulsion (i.e., the rapid shifting of channel location) and overbank flooding during storm events. Specially designed flood channels, including the Dan Wilson Canal associated with the Green Valley Project adjacent to Solano Community College and residential structures along Willotta Street, should be cleaned out and maintained to ensure that they can accommodate large flood flows.

Residential communities and infrastructure observed downslope of the steep slopes and debris flow drainages were identified as Values-at-Risk. A total of 2 VARs (VARs 38 and 39) were found within and downslope of the southern burned area within and downstream of the Suisun Bay portion of the burned area, including polygons encompassing several individual structures. Both of the VARs observed within and downslope of the southern burned area are determined to constitute a moderate risk to property, resulting from residential and recreational structures being located downstream of the mouths of debris and flood flow-prone catchments.

Recommendations

- Cleanout culverts, basins, stormwater and flood channels and drainage structures prior to, during and after large rain events where they cross residential streets.
- Consider the use of temporary signage in areas of increased flood and rockfall hazards.
- Perform storm infrastructure monitoring during large rain events to ensure drainage structures are functioning along commercial and residential roads, including but not limited to Suisun Valley Road, Abernathy Road, Gordon Valley Road, Mankas Corner Road and residential side streets.
- Monitor areas downslope of the Suisun Bay portion of the burned area, including but not limited to low-lying residential, commercial, agricultural and recreational developments along Suisun Valley Road, Abernathy Road, Gordon Valley Road, Mankas Corner Road and local side streets subject to increased inundation during significant storm events.

- Evaluate the potential for installing stormwater control structures, including sand bags and/or concrete K-rails, along stream banks and around residences where high flood flows and debris flows are predicted along drainages.
- Utilize existing early warning systems, linked to up-to-date storm information. Residents of structures located within and directly adjacent to delineated FEMA Flood Zones and DWR Awareness Floodplains should be notified prior to large rain events to expect an increased potential for inundation, including along Suisun Valley Road, Abernathy Road, Gordon Valley Road, Mankas Corner Road and local side streets, and residents along Willotta Street and Solano Community College between the Dan Wilson Canal and Suisun Creek.
- Consider closure of public parks and trails prior to and during predicted intense storms located within flood-prone areas, and at the base of steep canyons and steep side slopes that may be subject to hyperconcentrated or debris flows, floods and/or rockfall hazards.
- Consider the use of appropriate professionals to review and design additional engineered mitigations not provided in this report.
- Consider the applicability of constructing diversion structures where debris and flood flow channels may adversely impact residential development or restrict residential access roads where flooding is anticipated during predicted high intensity rain events. Site specific mitigations and containment and diversion structures should be designed by licensed professionals specializing in geotechnical engineering, soil erosion, and engineering geology.
- Provide Suisun Bay burned area subregion residents and commercial business owners with this VAR information so they may understand their proximity to hazard areas and take appropriate actions.

Ulatis Creek and Alamo Creek

Observations

The area within and downslope of the Ulatis Creek and Alamo Creek assessment area is a source of potential hazards to downslope residents, property, and infrastructure. In the burned area, the Ulatis Creek, Alamo Creek, Encinosa Creek, and Laguna Creek catchments drain the Vaca Mountains downslope from Blue Ridge to the Vaca Valley and Lagoon Valley, and then eastward into the heavily developed Vacaville area downstream of the burned area. Slopes within the upslope portions of the Ulatis Creek catchment area primarily burned at moderate to high soil burn severity, while the lower portions in and near the Vaca Valley primarily burned at very low to low soil burn severity. The Alamo Creek catchment area primarily burned at moderate and high soil burn severity in the upper portions of the catchment, while the lower portions primarily burned at low to moderate soil burn severity. The Encinosa Creek catchment primarily burned at low and moderate soil burn severity, while the Laguna Creek catchment primarily burned at low soil burn severity.

Regional geologic mapping (Wagner and Bortugno, 1982) shows that the Ulatis Creek and Alamo Creek assessment area is primarily underlain by marine sandstone, siltstone, mudstone, shale, and conglomerate comprising multiple formations within the Upper

Cretaceous-age Great Valley Sequence. These units are generally dipping moderately steeply eastward with differential erosion of more resistant sandstones and conglomerates typically forming ridgelines. Regional landslide mapping by Majmundar (1989, 1987) and Dwyer et al. (1976) identify numerous relatively large rockslides and numerous small landslides within the Ulatis Creek and Alamo Creek subregion of the burned area.

Slopes in the Vaca Mountains are generally steep to the west of the Vaca Valley. Unstable slope conditions are apparent throughout the Ulatis Creek and Alamo Creek catchments (upslope of the Vaca Valley and Lagoon Valley floors). Review of LiDAR imagery shows probable large rockslides and earthflows and smaller debris slides throughout the assessment area, which suggests active hillslope processes in the area in the absence of fire. These processes can provide material to stream channels that can be mobilized by subsequent flood flows, hyperconcentrated flows, and debris flows. We observed relatively small alluvial fan deposits at the mouths of some of the steep tributary channels and larger apparent alluvial fans that have been altered by grading and human activity where Ulatis Creek and Alamo Creek drain into the Vaca Valley, confirming preexisting hyperconcentrated flow and debris flow hazards in these areas.

USGS debris flow modeling on the slopes within the Ulatis Creek and Alamo Creek assessment area indicates that 96 of 107 modeled drainage basins exhibit debris flow probabilities of 40 to 60-percent or greater (using a threshold of a 15-minute duration at 36 mm hr⁻¹ rainfall rate) within the burned portions of these drainages (Figure 11).

The Ulatis Creek, Alamo Creek, Encinosa Creek, and Laguna Creek catchments drain into broad, flat alluvial plains (Vaca Valley, Lagoon Valley) and then eastward beyond low-relief foothills into the heavily developed Vacaville area in the Central Valley geomorphic province. We noted FEMA Special Flood Hazard Areas mapped along Ulatis Creek, Alamo Creek, Encinosa Creek, and Laguna Creek that generally extend to the base of the Vaca Mountains. Additionally, mapped DWR Awareness Floodplains extend further upstream well into the Vaca Mountains along these streams and several unnamed tributaries. Solano County Water Agency (SCWA) staff report that Ulatis Creek, Alamo Creek, Encinosa Creek, and Laguna Creek are significant flood risks to the City of Vacaville. SCWA staff reports that these channels often reach peak capacity before reaching city limits and that over 1,000 residents were impacted by flooding along Alamo Creek in December 2005. These observations support the presence of a preexisting flood hazard in the absence of fire.

Numerous residential and agricultural structures are located within Ulatis Creek and Alamo Creek subregion of the burned area, many of which are located within the low-lying, alluvial plains of the Vaca Valley or Lagoon Valley that may be subject to increased potential flooding. Many others are located low on the slopes near the base of the Vaca Mountains, including some constructed on alluvial fans at the mouth of steep tributary drainages, where there is a potential to be impacted by post-fire debris flows and/or flooding.

Within the Vaca Mountains, residences and agricultural structures are concentrated in two locations: Gates Canyon and Mix Canyon. These structures are frequently located in low-lying areas along the boulder-strewn primary channels where there may be an increased post-fire flooding and debris flow potential, or at the mouths of burned tributary canyons

where there is a potential to be impacted by post-fire debris flows and/or flooding. These residences are accessed by Gates Canyon Road and Mix Canyon Road. These roads are primarily located low on the slopes along the axis of the Alamo Creek and Ulatis Creek, respectively, and represent the one primary access route to the residential and agricultural structures in these drainages. Signage notes existing rockfall hazards along these entire road segments (from Vaca Valley to Blue Ridge). These roads cross numerous burned tributary watercourses via culverts and small bridges. There is a potential for debris flows or hyperconcentrated flows originating in the steep tributary drainages to flow downslope and block and/or damage these roads. Additionally, we observed that several culvert crossings were nearly plugged with sediment. Unmaintained drainage structures, including culverts and low bridges, can become overwhelmed and trigger in-channel avulsion (i.e., the rapid shifting of channel location) and overbank flooding during storm events.

Residences and infrastructure observed downslope of the steep slopes and debris flow drainages were identified as Values-at-Risk. A total of 24 VARs (VARs 14 through 37) were identified within and immediately downslope of the Ulatis Creek and Alamo Creek assessment area, including polygons encompassing several individual structures (Photographs E01, E02). Generally, all of the VARs identified within and downslope of the burned area are determined to constitute a moderate to high risk to life-safety or property, or both, resulting from residential and agricultural structures being located downstream of the mouths of debris and flood flow-prone catchments.

Downstream of the burned area, Ulatis Creek, Alamo Creek, Encinosa Creek, and Laguna Creek flow into the built environment of Vacaville. We observed an apparent flood-control structure along Encinosa Creek at the boundary of the burned area, and we understand that these catchments all ultimately drain into the Ulatis Flood Control Project. We did not specifically evaluate these flood control structures, nor the risks associated with flooding in the built environment downstream of the burned area. In general, we did not identify Values-at-Risk in these areas downstream of the burned area. However, structures along these creeks appear to have a pre-existing flood hazard regardless of post-fire conditions, and we do anticipate an increased flooding hazard within or near mapped FEMA Special Flood Hazard Areas downstream of the burned area due to increased post-fire peak flows.

Recommendations

- Cleanout culverts and drainage structures prior to, during and after large rain events along residential access roads, including but not limited to Mix Canyon Road and Gates Canyon Road.
- Consider the use of temporary signage in areas of increased flood and rockfall hazards.
- Perform storm infrastructure monitoring along residential access roads, including but not limited to Mix Canyon Road and Gates Canyon Road.
- Monitor areas downslope of the Ulatis Creek and Alamo Creek subregion burned area, including but not limited to residential and agricultural developments along Ulatis Creek, Alamo Creek, and Encinosa Creek, which are subject to increased inundation during significant storm events.

- Evaluate the potential for installing diversion stormwater control structures, including sand bags and/or concrete K-rails, along stream banks and around residences where high flood flows and debris flows are predicted along drainages.
- Utilize existing early warning systems, linked to up-to-date storm information. Since many of the residences accessed via Gates Canyon Road and Mix Canyon Road have one primary access route, which may be blocked or otherwise impacted by post-fire flooding and/or debris flows that may limit emergency responder access, consider evacuation of these areas prior to predicted large rain events.
- Consider the use of appropriate professionals to review and design additional engineered mitigations not provided in this report.
- Consider the applicability of constructing diversion structures where debris and flood flow channels may adversely impact residential and agricultural development or restrict residential access roads where flooding is anticipated during predicted high intensity rain events. Site specific mitigations and containment and diversion structures should be designed by licensed professionals specializing in geotechnical engineering, soil erosion, and engineering geology.
- Provide Ulatis Creek and Alamo Creek assessment area residents and commercial businesses with this VAR information so they may understand their proximity to hazard areas and take appropriate actions.

General Recommendations

Early Warning Systems

Existing early warning systems should be used and improved such that residents can be alerted to incoming storms, allowing enough time to safely vacate hazard areas. In areas where cellular reception is poor or non-existent, methods should be developed to effectively contact residents. For example, installation of temporary mobile cellular towers should be considered. Early warning systems should take advantage of the following services:

Emergency alert notification systems (Nixle, NOAA Weather Radio [frequency 162.400 for Napa residents, 162.525 for Lake County residents, 162.550 for Solano, Yolo, Colusa residents]) and other recommended systems at the following website:

<https://www.nixle.com/>

Napa County:

<https://www.countyofnapa.org/2481/Emergency-Alerts>

Solano County:

<http://www.solanocounty.com/depts/oes/alertsolano/information.asp>

Yolo County:

<https://www.yolocounty.org/residents/emergency-alerts-health-alerts>

Colusa County:

<http://www.countyofcolusa.org/64/Emergency-Alert>

Lake County:

<http://www.lakecountycal.gov/Residents/Emergencies/PSPS/Alerts.htm>

National Weather Service Forecasting

Flash flood and debris flow warnings with practical lead times of several hours must come from a combination of weather forecasts, rainfall measurements of approaching storms, and knowledge of triggering thresholds. The following information is from the National Weather Service (NWS); they provide flash flood and post-fire debris flow “watch” and “warning” notifications in burned areas:

The NWS provides 24/7 information on watches, warnings and advisories for California. For additional information, see:

NWS – San Francisco Bay Area Forecast Office: <https://www.weather.gov/mtr/>

NWS - Post-wildfire flash flood and debris flow guide

<http://www.wrh.noaa.gov/lox/hydrology/files/DebrisFlowSurvivalGuide.pdf>

Nixle

Nixle is a community information service dedicated to helping residents stay connected with alerts and advisories from local law enforcement and all agencies within an affected zip code. Resident can sign up by texting their zip code to 888777, or by signing up online at:

<https://local.nixle.com/accounts/login/>

Wireless Emergency Alerts (WEA)

WEA is an alert system originated by the NWS that can inform residents and businesses of flash flood warnings and other potential hazards. WEA alerts are emergency messages sent by authorized government alerting authorities through mobile carriers. Government partners include local and state public safety agencies, FEMA, the FCC, the Department of Homeland Security, and the National Weather Service. No signup is required, and alerts are automatically sent to WEA-capable phones during an emergency. Residents and businesses interested in this function must turn on the emergency alert setting for their phone.

<https://www.weather.gov/wrn/wea>

Emergency Alert System (EAS)

EAS is a national public warning system that may also be used by state and local authorities to delivery important emergency information, such as weather information, to targeted specific areas.

<https://www.fcc.gov/emergency-alert-system>

Integrated Public Alert and Warning System (IPAWS)

IPAWs is a FEMA-originated system that integrates federal, state, and local emergency warning systems (e.g., WEA, EAS) into a single interface.

<https://www.fema.gov/integrated-public-alert-warning-system>

Education for Residents, Park Personnel, Businesses and the General Public

The following information should be conveyed to residents, park personnel, businesses, and the general public that can be affected by post-fire runoff and erosion associated within the Hennessey Fire: First and foremost, it is critical that residents heed evacuation warnings from local officials. In the absence of an official notice, residents should pay attention to evolving conditions around their homes.

Suzanne Perry, disaster scientist from the USGS, suggests the following talking points:

- Be ready for debris flows for 2-5 years after a wildfire. Don't worry about every storm, as it takes more intense rain (typically about ½ inch per hour – like being in a thunderstorm) on a recently burned slope to trigger a debris flow.
- Follow all evacuation orders. Debris flows can destroy everything in their path.
- Pay attention to official weather forecasts. The National Weather Service will issue a Flash Flood “Watch” or “Warning” for your area when rainfall is anticipated to be intense. Also – and this is important - the rain back in the mountains can be different than where you are. It's the rain in the mountains that will start the debris flow.
- Don't rely on what you've seen in past floods or debris flows. Debris flows and floods can hit new areas or return to previous areas; they might be smaller - or larger - the next time. Whatever happened before, the next time could be different.
- If you must shelter in place, choose your spot in advance and stay alert. Find the highest point nearby (such as a 2nd story or roof) and be ready to get there with a moment's notice. Listen and watch for rushing water, mud, unusual sounds. Survivors describe sounds of cracking, breaking, roaring, or a freight train.
- Never underestimate a debris flow. Unlike other landslides, debris flows can start in places they've never been before. They can leave stream channels and plow through neighborhoods. When a debris flow is small, people can control it with walls, K-rails, and sandbags. When a debris flow is big enough, nothing can stop it.
- Expect other flood dangers. Storms that can cause debris flows can also cause more common flooding dangers.
- Turn Around, Don't Drown!® Never drive, walk, or bicycle through a flooded road or path. Even a few inches of water can hide currents that can sweep you away. Also, the water level can rise before you finish crossing.

For an easy to understand summary of what a debris flow is see Geology.com, [What is a Debris Flow](#).

Debris Basins

Clean (if necessary), monitor, and maintain all debris basins downslope/ downstream of burned areas. Particular emphasis should be placed on monitoring and maintaining debris basins upstream of residential and commercial developments, including, but not limited to the observed basins in Berryessa Highlands.

Burned Debris, Structures, Vehicles, Temporary and Replacement Housing

Before burned structures are replaced with temporary housing or rebuilt they should be specifically evaluated for site-specific post-fire hazards such as rockfall, flooding, debris flow, and excessive sedimentation. These evaluations should be conducted by qualified licensed professionals, such as licensed civil/geotechnical engineers and licensed geologists.

Increased Flood Flows, Erosion and Sedimentation

Estimated hydrologic response for watersheds of concern (i.e., pour points) indicate that a 2-year recurrence interval storm could potentially cause a flood flow in up to that of the 5- to 10-year event. Post-fire erosion modeling predicts that erosion, and therefore sedimentation, rates will be low to moderate following the wildfire, but more than in unburned conditions. Depending on the size of the storm event, sedimentation in some portions of the burned area may be increased through bulking or erosional response from debris flow processes. Therefore, emergency actions, maintenance, and storm response activities should be developed with these conditions in mind.

Stormwater Control

It is expected that runoff from the burned area will contain chemical contaminants, in addition to ash and fire-related sediment and debris, that may pose adverse environmental impacts ([Uzun et al., 2020](#)), particularly to James Creek downstream of the Aetna Mining District. Additional study of potential impacts to downstream receptors should be considered to ensure that stormwater and/or treatment systems are equipped to address potential fire-derived sediment, ash, and chemical contaminants. Additional study should include the monitoring of stream flow and sedimentation rates within the burned drainages prior to, during and after large rain events to evaluate post-fire impacts to water quality and promote the development of appropriate mitigation measures.

Hazardous Trees

Burned and damaged trees may be present adjacent to homes, infrastructure, and roadways, and should be felled to ensure safety of residents, workers, and the traveling public.

Debris Flow Runout

No tools are currently available to rapidly predict post-fire debris flow runout. WERT geologists rely partially on geomorphic evidence to estimate the downstream extent of debris flow inundation. However, many of the at-risk sites are within built environments where geomorphic evidence has been altered or destroyed through grading and/or construction. Also, geomorphic evidence may not be sufficient to predict the downstream extent of debris flows under these post-fire conditions. In areas below large, severely burned drainages (e.g., Encinosa and Alamo Creeks, Ulati Creek, Pleasants Creek, Sage Creek, Pope Creek and tributaries), the areal extent of debris flow inundation is highly uncertain. The WERT strongly recommends more detailed analysis to further refine the identification of downstream debris flow inundation areas.

Increased Rockfall

Rockfall hazards were identified during field evaluations, particularly along the eastern portion of SR 128 and northern portion of SR 16. However, due to the rapid nature of the evaluation, a fully comprehensive evaluation of rockfall hazard was not possible. DeGraff and Gallegos (2012) provide an overview of rockfall hazard following wildfire, along with suggested approaches for identifying these hazards. The WERT strongly recommends more detailed analysis to further refine the identification of rockfall hazard areas.

Road Drainage Systems, Storm Monitoring, and Storm Maintenance

The residential and business communities within and downstream of the burned area are serviced via a network of roads and highways. Caltrans, Napa, Solano, Yolo, Colusa and Lake counties, and various cities and municipalities maintain numerous roads within and downstream of the burned area. Due to observed moderate and high soil burn severities, increased flows on slopes and onto the road system and into storm drain systems can be expected. Loose and erodible soils that mantle the slopes could wash down, inundate, and plug these drainage systems. Flows could be diverted down roads and cause erosion and possible blockage, and/or loss of portions of the road infrastructure and structures along roads. The WERT did not evaluate the potential for rockfall, sedimentation, flooding or debris flow hazards at all roads or watercourse crossings along federal, state, county, municipal or private roads. Existing road drainage systems should be inspected by the appropriate controlling agency to evaluate potential impacts from floods, hyperconcentrated floods, debris torrents, debris flows, and sedimentation resulting from storm events. Spatial data generated by the USGS, and the WERT (e.g., USGS debris flow model, ERMiT erosion model, and flood flow predictions) can be used to screen potential at-risk areas.

Storm Drains

Storm drains will be subject to increased flooding, sediment, and debris. In addition, flooding below debris flow prone areas is difficult, if not impossible to predict. It was beyond the scope of this evaluation to examine every storm drain. The WERT recommends further evaluation of the storm drain systems so that appropriate protective measures are put into place.

Signage

Place temporary signage in areas of potential post-fire rockfall and flooding hazards. Place signage along roads, bridges, and other types of crossings identified at risk of flooding, rockfalls and debris flows. The WERT suggests responsible agencies consider installing gates, warning signs, or other measures to alert and keep people out of areas of identified risk.

Schools

Schools downstream of the Hennessey Fire boundary, including, but not limited to Suisun Valley School, Alamo Elementary School, Willis Jepson Middle School, Orchard Elementary, County High School, and Capell Valley Elementary School, are located within or adjacent to areas known to be prone to flooding and may have an increased likelihood for impacts from flooding following the Hennessey Fire. Consider closing the schools during threshold storm events because of the potential for increased flows experienced downstream of the fire.

Regional Parks, Campgrounds, and Trailer Parks

There are numerous public parks, campgrounds, day use areas and open space areas located within and downstream of the Hennessey Fire burned area that may be at risk from post-fire debris flows and flooding. Not all of the public areas were visited during our review due to time and access constraints. All of the public areas, including, but not limited to the Knoxville Recreation Area, Cache Creek Regional Park, Putah Creek Wildlife Area, Lake Hennessey Recreation Area, Lake Solano County Park, day use areas along SR 128 and numerous picnic areas and campgrounds adjacent to Lake Berryessa appear to contain structures and/or infrastructure that are low-lying or located below the mouths of steep debris flow drainages. Further evaluation of the public recreation areas should be undertaken to evaluate the increased potential for hazards to public safety and property from increased debris flows, hyperconcentrated flows and flooding. Additionally, until the level of increased risk can be determined, recreational areas that are low-lying or located below the mouths of steep debris flow canyons should be closed prior to and during predicted large rain events.

6. Acknowledgements

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APPENDIX A: HENNESSEY FIRE CONTACTS

Contact	Entity	EMAIL
Shana Jones	CAL FIRE LNU Unit Chief	Shana.Jones@fire.ca.gov
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APPENDIX B: VALUES-AT-RISK TABLE

Shaded row = polygon
 White row = point

Hennessey Fire Values-At-Risk Table

Site Number	Community / Local area	Latitude	Longitude	Potential hazard / Field observation	Hazard Category	Specific at-risk feature	Feature Category	Potential hazard to life?	Potential hazard to property?	Emergency protective measures
01	Lower Cache Creek			Rock fall, debris flow onto State Highway 16.	rock fall	Traveling vehicles	other	high	low	Signage, consider debris barrier.
02	Lower Cache Creek			Lots of structures near canal with little room for conveyance. Damage to drainage canal.	debris flow / flood	House, farm property	multiple	low	moderate	Early Warning, monitor and maintain.
03	Lower Cache Creek			Potential debris flow from large drainage, watercourse is narrow and house is adjacent to it.	debris flow / flood	Possible house and shed structure	home	moderate	moderate	Early Warning
04	Lower Cache Creek			Access limited. Based on large drainage area above, house identified as VAR.	debris flow / flood	House	home	moderate	moderate	Early Warning
05	Eticuera Creek			Structures at risk of potential flooding from main watercourse. Worker said stream eroded large part of bank a few years ago. House next to main watercourse is currently vacant. Knoxville Wildlife headquarters.	flood	Vacant house, office, garage	multiple	low	moderate	Early Warning
06	Lower Putah Creek			Rock fall onto Highway.	rock fall	Highway 128	other	moderate	low	Signage, monitor and maintain.
07	Lower Putah Creek			Potential rock fall hazards. Have had a boulder, a few feet across, land on office. Potential debris flows from basins directed at yurt and trailer. Debris retention basin upstream.	debris flow / flood	Multiple houses and office	multiple	high	high	Early Warning, monitor and maintain, signage.
08	Lower Putah Creek			Rock fall hazards.	rock fall	Hwy 128	other	moderate	low	Early Warning
09	Lower Putah Creek			Ag buildings in flow path of watercourse. Debris flow and flooding hazards.	debris flow / flood	Ag infrastructure	business	moderate	moderate	Early Warning
10	Lower Putah Creek			Outbuilding and playground equipment in path of watercourse.	flood	Outbuilding	home	moderate	low	Early Warning
11	Lower Putah Creek			Burned structures in the confluence of two watercourses. Potential flood risk.	flood	Burned structures	home	moderate	moderate	Early Warning

Shaded row = polygon
White row = point

Hennessey Fire Values-At-Risk Table

Site Number	Community / Local area	Latitude	Longitude	Potential hazard / Field observation	Hazard Category	Specific at-risk feature	Feature Category	Potential hazard to life?	Potential hazard to property?	Emergency protective measures
12	Lower Putah Creek	38.47978693	-122.0568908	Garage sitting at junction of two watercourses loaded with large boulders. Potential for debris flow to damage structure. Informed landowner of hazards to garage.	debris flow	Garage	other	low	moderate	Early Warning
13	Lower Putah Creek			Barn in flow path of watercourse. Debris flow and flooding hazards.	debris flow / flood	Barn	other	low	moderate	Early Warning
14	Ulatis Creek and Alamo Creek	38.41525008	-122.0808183	Burned House pad built on cut/fill bench in axis of relatively small watercourse. Watercourse is diverted in trench around house. Potential for flooding or debris flow.	debris flow / flood	House or possible trailer site	home	moderate	moderate	Early Warning, consider deflection structure.
15	Ulatis Creek and Alamo Creek			Burned house pad on alluvial fan at mouth of potential debris flow channel. House site. Somewhat setback from channel but could potentially be impacted. Possible trailer site in direct impact location.	debris flow	House or possible trailer site	home	high	high	Early Warning, place possible trailer site at east end of lot.
16	Ulatis Creek and Alamo Creek	38.40957239	-122.0758445	Wide area near watercourse that could be used as possible trailer site.	debris flow / flood	Possible trailer site	other	moderate	moderate	Early Warning
17	Ulatis Creek and Alamo Creek	38.40917689	-122.0752201	House site near watercourse. Potential for debris flow and flood.	debris flow / flood	House	home	moderate	moderate	Early Warning
18	Ulatis Creek and Alamo Creek			Potential for debris flow to escape watercourse channel at livestock paddock upstream and flow toward residence.	debris flow	House	home	moderate	moderate	Early Warning, consider deflection structure.
19	Ulatis Creek and Alamo Creek			House pads next to watercourse.	debris flow / flood	Houses	home	high	high	Early Warning
20	Ulatis Creek and Alamo Creek			Ulatis Creek opens from confined channel into braided network on fan like area. Houses constructed here. Potential for debris flow and flooding.	debris flow / flood	Houses or possible trailer sites	home	high	high	Early Warning
21	Ulatis Creek and Alamo Creek			Small fan with numerous boulders upslope of burned residence. Watercourse channel is shallow and there is potential for debris flow to overflow and impact house site.	debris flow	House or possible trailer site	home	moderate	moderate	Early Warning

Shaded row = polygon
White row = point

Hennessey Fire Values-At-Risk Table

Site Number	Community / Local area	Latitude	Longitude	Potential hazard / Field observation	Hazard Category	Specific at-risk feature	Feature Category	Potential hazard to life?	Potential hazard to property?	Emergency protective measures
22	Ulatis Creek and Alamo Creek			Houses and miscellaneous non-inhabited structures in potential floodplain adjacent to watercourse. Resident reports no major flooding out of incised banks of watercourse in memory. Not able to access.	flood	Houses	home	low	moderate	Early Warning
23	Ulatis Creek and Alamo Creek			Burned house at confluence of tributary and main watercourse. Dam/pond at tributary upslope of house. Potential for debris flow or flooding on main watercourse with potential for diversion toward house at crossings upslope.	debris flow / flood	House or trailer	home	moderate	moderate	Early Warning, consider deflection structure.
24	Ulatis Creek and Alamo Creek	38.38992651	-122.0783791	Burned house immediately adjacent to watercourse. Many large boulders in watercourse channel. Debris flow and flooding potential.	debris flow / flood	House or trailer site	home	high	high	Early Warning
25	Ulatis Creek and Alamo Creek	38.38879449	-122.0656364	Burned house in floodplain. House pad at confluence of Alamo Creek and side tributary. Possible trailer site with potential for flooding and debris flow.	debris flow / flood	House or trailer	home	high	high	Early Warning
26	Ulatis Creek and Alamo Creek	38.38646705	-122.0608409	House built on fan with very small poorly defined watercourse channel. Potential debris flow impact to burned house site or trailer.	debris flow	House or possible trailer site	home	high	high	Early Warning, consider deflection structure.
27	Ulatis Creek and Alamo Creek			House next to watercourse in potential floodplain. Steep side tributary with boulders descends to house. Dam upslope likely to act as debris basin. Dam spillway is severely eroded and flooding downstream appears possible. Spillway channel flows to house.	debris flow / flood	House and dam	multiple	moderate	moderate	Early Warning
28	Ulatis Creek and Alamo Creek			House in potential floodplain.	flood	House	home	low	moderate	Early Warning
29	Ulatis Creek and Alamo Creek	38.38099727	-122.0419027	Flooding potential. House is somewhat setback from watercourse but is on edge of mapped floodplain.	flood	House	home	low	moderate	Early Warning

Shaded row = polygon
White row = point

Hennessey Fire Values-At-Risk Table

Site Number	Community / Local area	Latitude	Longitude	Potential hazard / Field observation	Hazard Category	Specific at-risk feature	Feature Category	Potential hazard to life?	Potential hazard to property?	Emergency protective measures
30	Ulatis Creek and Alamo Creek			Houses in potential floodplain. Resident reports past floods close to house, but not to house. Limited to orchard flooding.	flood	Houses	home	low	moderate	Early Warning
31	Ulatis Creek and Alamo Creek			House in potential floodplain.	flood	House	home	low	moderate	Early Warning
32	Ulatis Creek and Alamo Creek			Burned house in potential floodplain at confluence of watercourses.	flood	House or trailer site	home	low	moderate	Early Warning
33	Ulatis Creek and Alamo Creek			Houses close to watercourse in potential floodplain. Local resident reports high flows have nearly overtopped watercourse channel in past and flooding post fire is expected. Burned trees observed fallen into the channel.	flood	Houses	home	low	moderate	Early Warning
34	Ulatis Creek and Alamo Creek			House built on fan. Channel directed to right, around house. 3 ft and larger boulders in watercourse. Potential for debris flow.	debris flow	House	home	moderate	moderate	Early Warning
35	Ulatis Creek and Alamo Creek			Houses and structures located in potential floodplain.	flood	Houses	home	low	moderate	Early Warning
36	Ulatis Creek and Alamo Creek			Locked gate, not able to access. House is potentially in floodplain.	flood	House	home	low	moderate	Early Warning
37	Ulatis Creek and Alamo Creek			Houses and structures along edge of channel in potential floodplain.	flood	Houses	home	low	moderate	Early Warning
38	Suisun Bay			Houses at outlet of debris flow channels.	debris flow / flood	Residential structures	home	low	moderate	Early Warning, consider deflection structure. Evacuate during large rain events.
39	Suisun Bay			Trailers along low terrace near watercourse.	flood	Residential trailers	home	low	moderate	Early Warning. Move trailers prior to predicted large rain event.
40	Napa Valley			Houses on toe/fan of landslide. Not able to access.	debris flow / flood	Houses	home	moderate	moderate	Early Warning

Shaded row = polygon
White row = point

Hennessey Fire Values-At-Risk Table

Site Number	Community / Local area	Latitude	Longitude	Potential hazard / Field observation	Hazard Category	Specific at-risk feature	Feature Category	Potential hazard to life?	Potential hazard to property?	Emergency protective measures
41	Napa Valley			Houses on toe/fan of landslide between three drainages. Large boulders in creeks. Owner says lower house has flooded recently.	debris flow / flood	Houses	home	moderate	moderate	Early Warning
42	Napa Valley			Rock fall onto road.	rock fall	Highway 128	other	moderate	low	Early Warning, signage. Consider closing road segment during large rain events.
43	Napa Valley			Trailers, barn, and winery infrastructure in path of watercourse. Debris flow and flooding hazards.	debris flow / flood	Winery infrastructure	business	moderate	moderate	Early Warning
44	Napa Valley			Burned structure next to watercourse in Sage Canyon. Flooding hazard.	flood	House	home	moderate	moderate	Early Warning
45	Napa Valley			House is in path of watercourse. Debris flow and flooding.	debris flow / flood	House	home	high	high	Early Warning
46	Napa Valley			Burned structure in path of two smaller watercourses in moderate burn. Barn across the road is also at risk. Debris flow and flooding hazards.	debris flow / flood	House and barn	home	high	high	Early Warning
47	Napa Valley			House sits next to watercourse. Debris flow and flooding.	debris flow / flood	House	drainage structure	moderate	moderate	Early Warning
48	Pope Creek			Debris flow and rock fall hazards for buildings at Center.	debris flow	Center structures and houses	multiple	high	high	Early Warning
49	Pope Creek			Potential for flooding from main channel, appears outside of mapped flood zone.	flood	House	home	low	moderate	Early Warning
50	Upper Putah Creek			Potential debris flow may impact shop/barn. Houses at risk for rock fall hazards.	rock fall	House and shop/barn	home	moderate	moderate	Early Warning
51	Upper Putah Creek			Potential flooding from road toward houses.	flood	Houses	multiple	low	moderate	Early Warning
52	Upper Putah Creek			Potential for debris flow from watercourse, low burn severity.	debris flow	Trailer home	home	low	moderate	Early Warning
53	Middle Putah Creek			Debris flow hazard at location of house, identified by damage inspection, based on proximity to channel on hillshade. Not able to access.	debris flow / flood	House	home	moderate	moderate	Early Warning

Shaded row = polygon
White row = point

Hennessey Fire Values-At-Risk Table

Site Number	Community / Local area	Latitude	Longitude	Potential hazard / Field observation	Hazard Category	Specific at-risk feature	Feature Category	Potential hazard to life?	Potential hazard to property?	Emergency protective measures
54	Middle Putah Creek			Debris flow hazard at location of house, identified by damage inspection, based on proximity to channel on hillshade. Not able to access.	debris flow / flood	House	home	moderate	moderate	Early Warning
55	Middle Putah Creek			Debris flow hazard at location of house, identified by damage inspection, based on proximity to channel on hillshade. Not able to access.	debris flow / flood	House	home	moderate	moderate	Early Warning
56	Middle Putah Creek	38.47608904	-122.1412356	Structure built at confluence of several burned drainages. Two locked gates. Not able to access.	debris flow / flood	Structure	other	low	moderate	Early Warning
57	Middle Putah Creek			Burned house along edge of potential debris flow drainage. Culvert at upstream edge of house pad has potential to plug and divert flows to house.	debris flow / flood	Burned structure	home	moderate	moderate	Early Warning
58	Middle Putah Creek			Burned house along edge of potential debris flow drainage. 1 to 4-foot diameter boulders in channel. Culvert at upstream edge of house pad has potential to plug and divert flows to house.	debris flow / flood	Burned structure	home	moderate	moderate	Early Warning
59	Middle Putah Creek			Burned house within potential debris flow drainage. Channel diverted around house pad. Large boulders in channel.	debris flow / flood	Burned structure	home	high	high	Early Warning
60	Middle Putah Creek			Debris flow and flood hazard. Not able to access due to locked gate.	debris flow / flood	Burned structure	home	moderate	moderate	Early Warning
61	Middle Putah Creek			Houses adjacent to watercourses, creek filled with small to large boulders. Culvert could plug and watercourse could avulse.	debris flow / flood	Houses	home	high	high	Early Warning
62	Middle Putah Creek			House built next to watercourse. Debris flow and flooding potential.	debris flow / flood	Houses	home	high	high	Early Warning
63	Middle Putah Creek			Campsites and cabins in debris flow and flooding path.	debris flow / flood	Structures and campsites	recreational	moderate	moderate	Early Warning. Close campground and during rain events.

Shaded row = polygon
White row = point

Hennessey Fire Values-At-Risk Table

Site Number	Community / Local area	Latitude	Longitude	Potential hazard / Field observation	Hazard Category	Specific at-risk feature	Feature Category	Potential hazard to life?	Potential hazard to property?	Emergency protective measures
64	Middle Putah Creek			House near watercourse. Locked gate, not able to access. Debris flow and flooding potential.	debris flow / flood	House	home	moderate	moderate	Early Warning
65	Middle Putah Creek			House built on low terrace next to watercourse.	flood	Residential structure	home	moderate	moderate	Early Warning
66	Middle Putah Creek			Drainage channel has been routed around housing pad. Debris flow and flooding potential.	debris flow / flood	Burned structure	home	high	high	Early Warning
67	Middle Putah Creek			Burned mobile home next to watercourse.	debris flow / flood	Mobile home	home	moderate	low	Early Warning
68	Middle Putah Creek			Houses and drainage structures at mouth of potential debris flow canyon. Home owner says drainage structure aggrades and plugs. Flow has been directed through his driveway before.	debris flow / flood	Houses	home	moderate	moderate	Early Warning, clear and maintain culvert.
69	Middle Putah Creek	38.51235896	-122.1907658	House built at mouth of potential debris flow channel.	debris flow / flood	House	home	moderate	moderate	Early Warning, clear and maintain culvert.
70	Middle Putah Creek			House pads in watercourse channels and below steep rocky side tributaries. Small debris basin at top of road.	debris flow / flood	Houses	home	moderate	moderate	Early Warning, clear and maintain basin, clear and maintain culvert.
71	Middle Putah Creek			Teen Center with lots of cabins in path of watercourse. Low soil burn severity.	debris flow / flood	Teen Center	recreational	moderate	low	Early Warning
72	Middle Putah Creek			House in drainage path.	debris flow / flood	House	home	moderate	moderate	Early Warning
73	Middle Putah Creek			Burned structure and outbuilding in a floodway. Flood hazards.	flood	Burned structure and outbuilding	home	low	moderate	Early Warning
74	Middle Putah Creek			Potential for northern watercourse to overtop (bends towards house), will likely be directed towards driveway.	debris flow / flood	Houses	home	moderate	moderate	Early Warning
75	Middle Putah Creek	38.49660731	-122.2447711	Debris flow outlet where garage/stable is currently sitting. House offset from debris flow path.	debris flow	Garage/stable	home	moderate	high	Early Warning

Shaded row = polygon
White row = point

Hennessey Fire Values-At-Risk Table

Site Number	Community / Local area	Latitude	Longitude	Potential hazard / Field observation	Hazard Category	Specific at-risk feature	Feature Category	Potential hazard to life?	Potential hazard to property?	Emergency protective measures
76	Middle Putah Creek			Potential rock fall hazards, owner confirms existing nuisance of rock fall hazards (yearly issues) onto road.	rock fall	Road	other	high	moderate	Signage
77	Middle Putah Creek			Complex of trailers and storage structures in path of drainage. Debris flow and flooding hazards.	debris flow / flood	Trailers and storage structures	home	high	high	Early Warning
78	Middle Putah Creek			House is built below mouth of watercourse channel. House is across highway but drainage includes moderate and high soil burn severity.	debris flow / flood	House and shed	home	moderate	moderate	Early Warning
79	Middle Putah Creek			Small bank protecting house but potential for debris flow to plug small culvert and divert towards house or overtop bank towards house.	debris flow / flood	House	home	moderate	moderate	Early Warning
80	Middle Putah Creek			House between downstream small watercourse channel with cobble and small boulders. Larger watercourse is likely to travel down road and avoid house, with exception of nuisance debris. Garage is downstream of road.	debris flow	House and garage	home	moderate	moderate	Early Warning
81	Middle Putah Creek			Potential debris flow avulsion from steep watercourse adjacent to house.	debris flow	House	home	moderate	moderate	Early Warning
82	Middle Putah Creek			Potential flooding and hyper concentrated flows from watercourse adjacent to mobile home facility.	flood	Mobile home park	multiple	low	moderate	Early Warning
83	Middle Putah Creek			Potential for flooding or sediment laden flow to enter property. Small source material (gravel, sand).	debris flow / flood	A couple trailer homes and horse ring.	home	moderate	moderate	Early Warning
84	Middle Putah Creek			Repair yard and shop has potential for debris flow or flood to enter yard, mostly small material but a few large cobbles were noted. No capacity for water flow in channel.	debris flow / flood	Boat yard maybe shop	business	low	moderate	Early Warning

Shaded row = polygon
 White row = point

Hennessey Fire Values-At-Risk Table

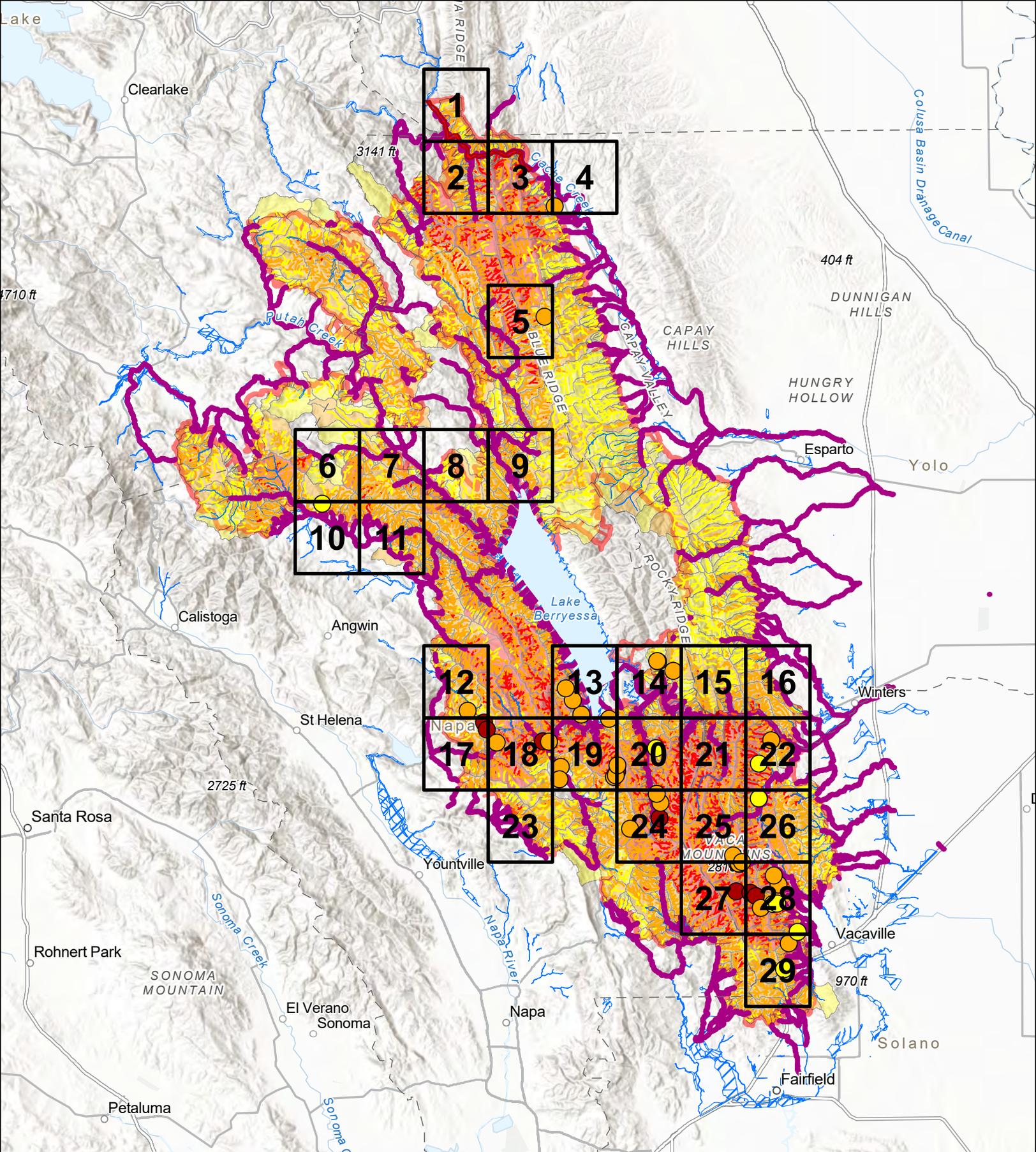
Site Number	Community / Local area	Latitude	Longitude	Potential hazard / Field observation	Hazard Category	Specific at-risk feature	Feature Category	Potential hazard to life?	Potential hazard to property?	Emergency protective measures
85	Middle Putah Creek			Mobile home and storage area downstream of active watercourse containing large material, at risk for debris flows.	debris flow / flood	Mobile home and storage yard	multiple	moderate	moderate	Early Warning. Move trailer to higher ground to mitigate risk.
86	Lower Putah Creek			Day use area and parking. Potential for debris flow and/or flooding from Cold Canyon.	debris flow / flood	Parking and recreation area	recreational	high	low	Signage. Close prior to and during large storm events.
87	Lower Putah Creek			Resort and RV parking in floodplain of Putah Creek opposite mouth of Cold Canyon. Potential for debris flow and flooding.	debris flow / flood	Occupied RV's and resort buildings	multiple	high	moderate	
88	Lower Putah Creek			Day use area and facilities downslope of Bray Canyon and other steep tributary canyon. Potential for debris flow or flooding.	debris flow / flood	Day use facility	recreational	moderate	low	
89	Lower Putah Creek			Day use area parking located downslope of several potential debris flow channels.	debris flow	Day use area	recreational	moderate	low	Signage. Close prior to and during large storm events.
90	Lower Putah Creek			Campground low on banks of Putah Creek. Potential for flooding due to runoff from drainages downstream of Monticello Dam.	flood	Campground	recreational	moderate	low	Signage. Close prior to and during large storm events.
91	Upper Putah Creek			Campground low on banks of Putah Creek. Potential for flooding due to runoff from drainages downstream of Monticello Dam.	flood	School and firehouse	other	moderate	moderate	Signage. Close prior to and during large storm events.
92	Napa Valley			Winery, parking area and terraced picnic area below mouth of debris flow catchment	debris flow / flood	Winery and infrastructure	business	moderate	moderate	
93	Middle Putah Creek			Resort at mouth of two potential debris flow drainages	debris flow / flood	Resort and infrastructure	recreational	high	high	
94	Middle Putah Creek			Somerston Winery and related structures at mouth of potential debris flow drainage	debris flow / flood	Winery structures	business	moderate	moderate	
95	Pope Creek			Houses located within and below the mouth of potential debris flow drainage	debris flow / flood	Houses or possible trailer sites	home	high	high	

Shaded row = polygon
White row = point

Hennessey Fire Values-At-Risk Table

Site Number	Community / Local area	Latitude	Longitude	Potential hazard / Field observation	Hazard Category	Specific at-risk feature	Feature Category	Potential hazard to life?	Potential hazard to property?	Emergency protective measures
96	Pope Creek			Houses and commercial building below mouth of potential debris flow drainage	debris flow / flood	House, trailer and building	multiple	moderate	moderate	

APPENDIX C: VAR MAPS



Incident: CA-LNU-013407
LNU Lightning Complex
Hennessey Fire



Value at Risk (Point)

- Potential hazard to life*
- High
 - Moderate
 - Low

Values at Risk (Polygon)

- Potential hazard to life*
- high
 - Moderate
 - Low

Segment Combined Hazard

- 15 min 36mm/hr*
- High
 - Moderate
 - Low

Basin Combined Hazard

- 15 min 36mm/hr*
- High
 - Moderate
 - Low

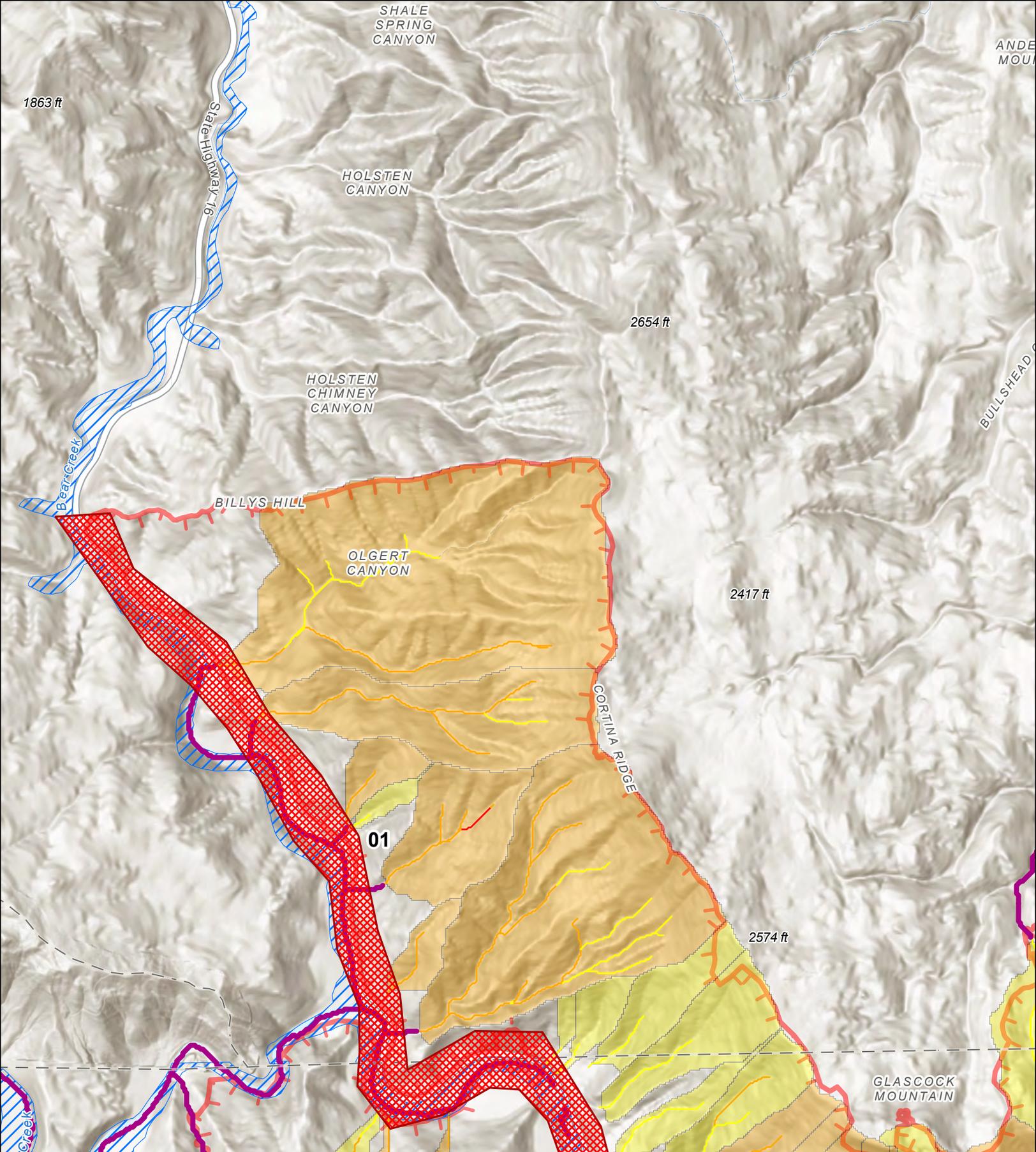
USGS Watchstream

FEMA/DWR Floodplain

Fire Perimeters



Scale: 1:375,000



Incident: CA-LNU-013407
LNU Lightning Complex
Hennessey Fire



Value at Risk (Point)

Potential hazard to life

- High
- Moderate
- Low

Values at Risk (Polygon)

Potential hazard to life

- high
- Moderate
- Low

Segment Combined Hazard

- High
- Moderate
- Low

Basin Combined Hazard

- High
- Moderate
- Low

USGS Watchstream

— USGS Watchstream

FEMA/DWR Floodplain

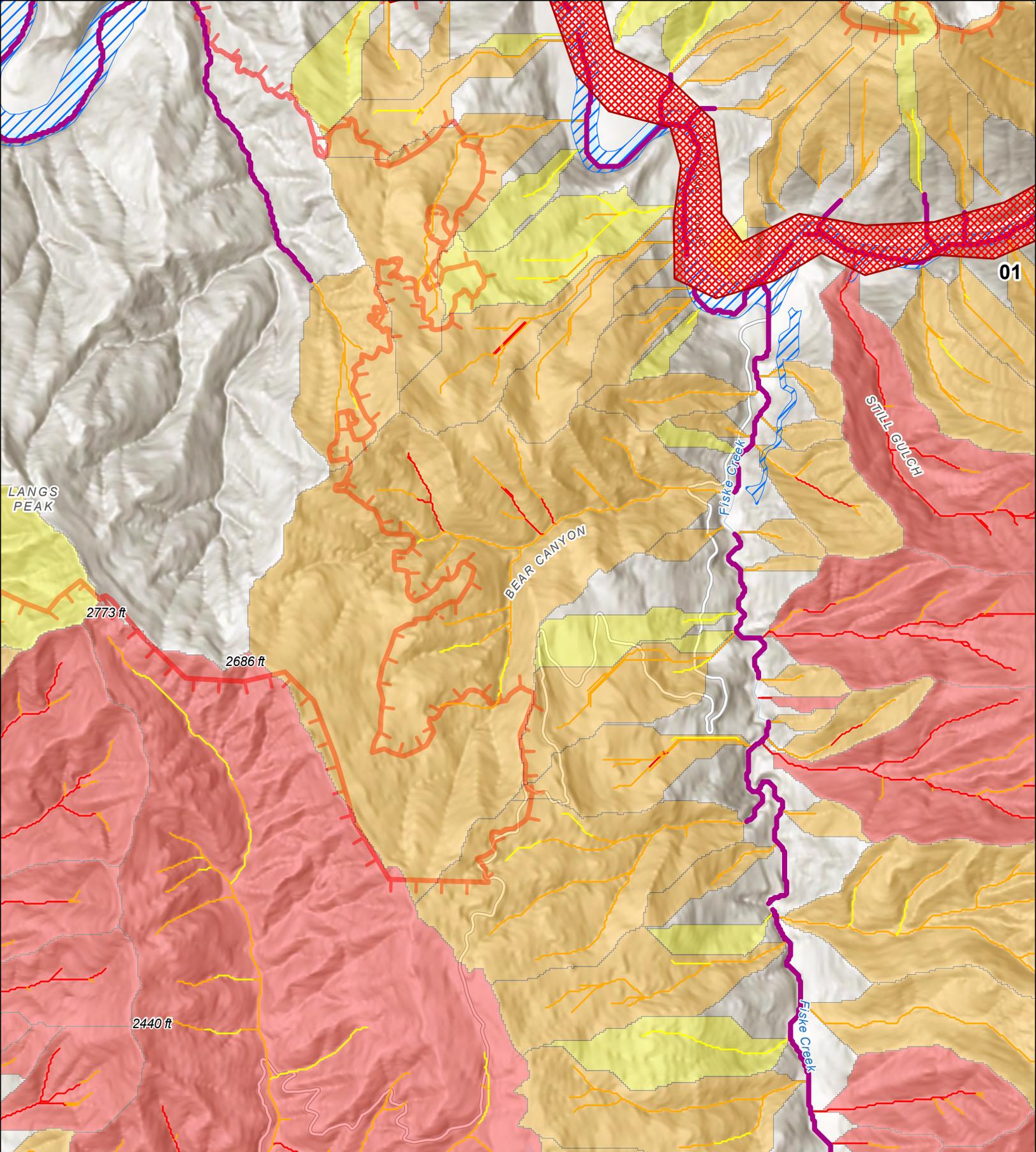
Fire Perimeters



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Scale: 1:24,000



Incident: CA-LNU-013407
LNU Lightning Complex
Hennessey Fire



Value at Risk (Point)

Potential hazard to life

- High
- Moderate
- Low

Values at Risk (Polygon)

Potential hazard to life

- high
- Moderate
- Low

Segment Combined Hazard

- High
- Moderate
- Low

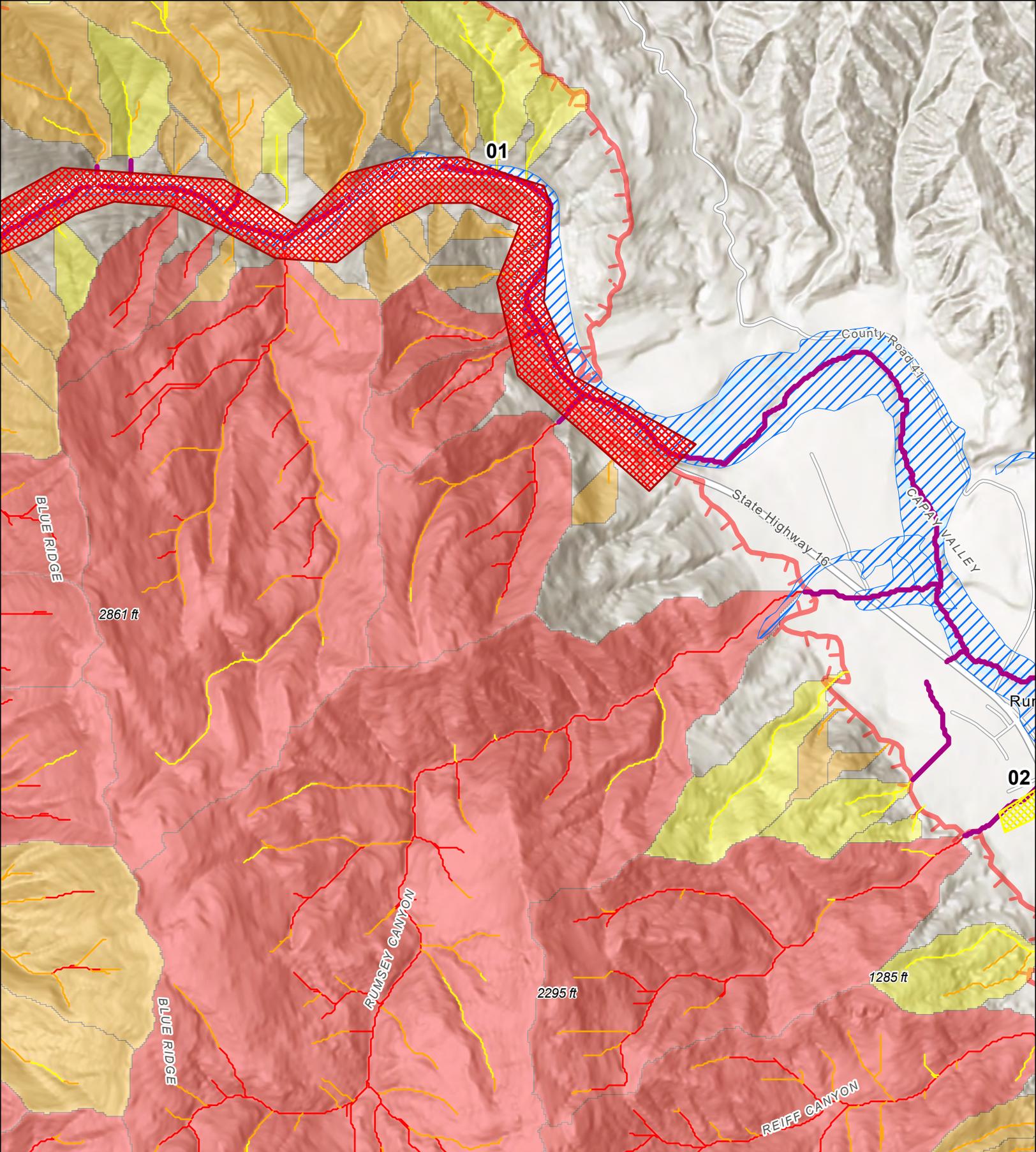
Basin Combined Hazard

- High
- Moderate
- Low

USGS Watchstream

FEMA/DWR Floodplain

Fire Perimeters



Incident: CA-LNU-013407
LNU Lightning Complex
Hennessey Fire



Date Saved: 9/20/2020 9:36 AM

Value at Risk (Point)

Potential hazard to life

- High
- Moderate
- Low

Values at Risk (Polygon)

Potential hazard to life

- + high
- + Moderate
- + Low

Segment Combined Hazard

15 min 36mm/hr

- High
- Moderate
- Low

Basin Combined Hazard

15 min 36mm/hr

- High
- Moderate
- Low

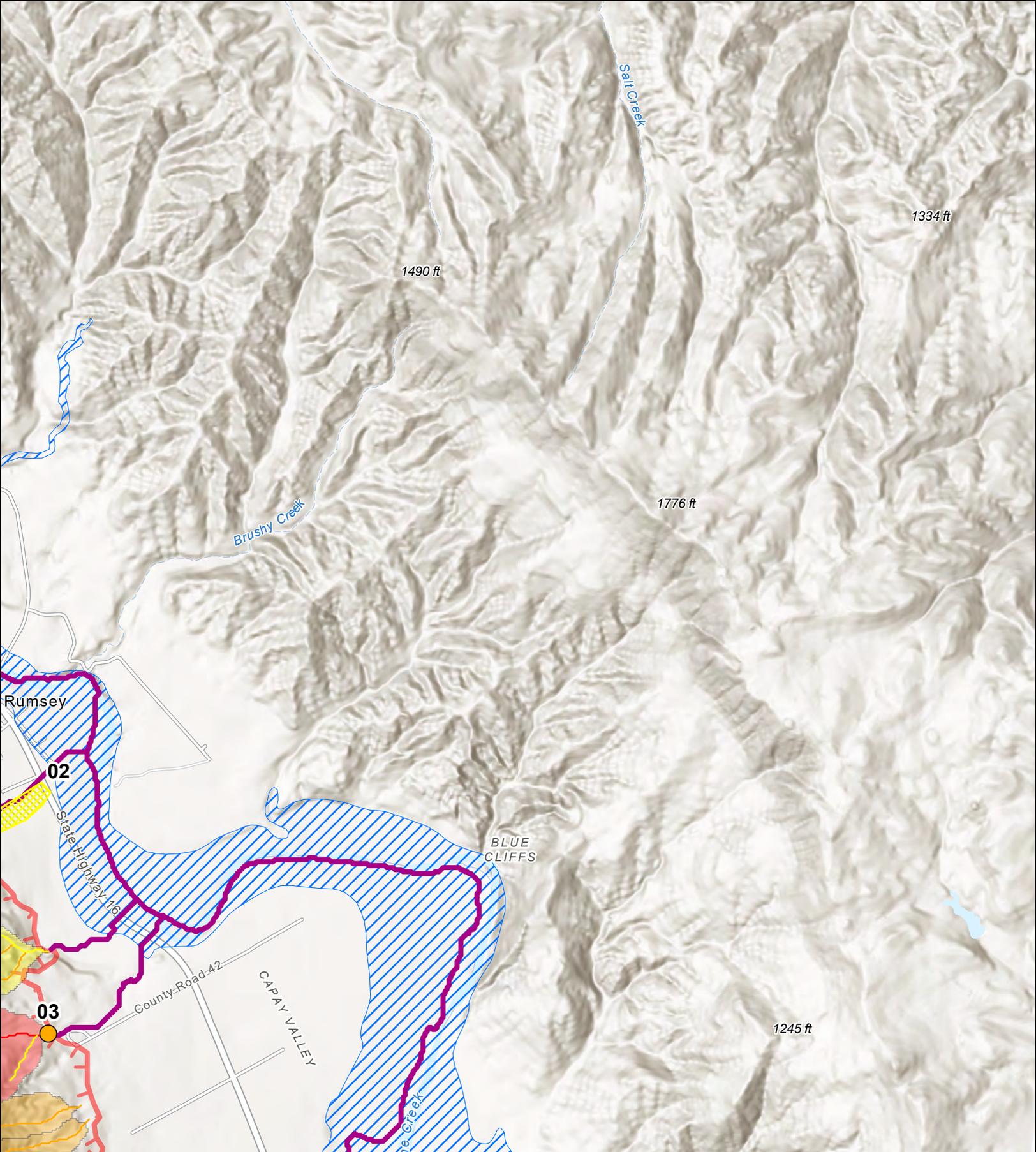
— USGS Watchstream

FEMA/DWR Floodplain

Fire Perimeters



Scale: 1:24,000



Incident: CA-LNU-013407
LNU Lightning Complex
Hennessey Fire



Value at Risk (Point)

Potential hazard to life

- High
- Moderate
- Low

Values at Risk (Polygon)

Potential hazard to life

- high
- Moderate
- Low

Segment Combined Hazard

- High
- Moderate
- Low

Basin Combined Hazard

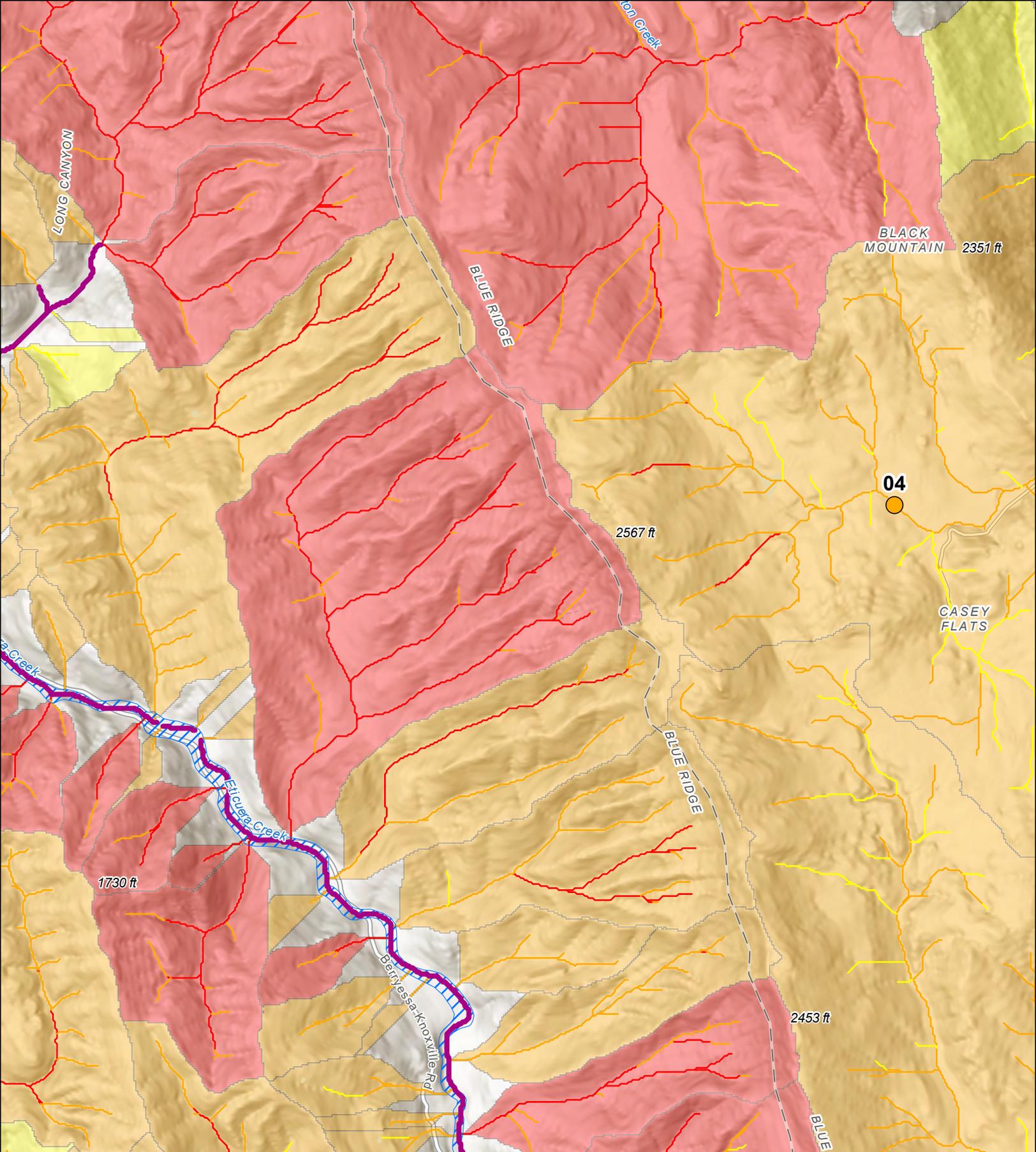
- High
- Moderate
- Low

USGS Watchstream

USGS Watchstream

FEMA/DWR Floodplain

Fire Perimeters



Incident: CA-LNU-013407
LNU Lightning Complex
Hennessey Fire



Date Saved: 9/20/2020 9:36 AM

Value at Risk (Point)

Potential hazard to life

- High
- Moderate
- Low

Values at Risk (Polygon)

Potential hazard to life

- high
- Moderate
- Low

Segment Combined Hazard

- High
- Moderate
- Low

Basin Combined Hazard

- High
- Moderate
- Low

USGS Watchstream

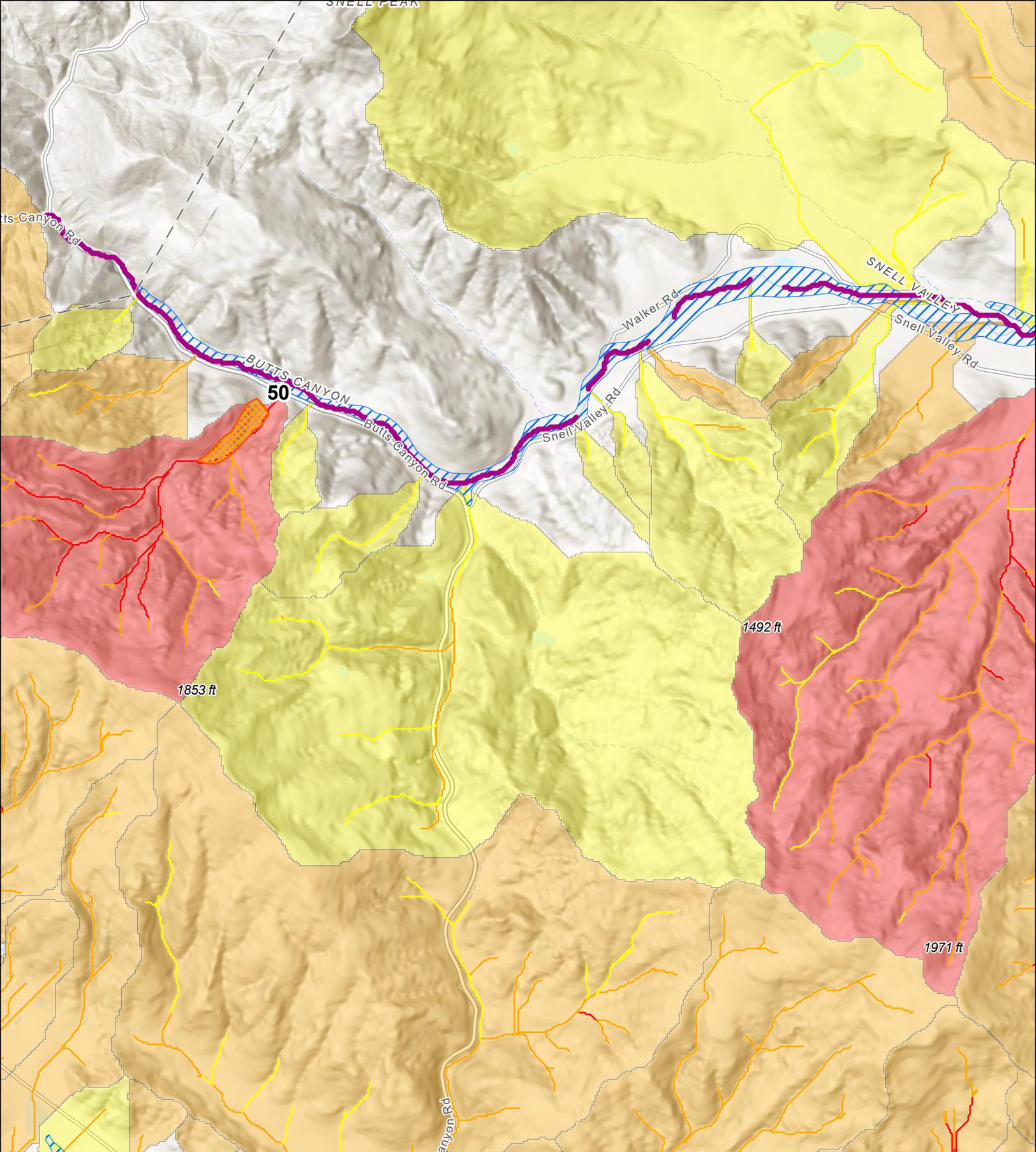
USGS Watchstream

FEMA/DWR Floodplain

Fire Perimeters



Scale: 1:24,000



Incident: CA-LNU-013407
LNU Lightning Complex
Hennessey Fire



Date Saved: 9/20/2020 9:36 AM

Value at Risk (Point)

Potential hazard to life

- High
- Moderate
- Low

Values at Risk (Polygon)

Potential hazard to life

- high
- Moderate
- Low

Segment Combined Hazard

- 15 min 36mm/hr High
- Moderate
- Low

Basin Combined Hazard

- 15 min 36mm/hr High
- Moderate
- Low

USGS Watchstream

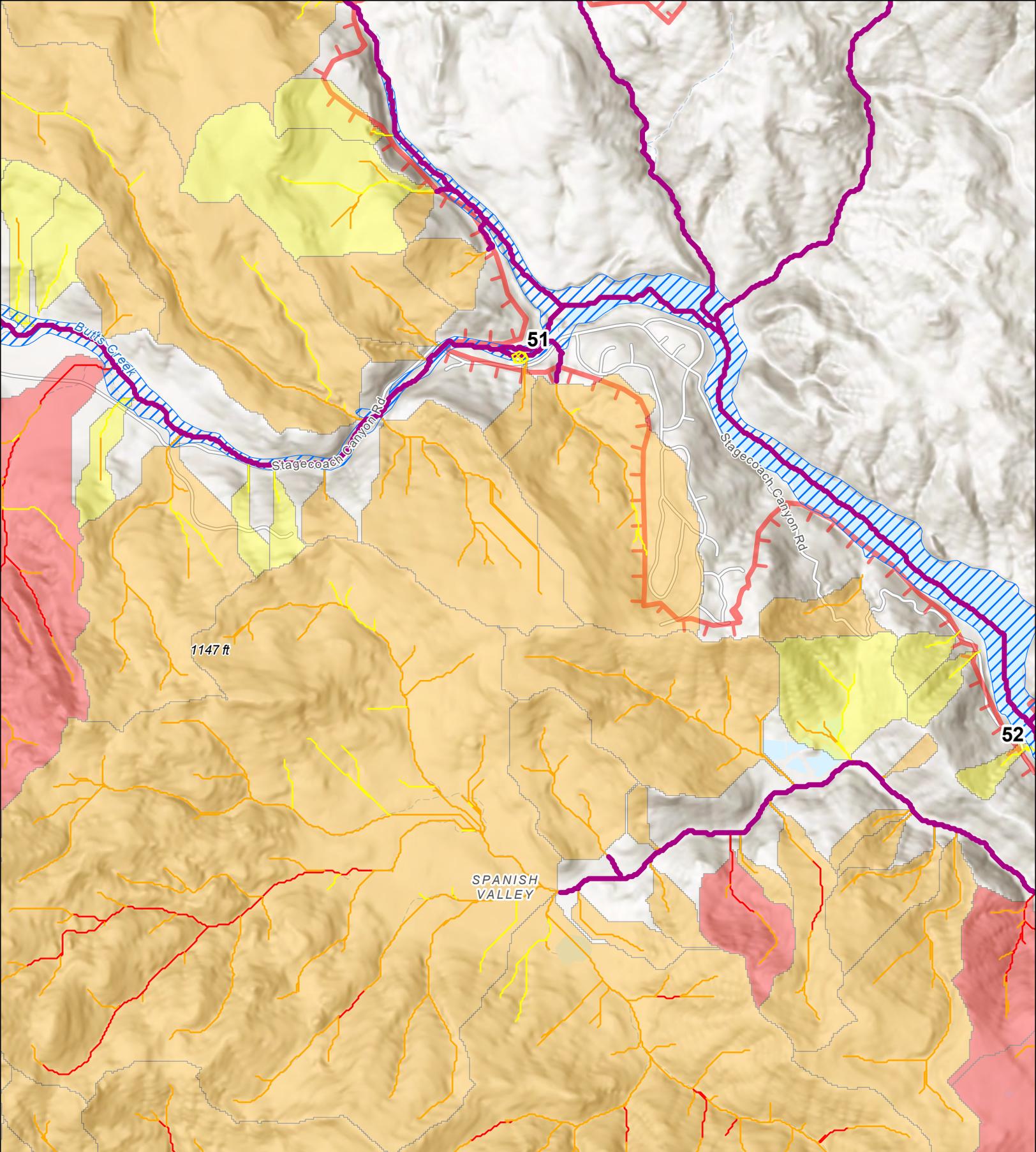
USGS Watchstream

FEMA/DWR Floodplain

Fire Perimeters



Scale: 1:24,000



Incident: CA-LNU-013407
LNU Lightning Complex
Hennessey Fire



Date Saved: 9/20/2020 9:36 AM

Value at Risk (Point)

Potential hazard to life

- High
- Moderate
- Low

Values at Risk (Polygon)

Potential hazard to life

- high
- Moderate
- Low

Segment Combined Hazard

15 min 36mm/hr

- High
- Moderate
- Low

Basin Combined Hazard

15 min 36mm/hr

- High
- Moderate
- Low

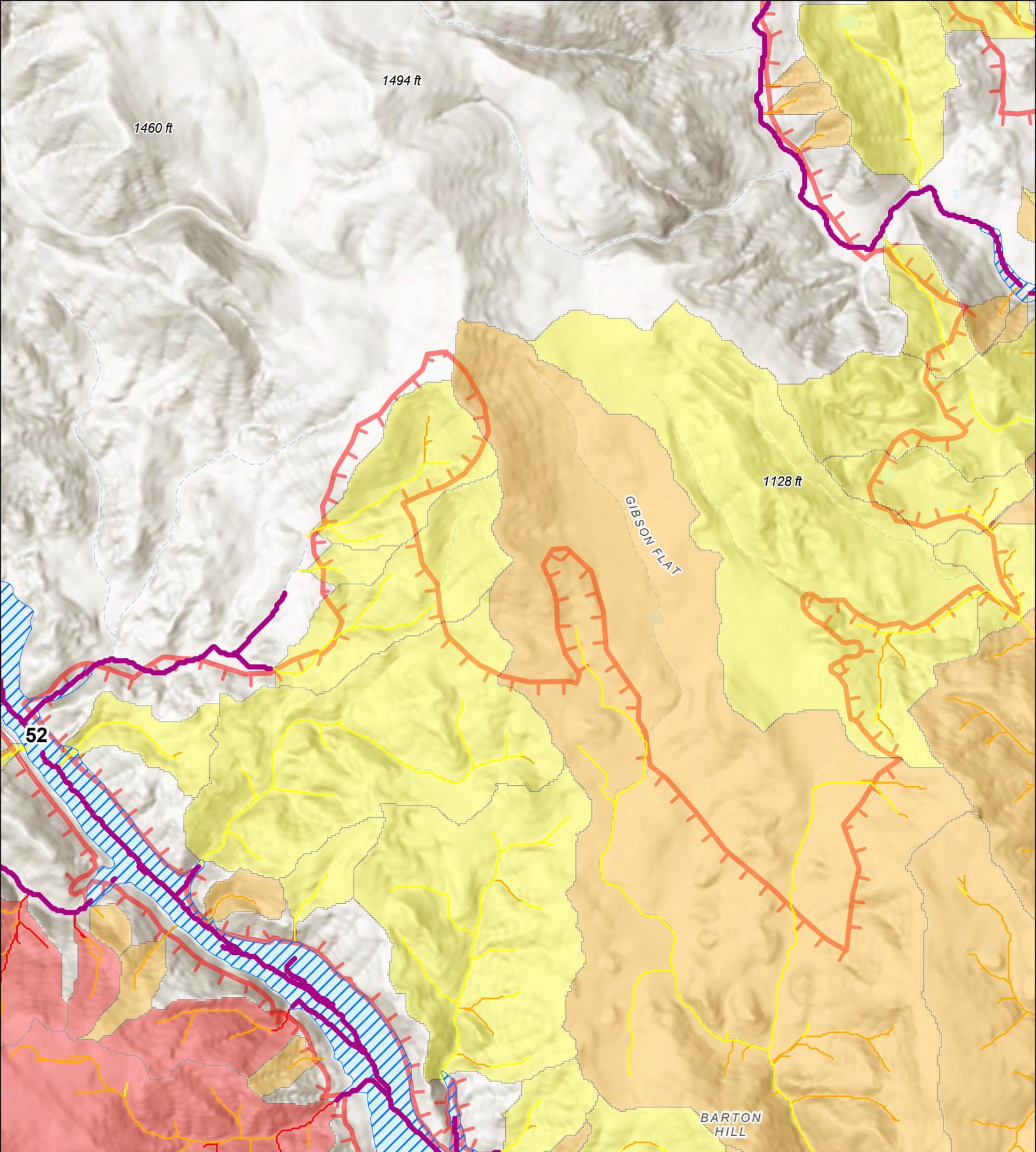
USGS Watchstream

FEMA/DWR Floodplain

Fire Perimeters



Scale: 1:24,000



Incident: CA-LNU-013407
LNU Lightning Complex
Hennessey Fire



Date Saved: 9/20/2020 9:36 AM

Value at Risk (Point)

Potential hazard to life

- High
- Moderate
- Low

Values at Risk (Polygon)

Potential hazard to life

- high
- Moderate
- Low

Segment Combined Hazard

- 15 min 36mm/hr High
- Moderate
- Low

Basin Combined Hazard

- 15 min 36mm/hr High
- Moderate
- Low

USGS Watchstream

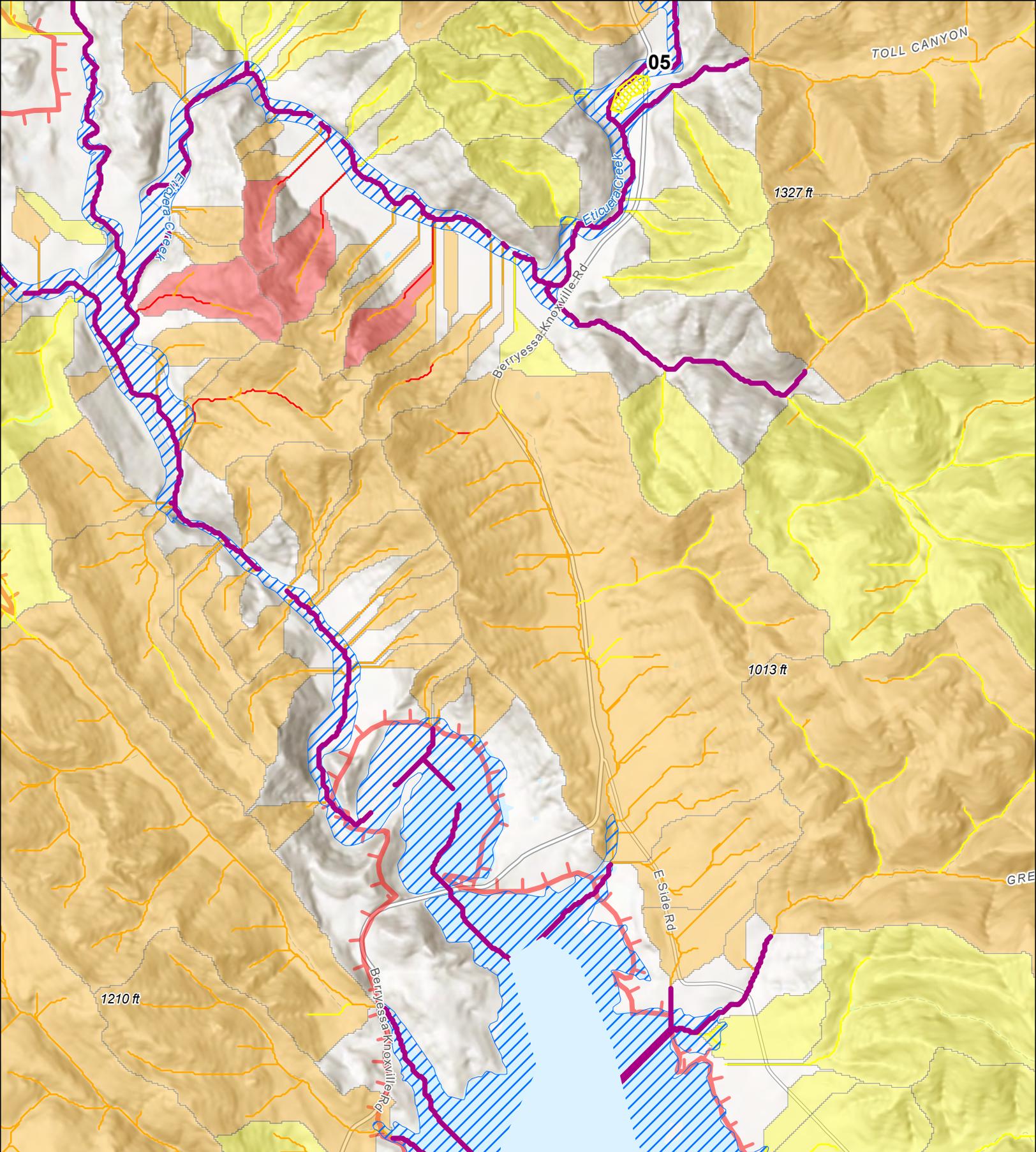
— USGS Watchstream

FEMA/DWR Floodplain

Fire Perimeters



Scale: 1:24,000



Incident: CA-LNU-013407
LNU Lightning Complex
Hennessey Fire

Value at Risk (Point)
Potential hazard to life

- High
- Moderate
- Low

Values at Risk (Polygon)
Potential hazard to life

- high
- Moderate
- Low

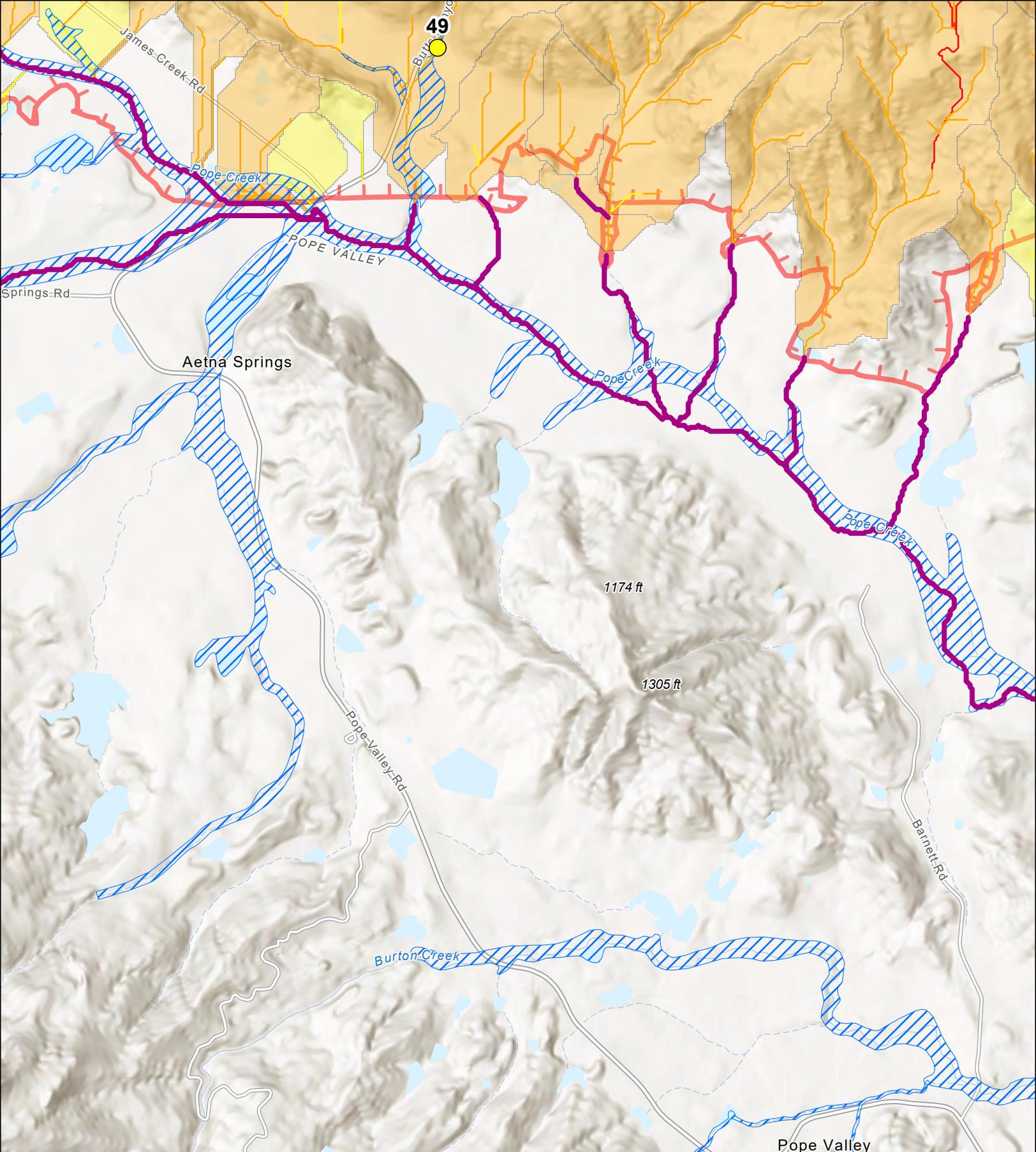
Segment Combined Hazard

- High
- Moderate
- Low

Basin Combined Hazard

- High
- Moderate
- Low

- USGS Watchstream
- FEMA/DWR Floodplain
- Fire Perimeters



Incident: CA-LNU-013407
LNU Lightning Complex
Hennessey Fire



Date Saved: 9/20/2020 9:36 AM

Value at Risk (Point)

Potential hazard to life

- High
- Moderate
- Low

Values at Risk (Polygon)

Potential hazard to life

- high
- Moderate
- Low

Segment Combined Hazard

- High
- Moderate
- Low

Basin Combined Hazard

- High
- Moderate
- Low

USGS Watchstream

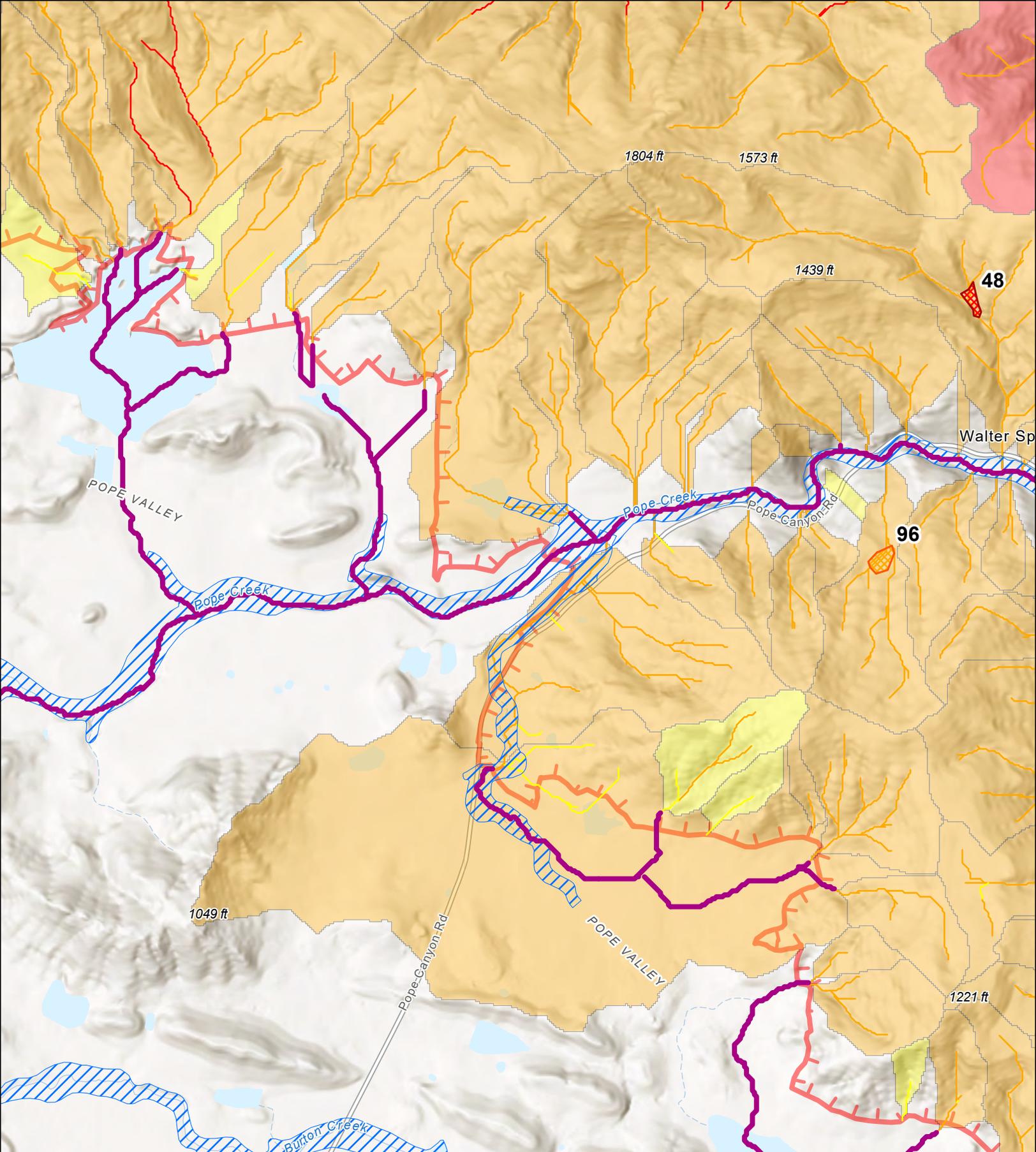
USGS Watchstream

FEMA/DWR Floodplain

Fire Perimeters



Scale: 1:24,000



Incident: CA-LNU-013407
LNU Lightning Complex
Hennessey Fire



Date Saved: 9/20/2020 9:36 AM

Value at Risk (Point)

Potential hazard to life

- High
- Moderate
- Low

Values at Risk (Polygon)

Potential hazard to life

- high
- Moderate
- Low

Segment Combined Hazard

15 min 36mm/hr

- High
- Moderate
- Low

Basin Combined Hazard

15 min 36mm/hr

- High
- Moderate
- Low

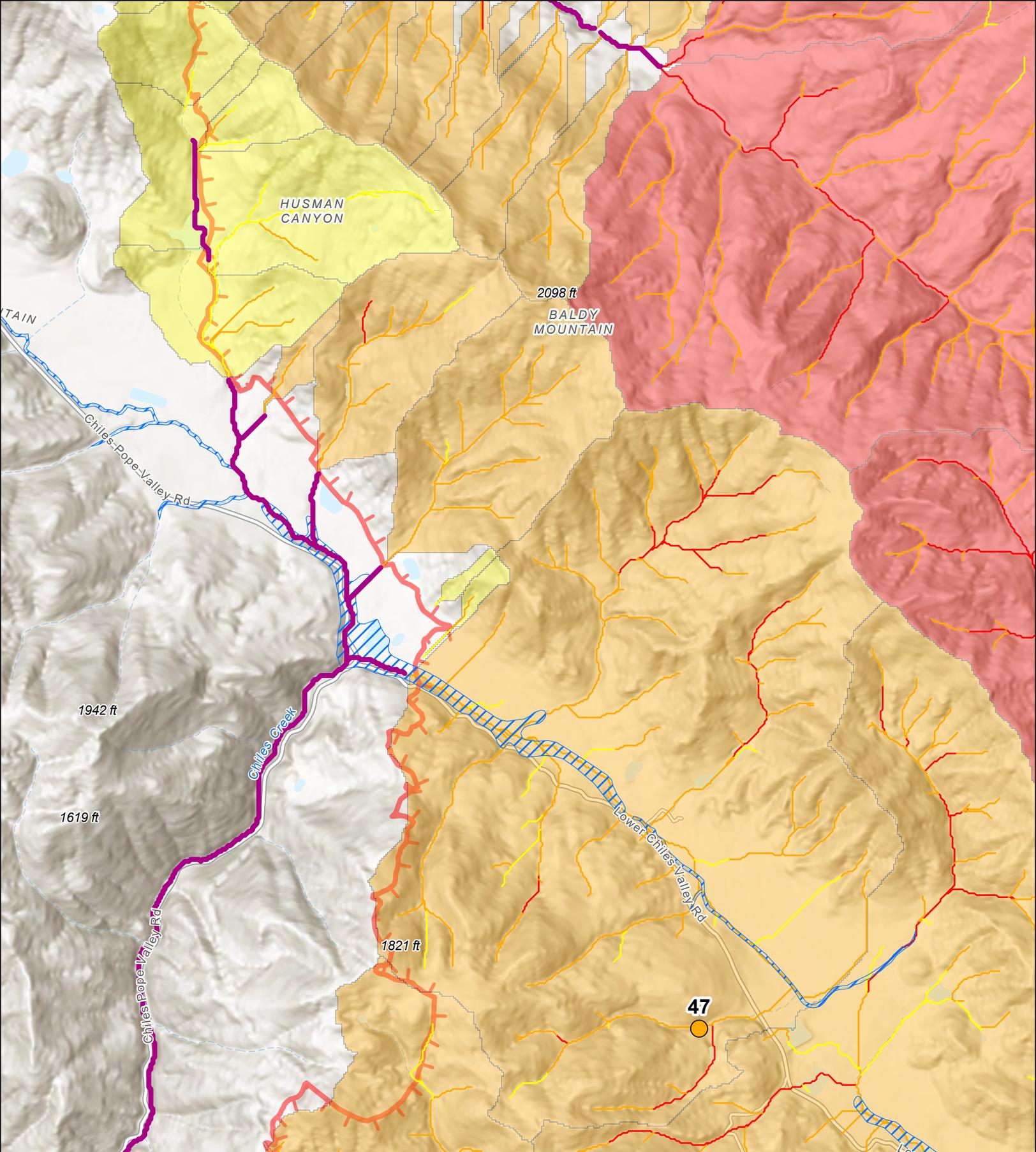
USGS Watchstream

FEMA/DWR Floodplain

Fire Perimeters



Scale: 1:24,000



Incident: CA-LNU-013407
LNU Lightning Complex
Hennessey Fire



Value at Risk (Point)

Potential hazard to life

- High
- Moderate
- Low

Values at Risk (Polygon)

Potential hazard to life

- high
- Moderate
- Low

Segment Combined Hazard

15 min 36mm/hr

- High
- Moderate
- Low

Basin Combined Hazard

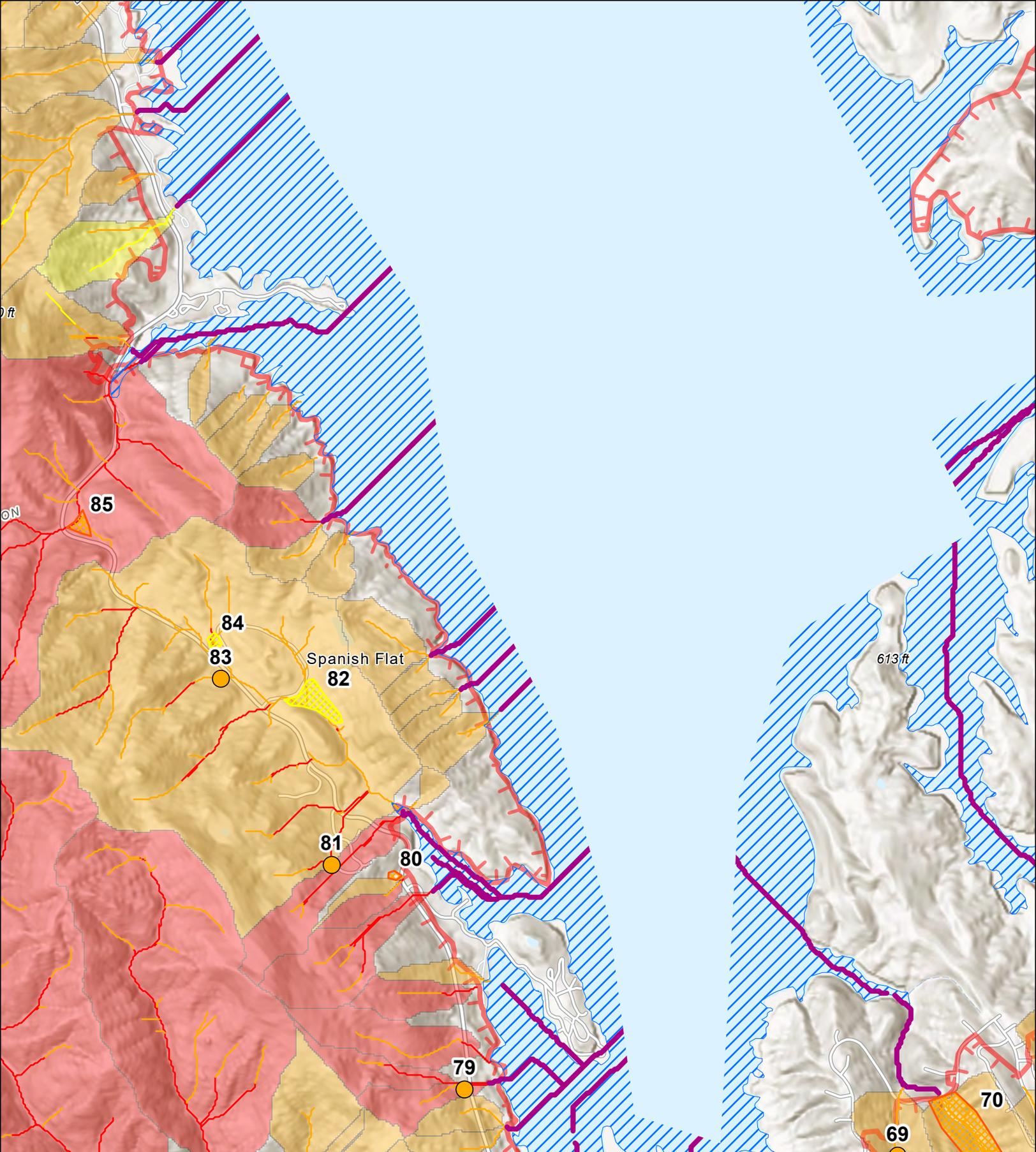
15 min 36mm/hr

- High
- Moderate
- Low

USGS Watchstream

FEMA/DWR Floodplain

- Fire Perimeters



Incident: CA-LNU-013407
LNU Lightning Complex
Hennessey Fire



Date Saved: 9/20/2020 9:36 AM

Value at Risk (Point)

Potential hazard to life

- High
- Moderate
- Low

Values at Risk (Polygon)

Potential hazard to life

- high
- Moderate
- Low

Segment Combined Hazard

- 15 min 36mm/hr High
- Moderate
- Low

Basin Combined Hazard

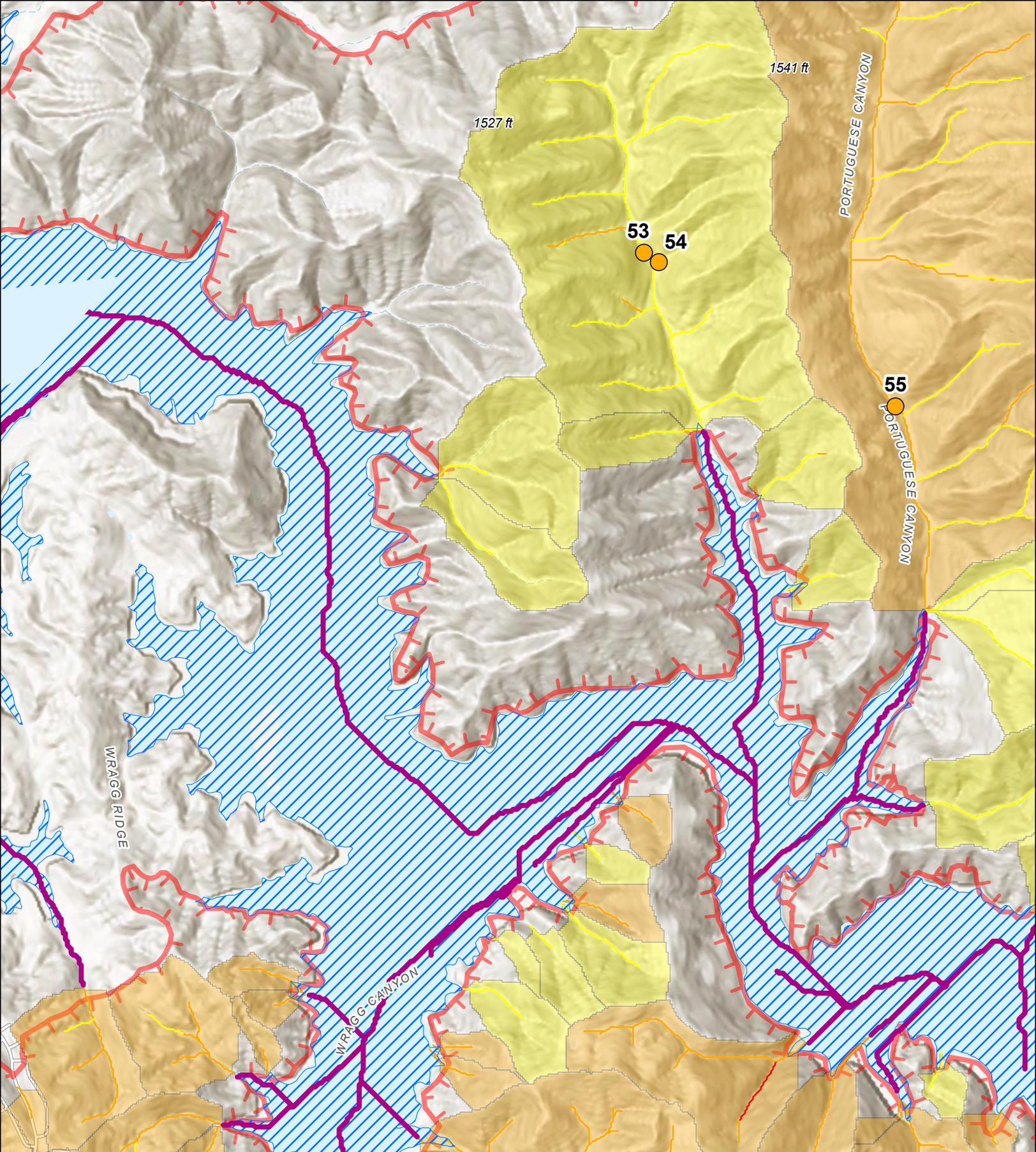
- 15 min 36mm/hr High
- Moderate
- Low

USGS Watchstream

- FEMA/DWR Floodplain
- Fire Perimeters



Scale: 1:24,000



Incident: CA-LNU-013407
LNU Lightning Complex
Hennessey Fire



Date Saved: 9/20/2020 9:36 AM

Value at Risk (Point)

Potential hazard to life

- High
- Moderate
- Low

Values at Risk (Polygon)

Potential hazard to life

- high
- Moderate
- Low

Segment Combined Hazard

- High
- Moderate
- Low

Basin Combined Hazard

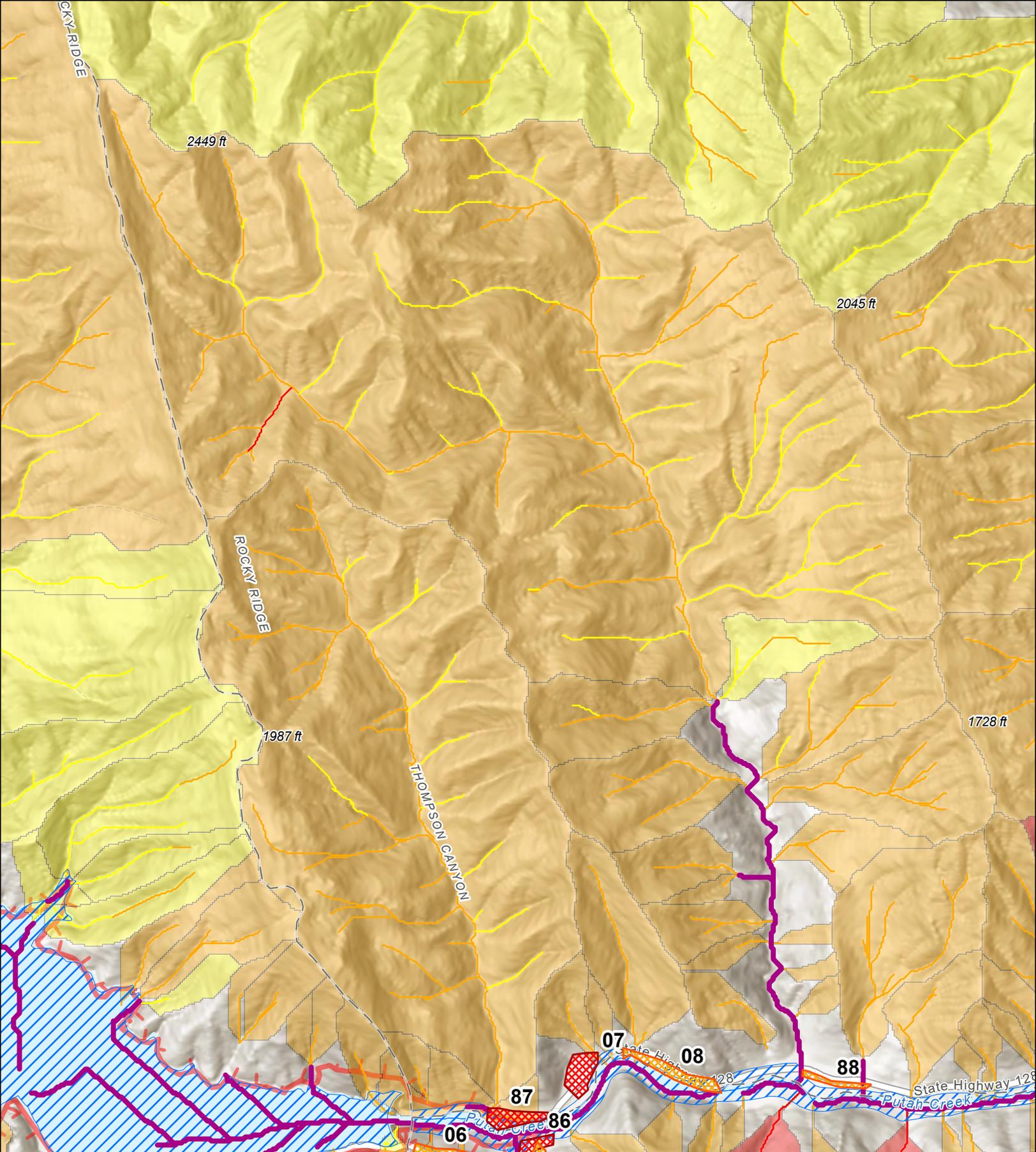
- High
- Moderate
- Low

USGS Watchstream

- FEMA/DWR Floodplain
- Fire Perimeters



Scale: 1:24,000



Incident: CA-LNU-013407
LNU Lightning Complex
Hennessey Fire



Date Saved: 9/20/2020 9:36 AM

Value at Risk (Point)

Potential hazard to life

- High
- Moderate
- Low

Values at Risk (Polygon)

Potential hazard to life

- high
- Moderate
- Low

Segment Combined Hazard

- 15 min 36mm/hr High
- Moderate
- Low

Basin Combined Hazard

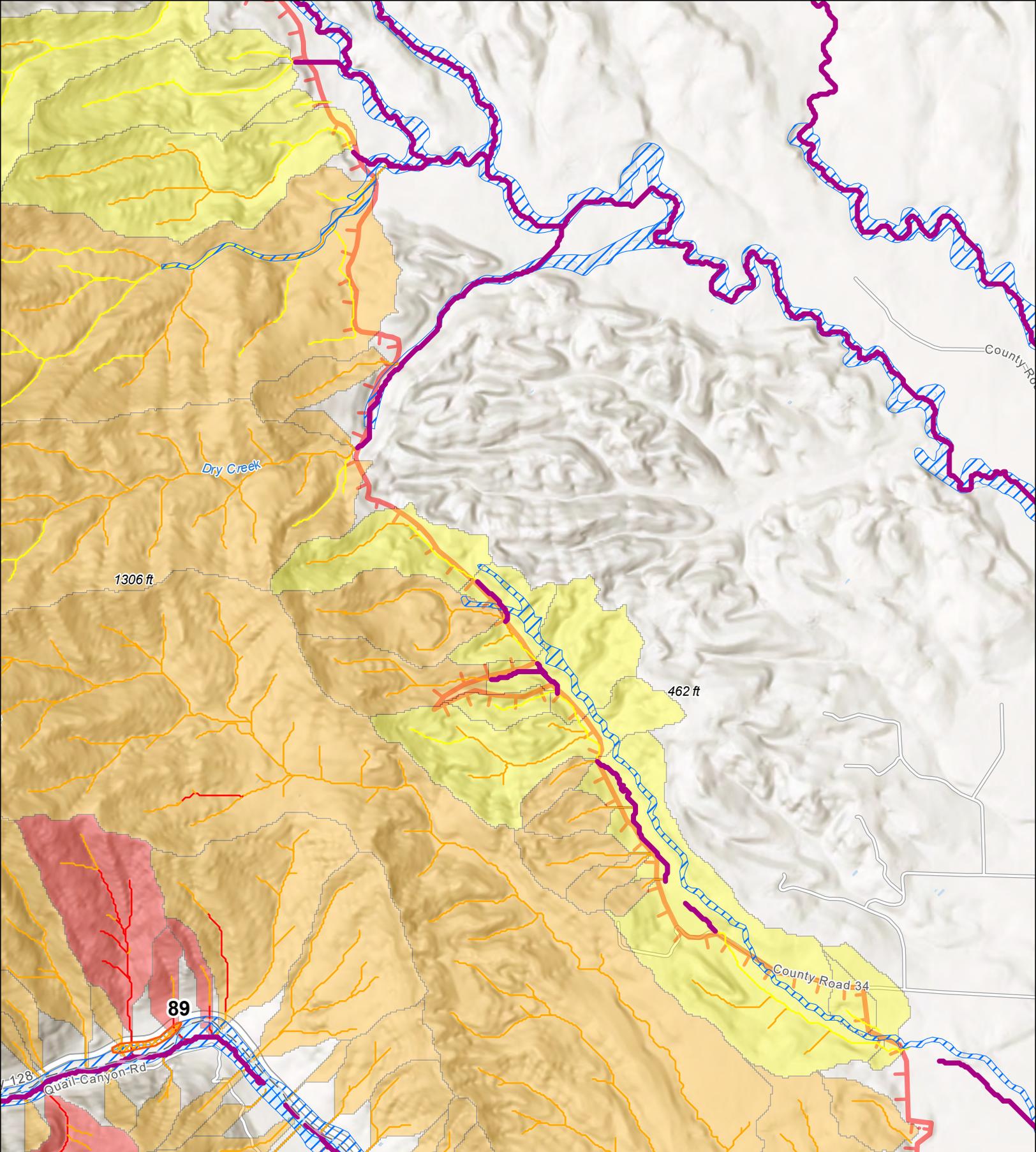
- 15 min 36mm/hr High
- Moderate
- Low

USGS Watchstream

- FEMA/DWR Floodplain
- Fire Perimeters



Scale: 1:24,000



Incident: CA-LNU-013407
LNU Lightning Complex
Hennessey Fire



Date Saved: 9/20/2020 9:36 AM

Value at Risk (Point)

Potential hazard to life

- High
- Moderate
- Low

Values at Risk (Polygon)

Potential hazard to life

- high
- Moderate
- Low

Segment Combined Hazard

- High
- Moderate
- Low

Basin Combined Hazard

- High
- Moderate
- Low

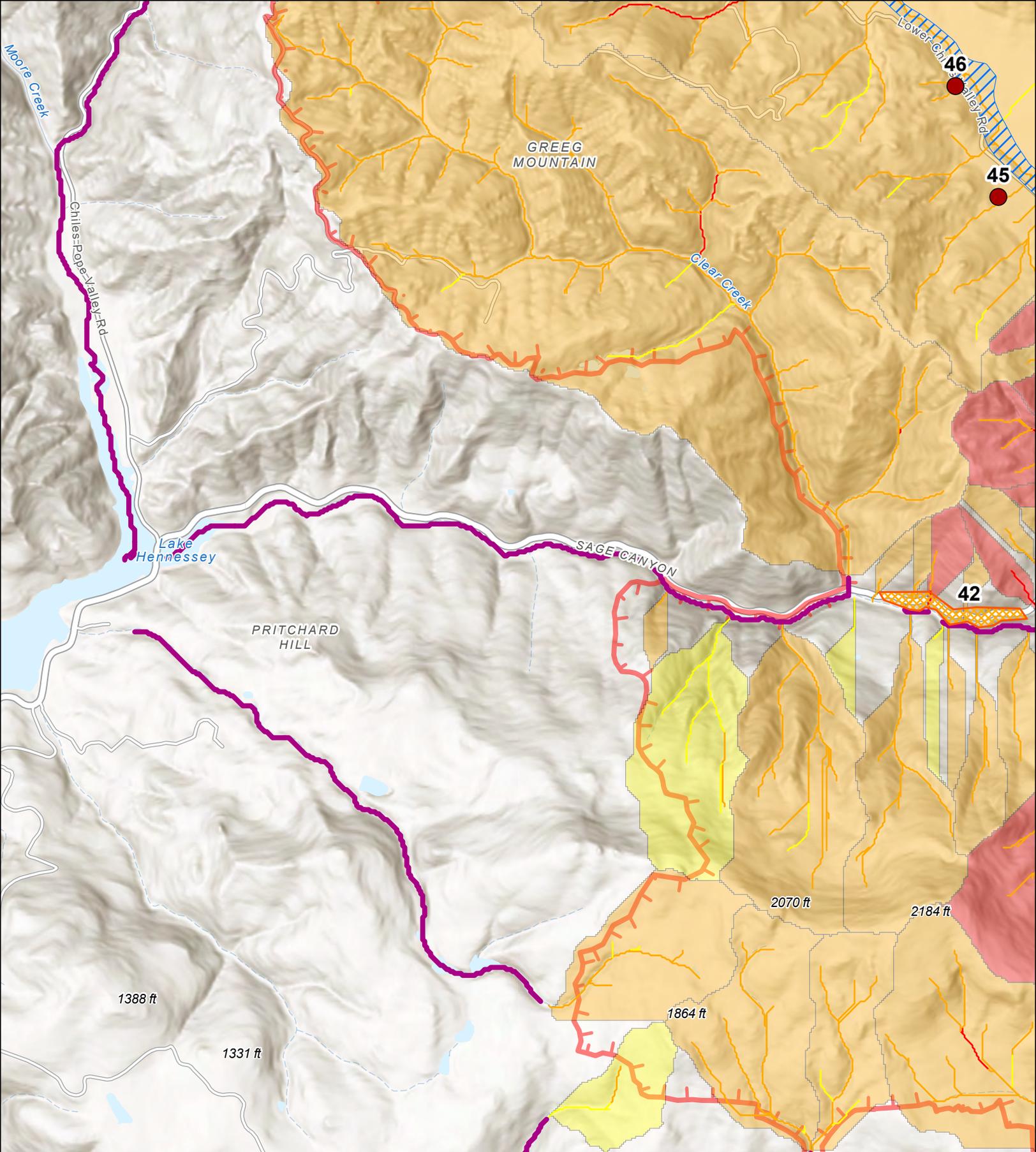
USGS Watchstream

FEMA/DWR Floodplain

Fire Perimeters



Scale: 1:24,000



Incident: CA-LNU-013407
LNU Lightning Complex
Hennessey Fire



Value at Risk (Point)

Potential hazard to life

- High
- Moderate
- Low

Values at Risk (Polygon)

Potential hazard to life

- high
- Moderate
- Low

Segment Combined Hazard

- High
- Moderate
- Low

Basin Combined Hazard

- High
- Moderate
- Low

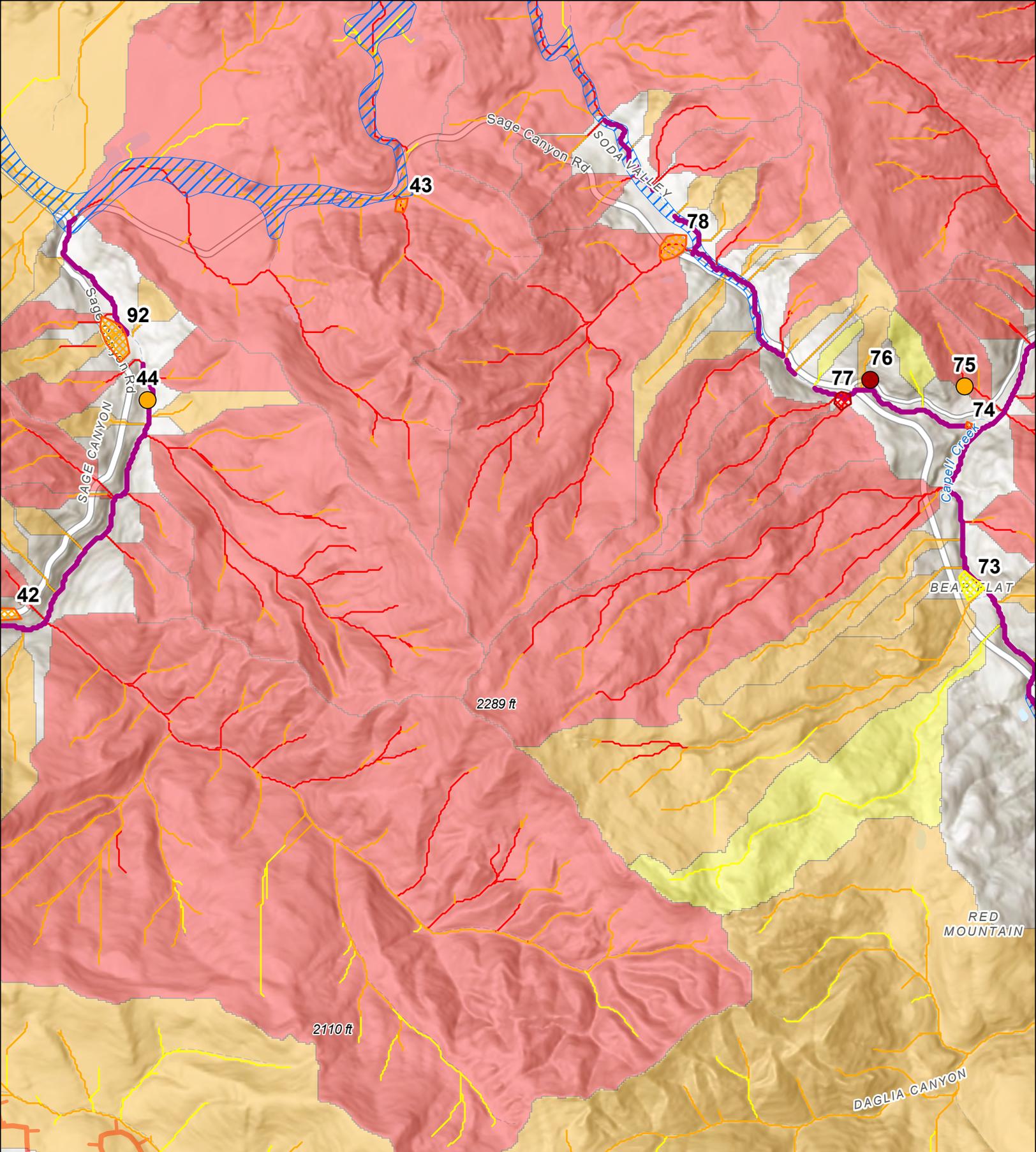
USGS Watchstream

FEMA/DWR Floodplain

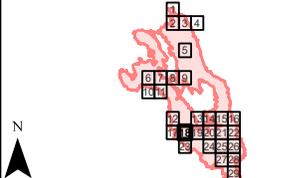
Fire Perimeters



Scale: 1:24,000



Incident: CA-LNU-013407
LNU Lightning Complex
Hennessey Fire



Date Saved: 9/20/2020 9:36 AM

Value at Risk (Point)

Potential hazard to life

- High
- Moderate
- Low

Values at Risk (Polygon)

Potential hazard to life

- high
- Moderate
- Low

Segment Combined Hazard

- High
- Moderate
- Low

Basin Combined Hazard

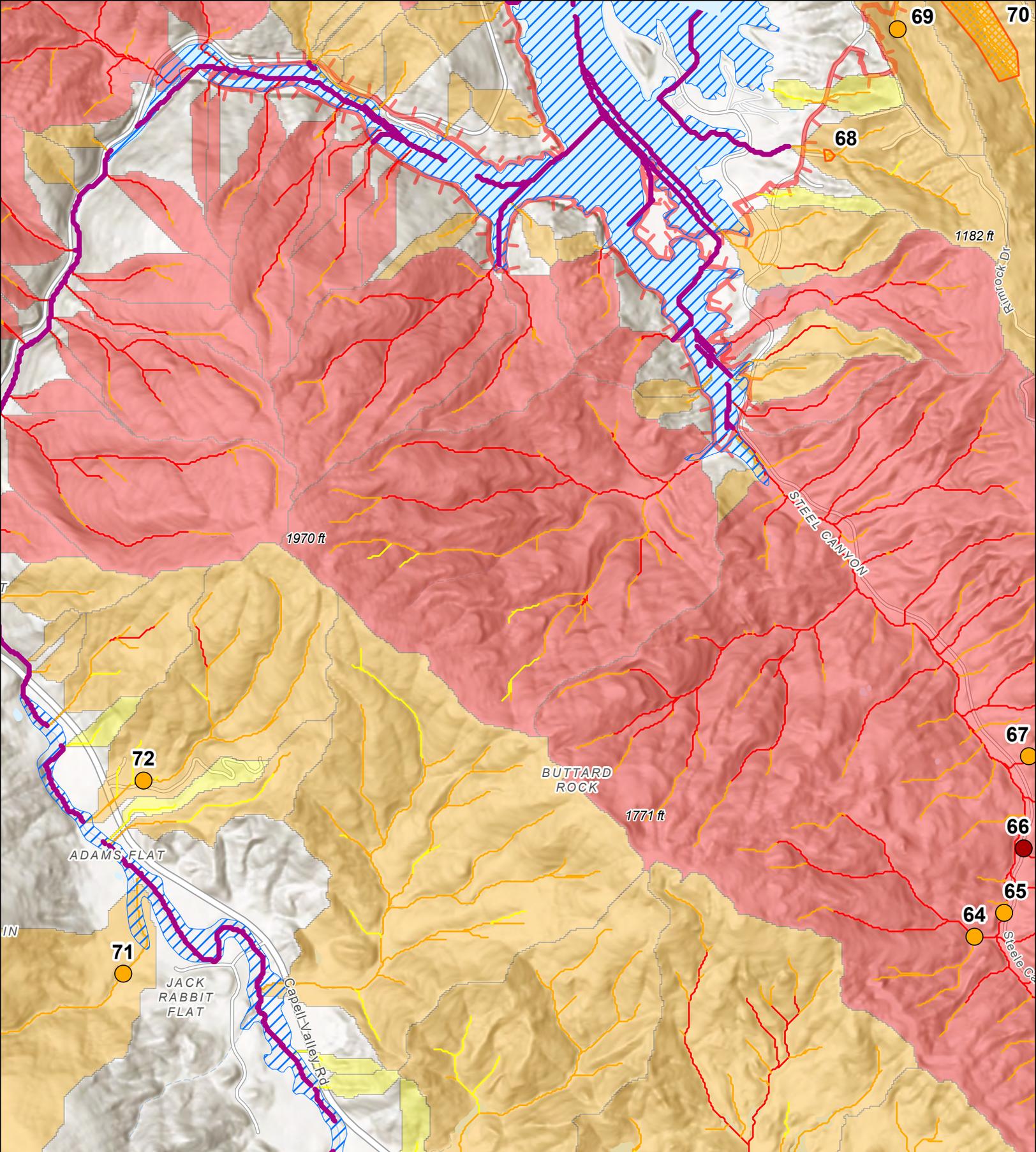
- High
- Moderate
- Low

USGS Watchstream

- FEMA/DWR Floodplain
- Fire Perimeters



Scale: 1:24,000



Incident: CA-LNU-013407
LNU Lightning Complex
Hennessey Fire



Value at Risk (Point)

Potential hazard to life

- High
- Moderate
- Low

Values at Risk (Polygon)

Potential hazard to life

- high
- Moderate
- Low

Segment Combined Hazard

- 15 min 36mm/hr High
- Moderate
- Low

Basin Combined Hazard

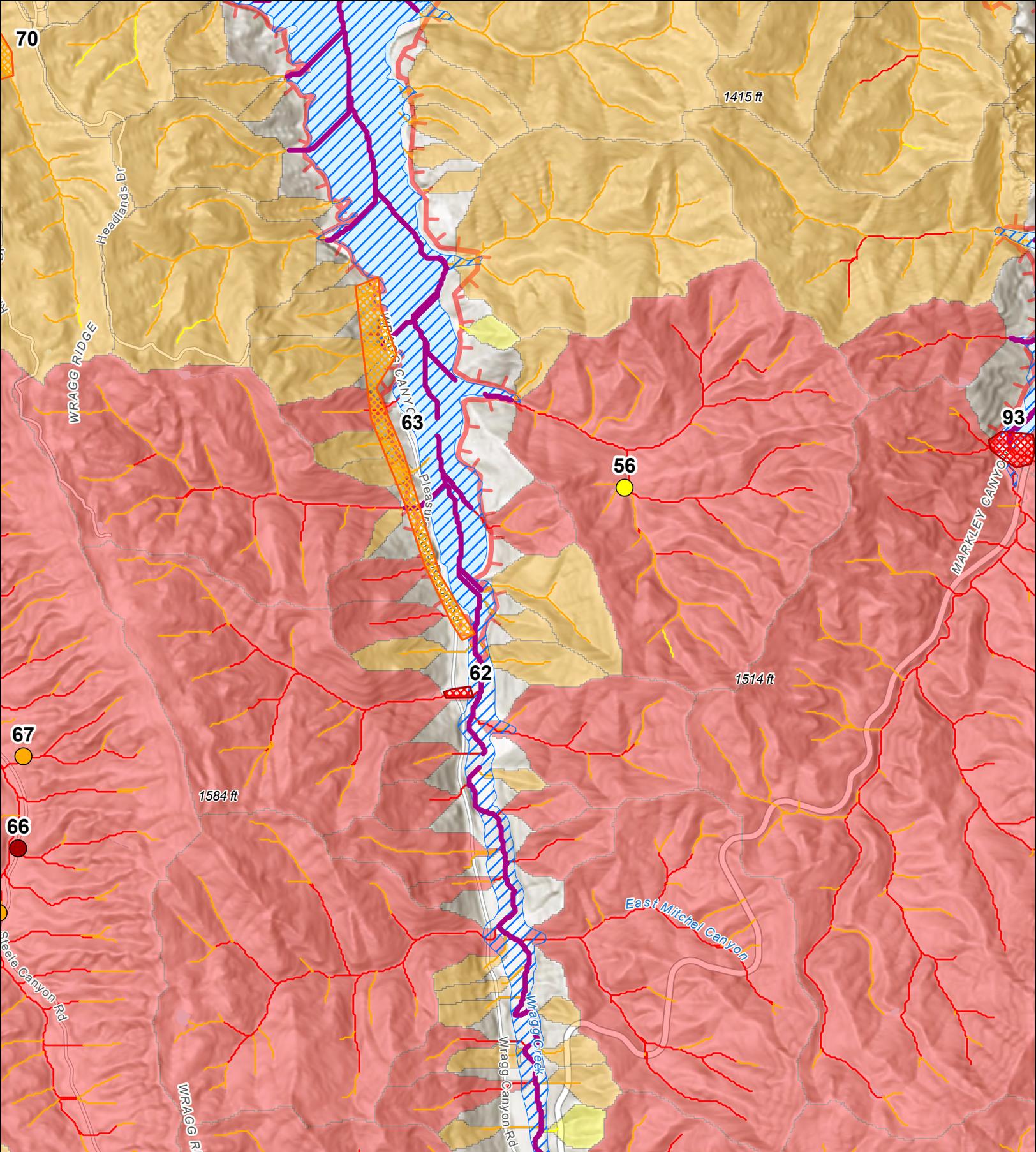
- 15 min 36mm/hr High
- Moderate
- Low

USGS Watchstream

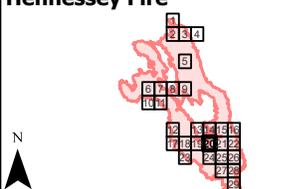
FEMA/DWR Floodplain

Fire Perimeters





Incident: CA-LNU-013407
LNU Lightning Complex
Hennessey Fire



Date Saved: 9/20/2020 9:36 AM

Value at Risk (Point)

Potential hazard to life

- High
- Moderate
- Low

Values at Risk (Polygon)

Potential hazard to life

- high
- Moderate
- Low

Segment Combined Hazard

- High
- Moderate
- Low

Basin Combined Hazard

- High
- Moderate
- Low

USGS Watchstream

— USGS Watchstream

FEMA/DWR Floodplain

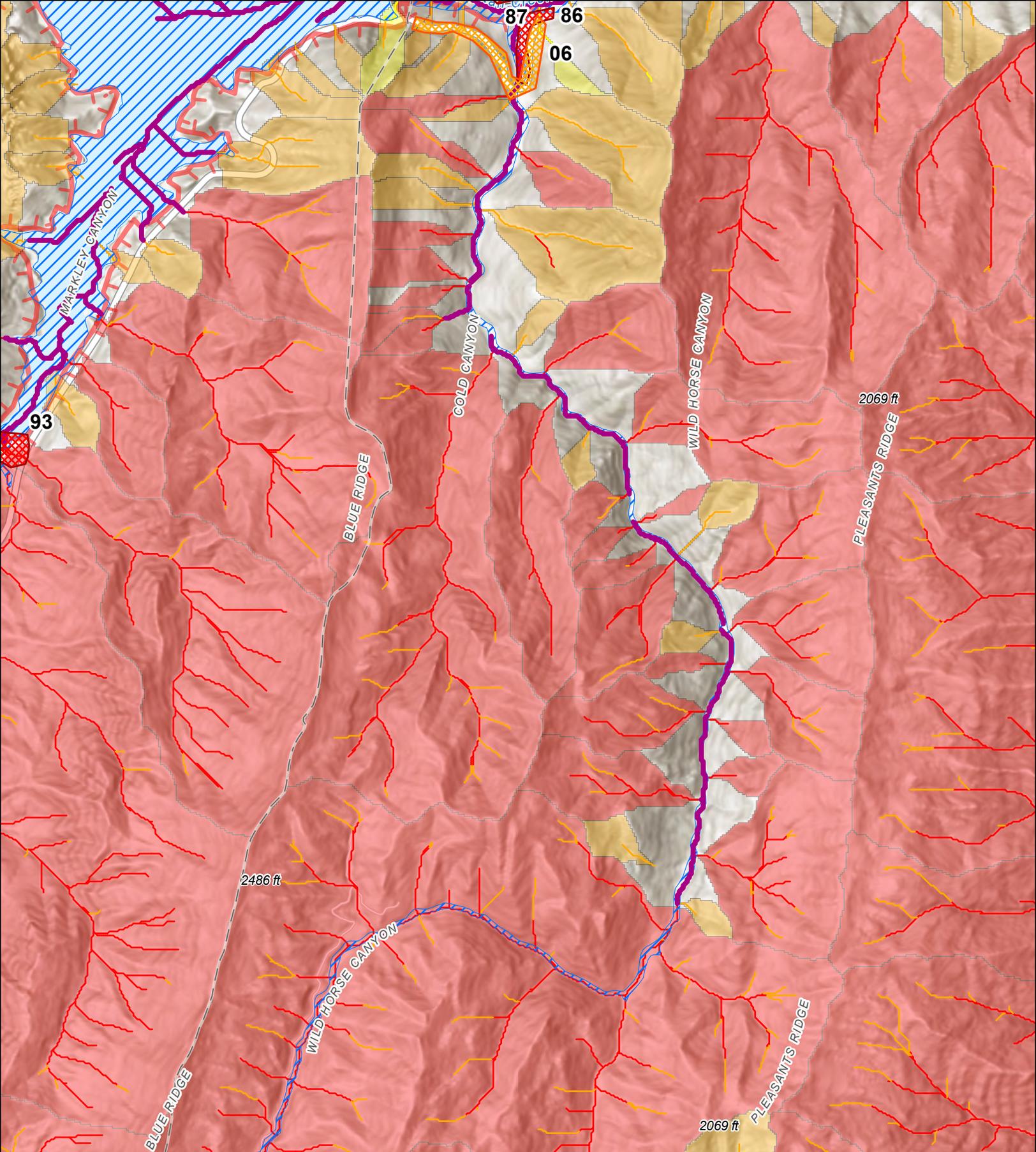
FEMA/DWR Floodplain

Fire Perimeters

Fire Perimeters



Scale: 1:24,000



Incident: CA-LNU-013407
LNU Lightning Complex
Hennessey Fire



Date Saved: 9/20/2020 9:36 AM

Value at Risk (Point)

Potential hazard to life

- High
- Moderate
- Low

Values at Risk (Polygon)

Potential hazard to life

- high
- Moderate
- Low

Segment Combined Hazard

- High
- Moderate
- Low

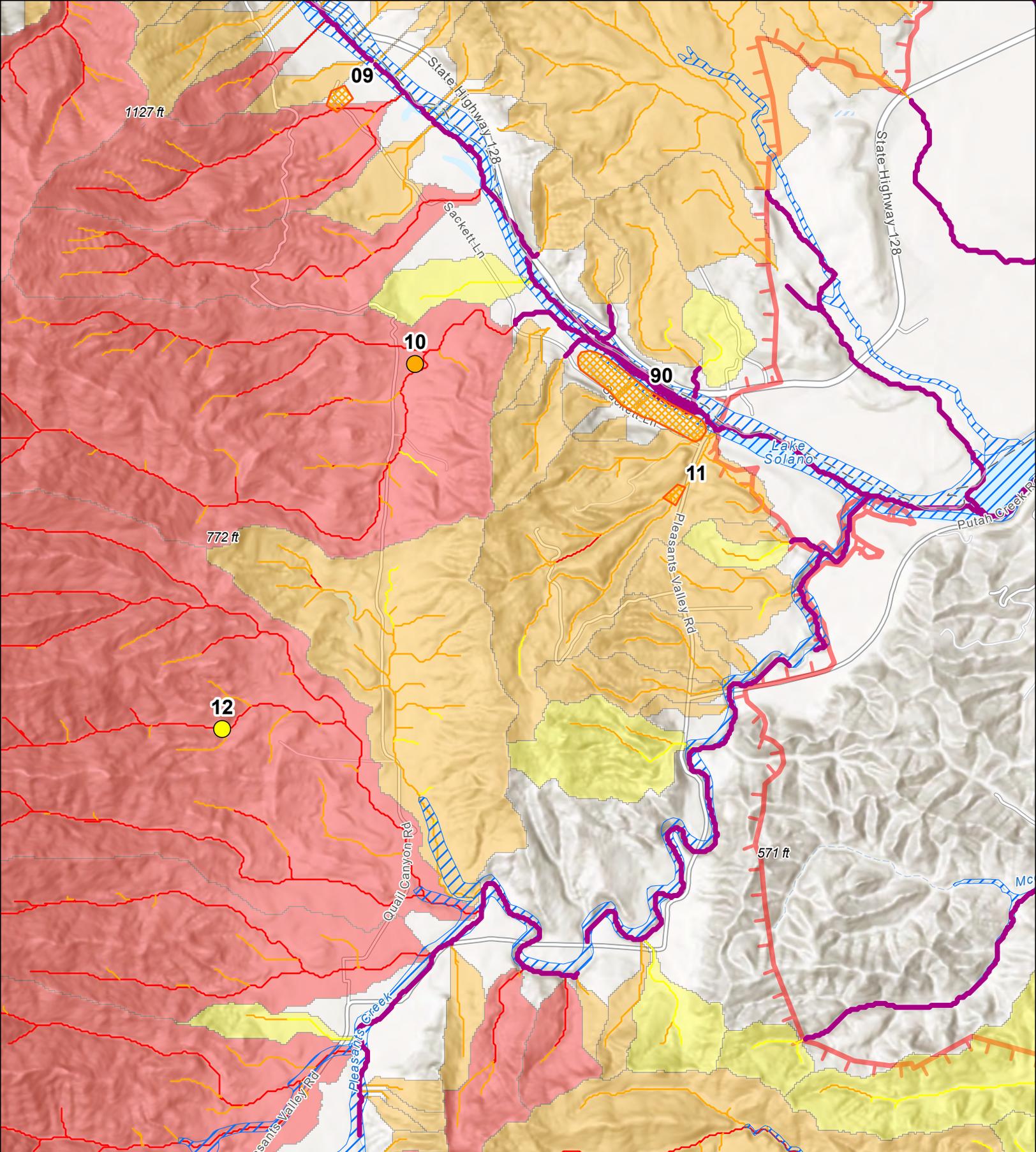
Basin Combined Hazard

- High
- Moderate
- Low

Legend

- USGS Watchstream
- FEMA/DWR Floodplain
- Fire Perimeters





Incident: CA-LNU-013407
LNU Lightning Complex
Hennessey Fire



Date Saved: 9/20/2020 9:36 AM

Value at Risk (Point)

Potential hazard to life

- High
- Moderate
- Low

Values at Risk (Polygon)

Potential hazard to life

- high
- Moderate
- Low

Segment Combined Hazard

- High
- Moderate
- Low

Basin Combined Hazard

- High
- Moderate
- Low

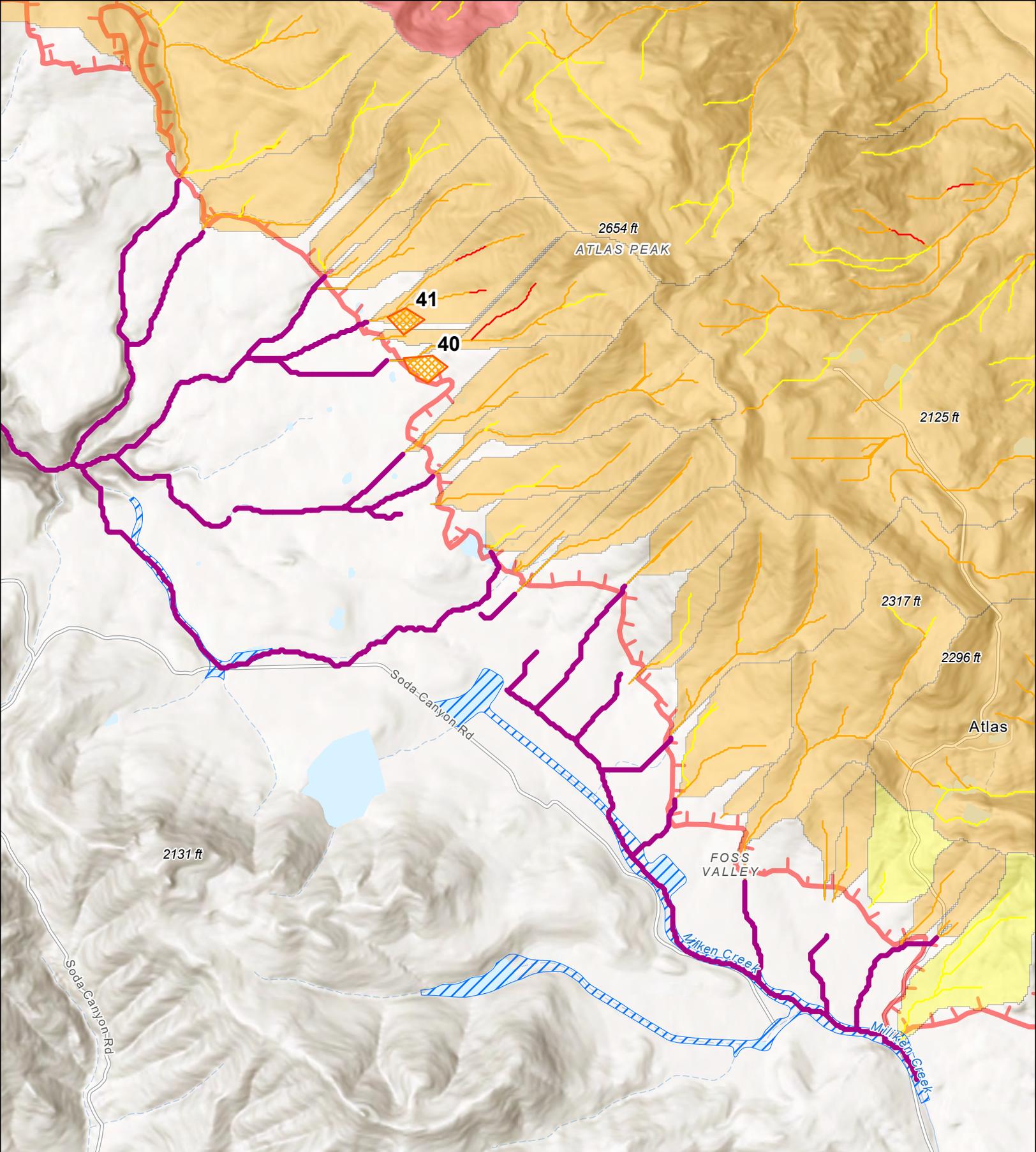
— USGS Watchstream

FEMA/DWR Floodplain

Fire Perimeters



Scale: 1:24,000



Incident: CA-LNU-013407
LNU Lightning Complex
Hennessey Fire



Date Saved: 9/20/2020 9:36 AM

Value at Risk (Point)

Potential hazard to life

- High
- Moderate
- Low

Values at Risk (Polygon)

Potential hazard to life

- ▣ high
- ▣ Moderate
- ▣ Low

Segment Combined Hazard

15 min 36mm/hr

- High
- Moderate
- Low

Basin Combined Hazard

15 min 36mm/hr

- ▣ High
- ▣ Moderate
- ▣ Low

USGS Watchstream

USGS Watchstream

FEMA/DWR Floodplain

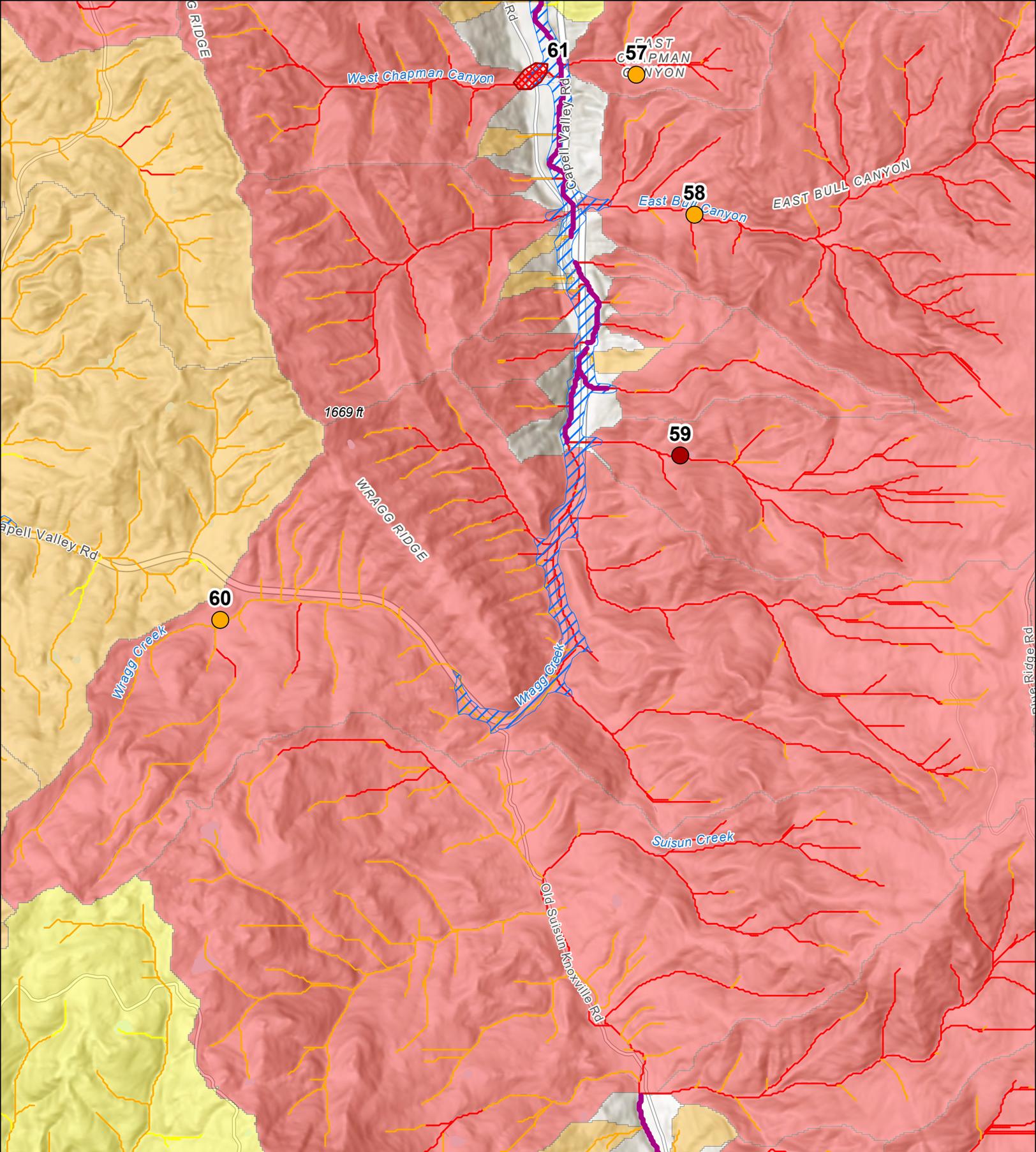
▣ FEMA/DWR Floodplain

Fire Perimeters

▣ Fire Perimeters



Scale: 1:24,000



Incident: CA-LNU-013407
LNU Lightning Complex
Hennessey Fire



Date Saved: 9/20/2020 9:36 AM

Value at Risk (Point)

Potential hazard to life

- High
- Moderate
- Low

Values at Risk (Polygon)

Potential hazard to life

- high
- Moderate
- Low

Segment Combined Hazard

- High
- Moderate
- Low

Basin Combined Hazard

- High
- Moderate
- Low

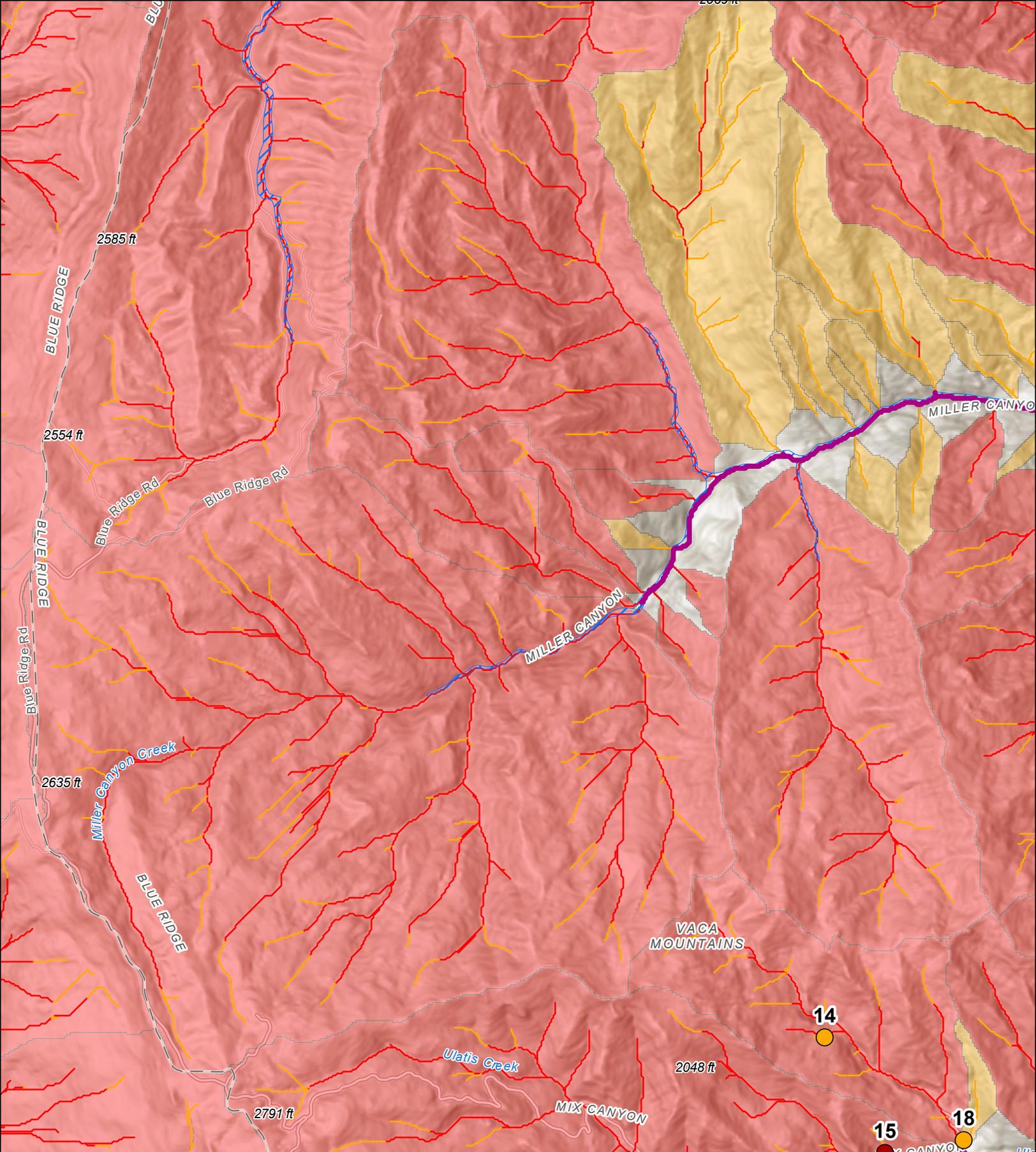
USGS Watchstream

FEMA/DWR Floodplain

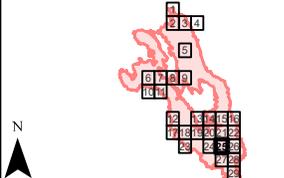
Fire Perimeters



Scale: 1:24,000



Incident: CA-LNU-013407
LNU Lightning Complex
Hennessey Fire



Date Saved: 9/20/2020 9:36 AM

Value at Risk (Point)

Potential hazard to life

- High
- Moderate
- Low

Values at Risk (Polygon)

Potential hazard to life

- high
- Moderate
- Low

Segment Combined Hazard

- High
- Moderate
- Low

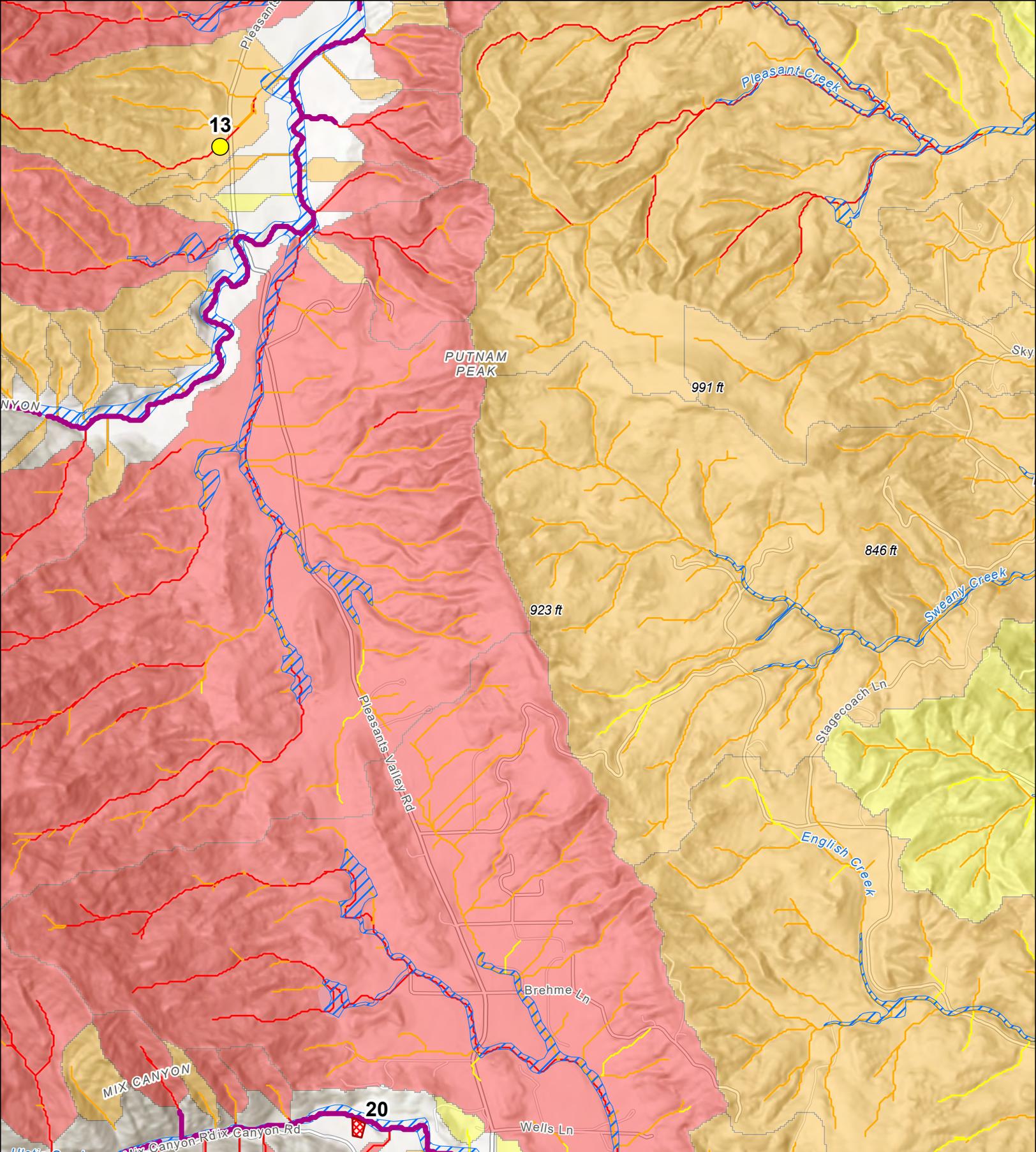
Basin Combined Hazard

- High
- Moderate
- Low

- USGS Watchstream
- FEMA/DWR Floodplain
- Fire Perimeters



Scale: 1:24,000



Incident: CA-LNU-013407
LNU Lightning Complex
Hennessey Fire



Date Saved: 9/20/2020 9:36 AM

Value at Risk (Point)

Potential hazard to life

- High
- Moderate
- Low

Values at Risk (Polygon)

Potential hazard to life

- high
- Moderate
- Low

Segment Combined Hazard

- High
- Moderate
- Low

Basin Combined Hazard

- High
- Moderate
- Low

USGS Watchstream

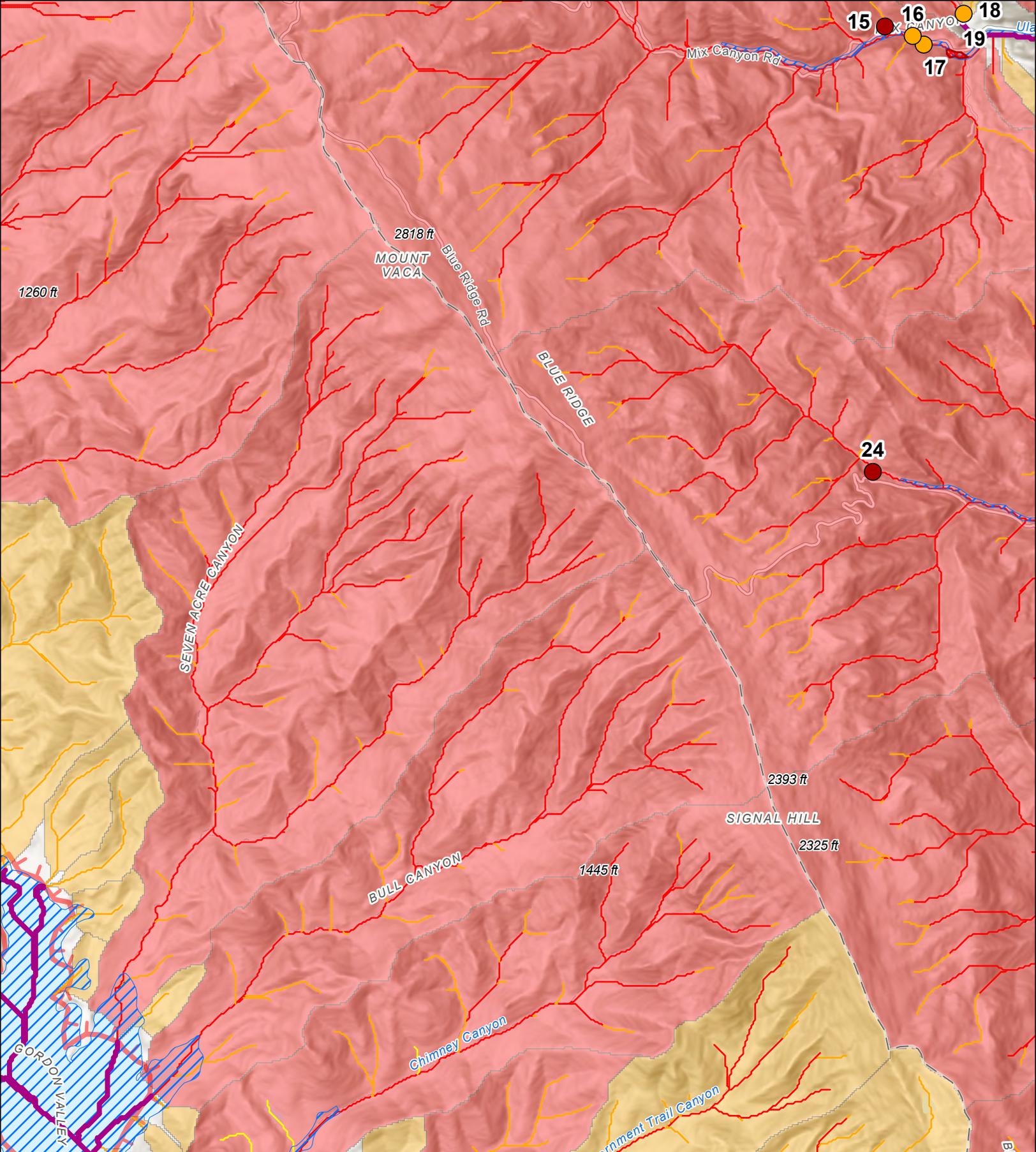
USGS Watchstream

FEMA/DWR Floodplain

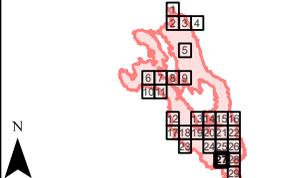
Fire Perimeters



Scale: 1:24,000



Incident: CA-LNU-013407
LNU Lightning Complex
Hennessey Fire



Date Saved: 9/20/2020 9:36 AM

Value at Risk (Point)

Potential hazard to life

- High
- Moderate
- Low

Values at Risk (Polygon)

Potential hazard to life

- high
- Moderate
- Low

Segment Combined Hazard

- High
- Moderate
- Low

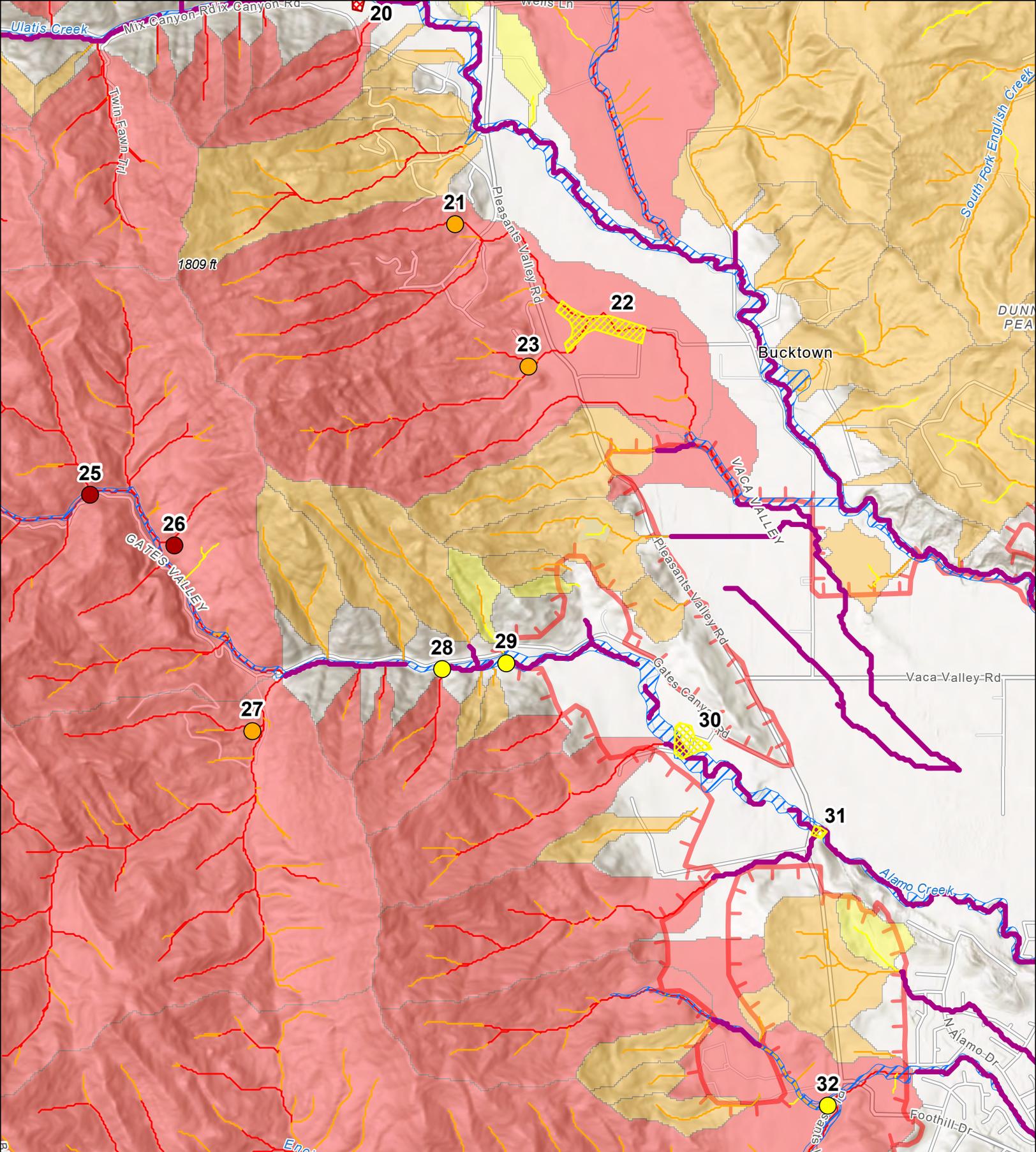
Basin Combined Hazard

- High
- Moderate
- Low

USGS Watchstream

- USGS Watchstream
- FEMA/DWR Floodplain
- Fire Perimeters





Incident: CA-LNU-013407
LNU Lightning Complex
Hennessey Fire



Date Saved: 9/20/2020 9:36 AM

Value at Risk (Point)

Potential hazard to life

- High
- Moderate
- Low

Values at Risk (Polygon)

Potential hazard to life

- high
- Moderate
- Low

Segment Combined Hazard

- 15 min 36mm/hr High
- Moderate
- Low

Basin Combined Hazard

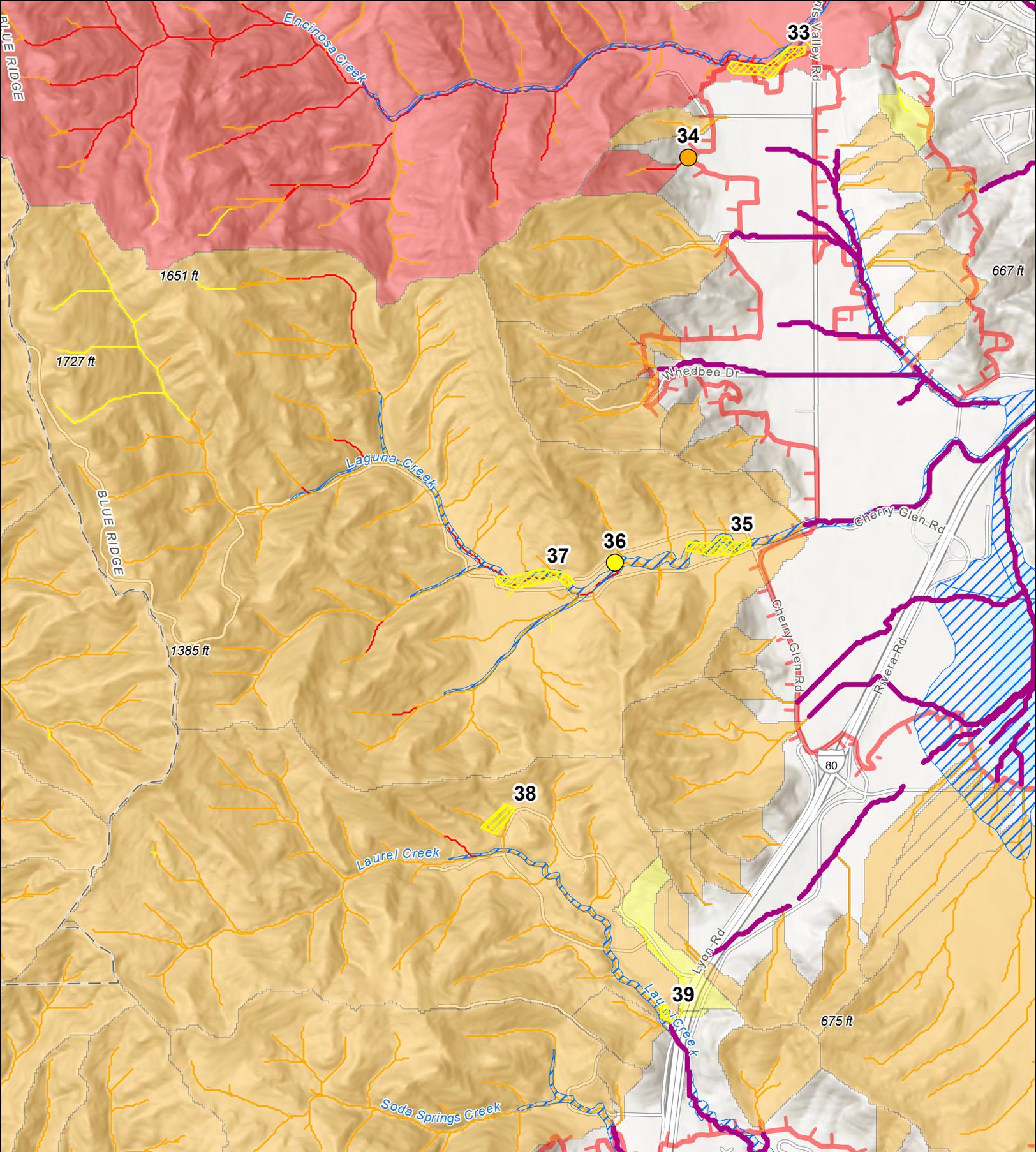
- 15 min 36mm/hr High
- Moderate
- Low

USGS Watchstream

- USGS Watchstream
- FEMA/DWR Floodplain
- Fire Perimeters



Scale: 1:24,000



Incident: CA-LNU-013407
LNU Lightning Complex
Hennessey Fire



Date Saved: 9/20/2020 9:36 AM

Value at Risk (Point)

Potential hazard to life

- High
- Moderate
- Low

Values at Risk (Polygon)

Potential hazard to life

- high
- Moderate
- Low

Segment Combined Hazard

- 15 min 36mm/hr
- High
- Moderate
- Low

Basin Combined Hazard

- 15 min 36mm/hr
- High
- Moderate
- Low

USGS Watchstream

- USGS Watchstream
- FEMA/DWR Floodplain
- Fire Perimeters



Scale: 1:24,000

APPENDIX D: VAR SITE INFORMATION SHEETS

VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Lower Cache Creek

Site Number: 03

Feature: Possible house and shed structure

Feature Category: home

Field Observation Potential debris flow from large drainage, watercourse is narrow and house is adjacent to it.
Potential Hazard: adjacent to it.

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

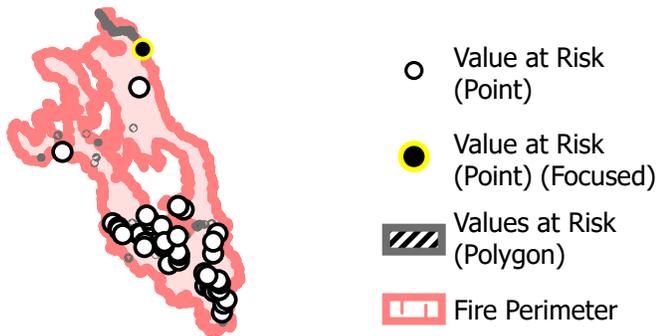
Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

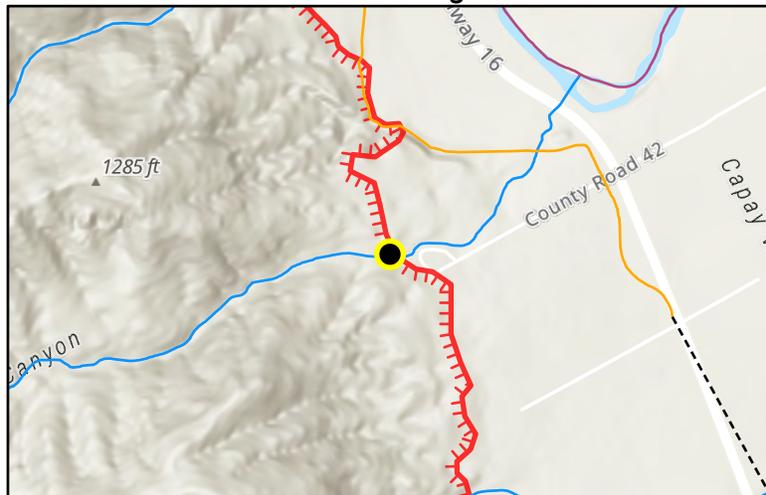
Description: NA

LOCATION AND PHOTO



Latitude: 38.8739

Longitude: -122.2357



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: **Lower Cache Creek**

Site Number: **04**

Feature: **House**

Feature Category: **home**

Field Observation Access limited. Based on large drainage area above, house identified as VAR.
or Potential Hazard:

Potential Hazard to Life: **moderate**

Potential Hazard to Property: **moderate**

Preliminary Emergency Protective Measures (1): **Early Warning**

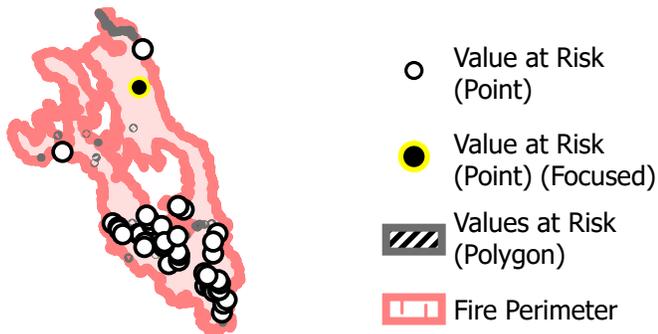
Preliminary Emergency Protective Measures (2): **NA**

Preliminary Emergency Protective Measures (3): **NA**

Preliminary Emergency Protective Measures (4): **NA**

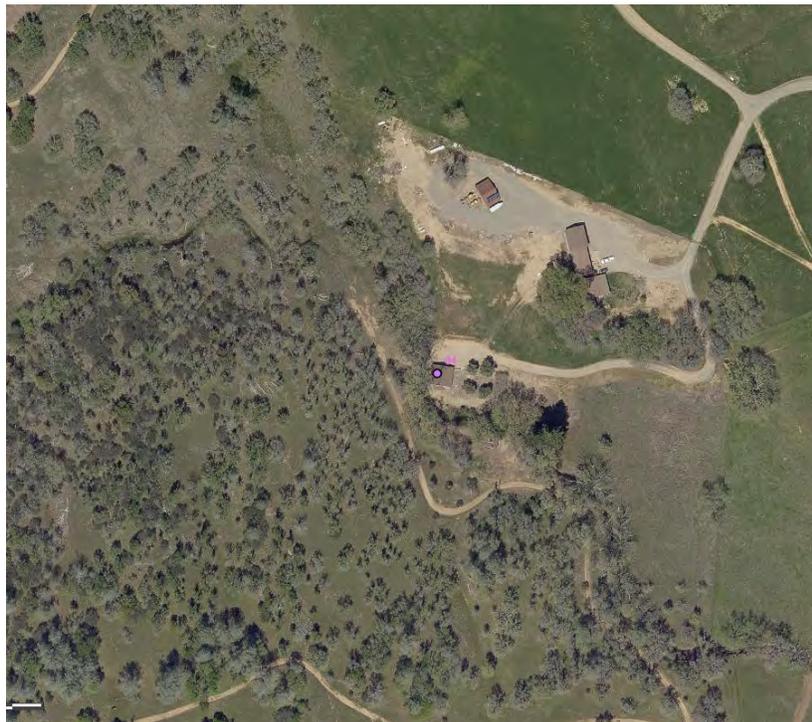
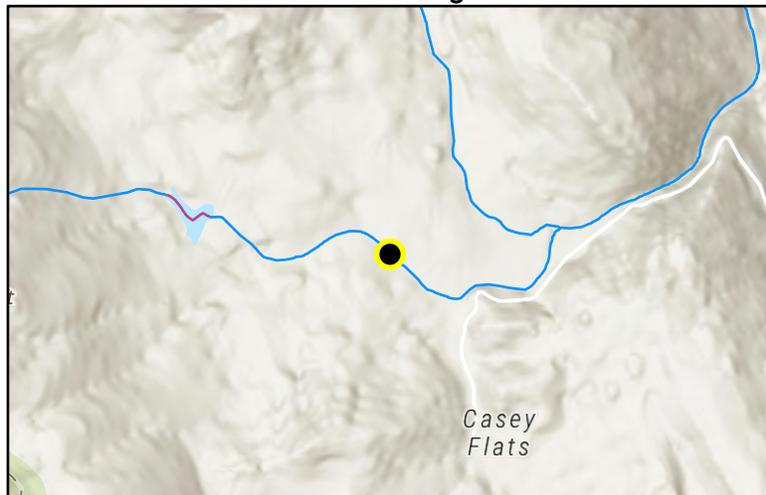
Description: NA

LOCATION AND PHOTO



Latitude: 38.7961

Longitude: -122.2457



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Lower Putah Creek

Site Number: 10

Feature: Outbuilding

Feature Category: home

Field Observation Outbuilding and playground equipment in path of watercourse.
or Potential Hazard:

Potential Hazard to Life: moderate

Potential Hazard to Property: low

Preliminary Emergency Protective Measures (1): Early Warning

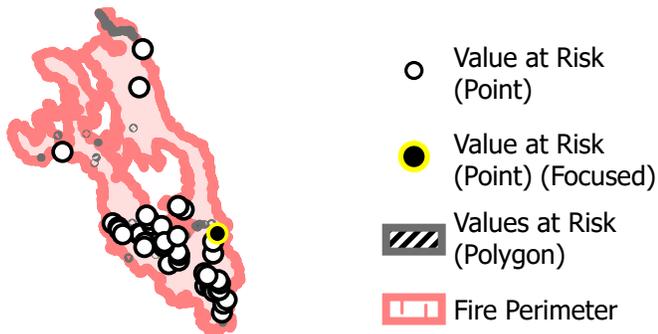
Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

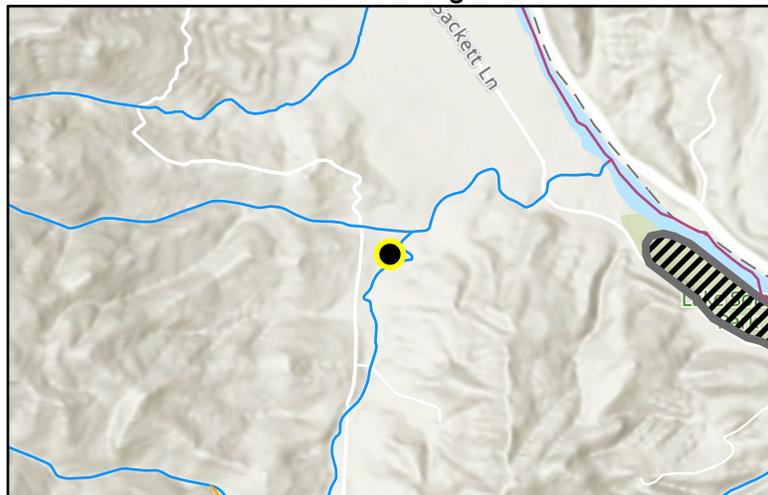
Description: NA

LOCATION AND PHOTO



Latitude: 38.4962

Longitude: -122.0456



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: **Lower Putah Creek**

Site Number: **12**

Feature: **Garage**

Feature Category: **other**

Field Observation Garage sitting at junction of two watercourses loaded with large boulders.
or Potential Hazard: Potential for debris flow to damage structure. Informed landowner of hazards to garage.

Potential Hazard to Life: **low**

Potential Hazard to Property: **moderate**

Preliminary Emergency Protective Measures (1): **Early Warning**

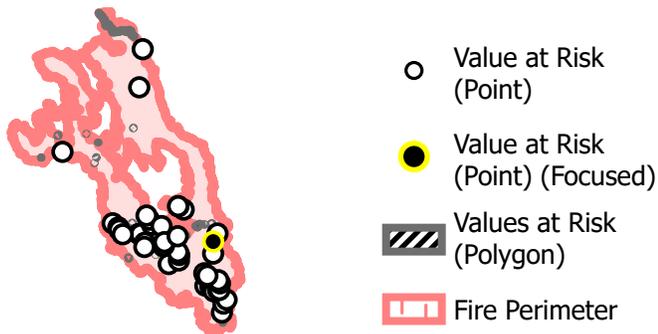
Preliminary Emergency Protective Measures (2): **NA**

Preliminary Emergency Protective Measures (3): **NA**

Preliminary Emergency Protective Measures (4): **NA**

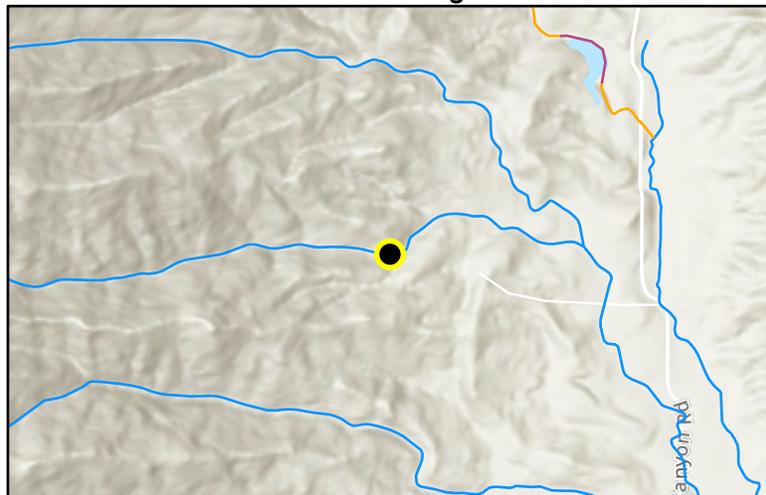
Description: NA

LOCATION AND PHOTO



Latitude: 38.4798

Longitude: -122.0569



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Lower Putah Creek

Site Number: 13

Feature: Barn

Feature Category: other

Field Observation Barn in flow path of watercourse. Debris flow and flooding hazards.
or Potential Hazard:

Potential Hazard to Life: low

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

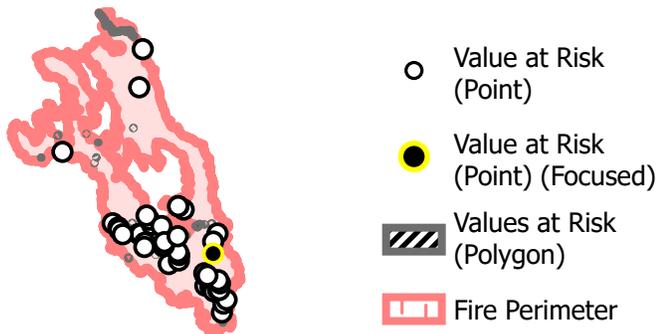
Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

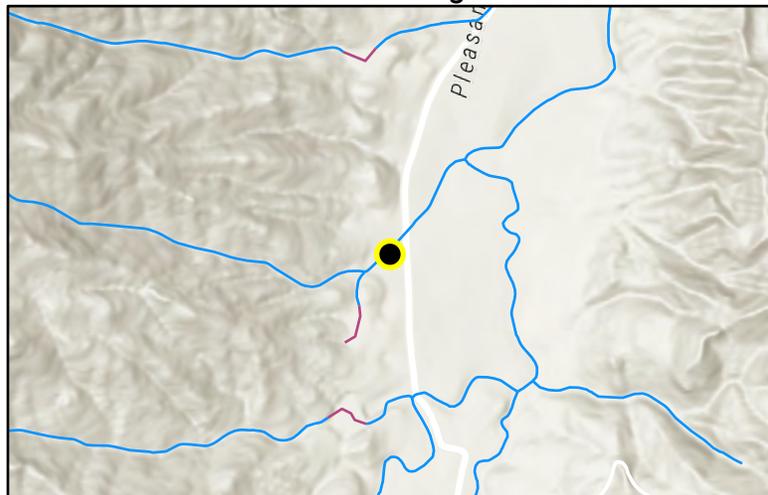
Description: NA

LOCATION AND PHOTO



Latitude: 38.4552

Longitude: -122.0573



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Ulatis Creek and Alamo Creek

Site Number: 14

Feature: House or possible trailer site

Feature Category: home

Field Observation Burned House pad built on cut/fill bench in axis of relatively small watercourse.
or Potential Hazard: Watercourse is diverted in trench around house. Potential for flooding or debris flow.

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

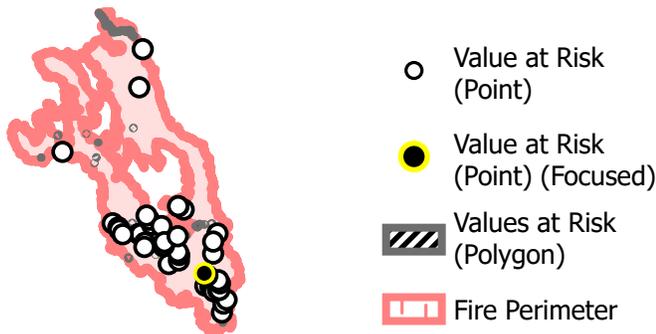
Preliminary Emergency Protective Measures (2): Deflection structure

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

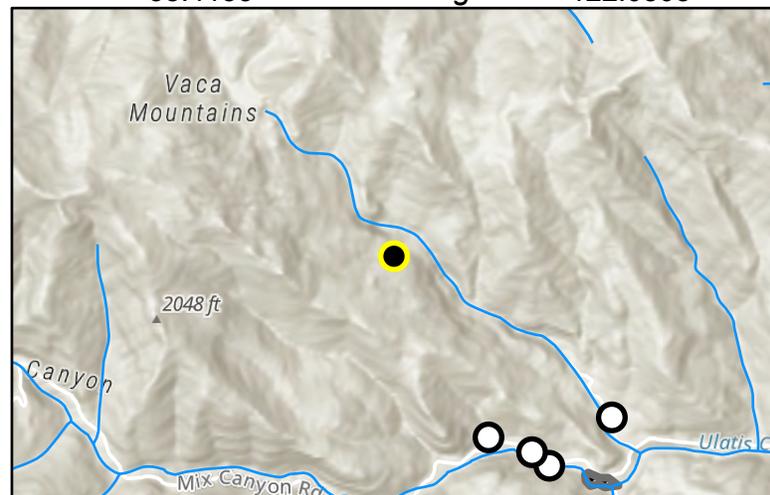
Description: NA

LOCATION AND PHOTO



Latitude: 38.4153

Longitude: -122.0808



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Ulatis Creek and Alamo Creek

Site Number: 15

Feature: House or possible trailer site

Feature Category: home

Field Observation Burned house pad on alluvial fan at mouth of potential debris flow channel.
or Potential Hazard: House site. Somewhat setback from channel but could potentially be impacted.
Possible trailer site in direct impact location.

Potential Hazard to Life: high

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Early Warning

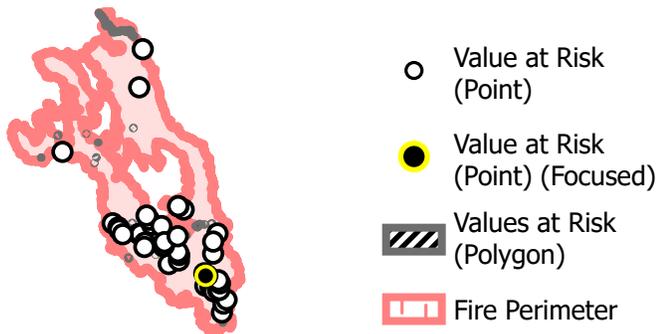
Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

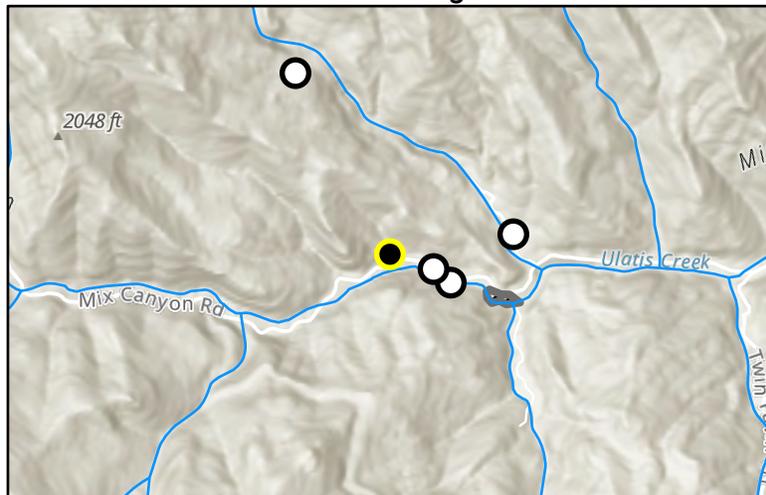
Description: Place possible trailer site at east end of lot.

LOCATION AND PHOTO



Latitude: 38.4100

Longitude: -122.0774



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Ulatis Creek and Alamo Creek

Site Number: 16

Feature: Possible trailer site

Feature Category: other

Field Observation Wide area near watercourse that could be used as possible trailer site.
or Potential Hazard:

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

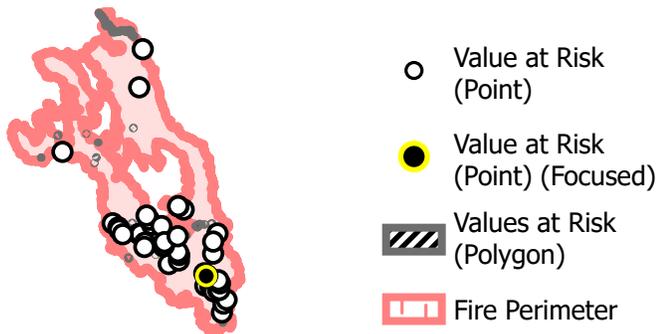
Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

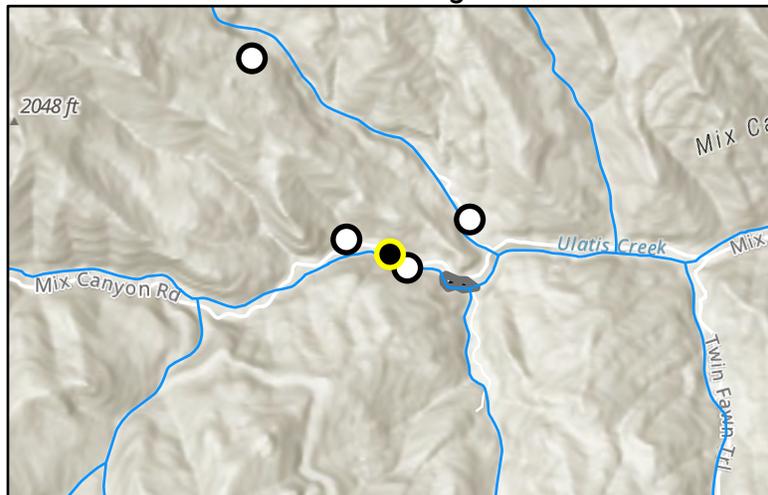
Description: NA

LOCATION AND PHOTO



Latitude: 38.4096

Longitude: -122.0758



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Ulatis Creek and Alamo Creek

Site Number: 17

Feature: House

Feature Category: home

Field Observation House site near watercourse. Potential for debris flow and flood.
or Potential Hazard:

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

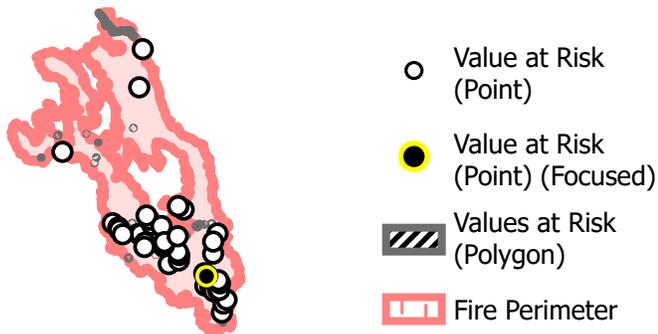
Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

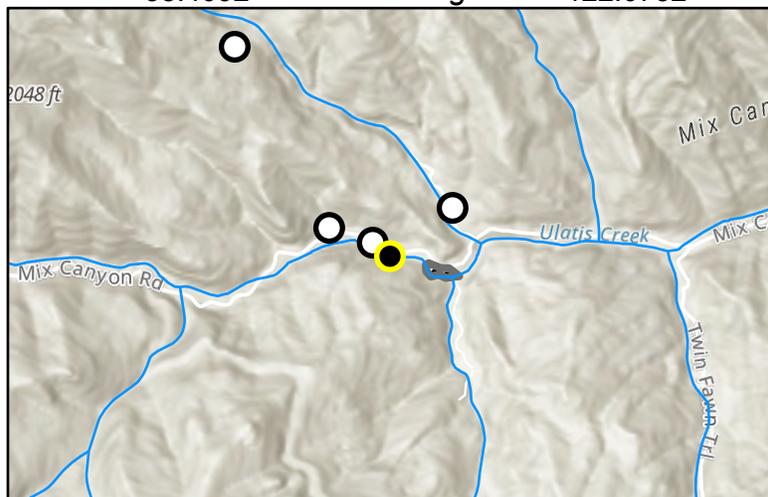
Description: NA

LOCATION AND PHOTO



Latitude: 38.4092

Longitude: -122.0752



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Ulatis Creek and Alamo Creek

Site Number: 18

Feature: House

Feature Category: home

Field Observation Potential for debris flow to escape watercourse channel at livestock paddock or **Potential Hazard:** upstream and flow toward residence.

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

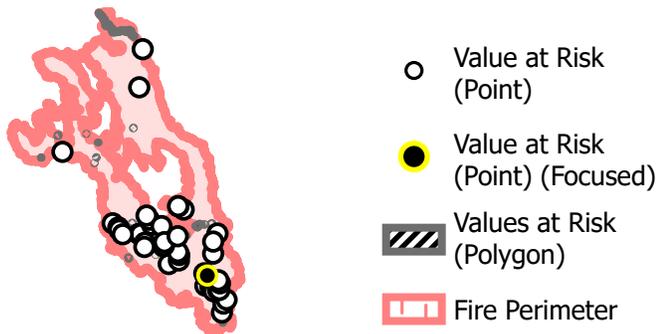
Preliminary Emergency Protective Measures (2): Deflection structure

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

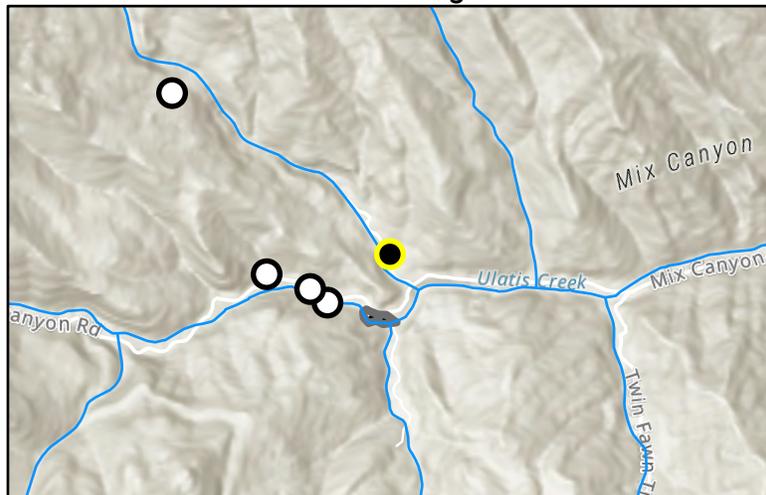
Description: NA

LOCATION AND PHOTO



Latitude: 38.4106

Longitude: -122.0729



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Ulatis Creek and Alamo Creek

Site Number: 21

Feature: House or possible trailer site

Feature Category: home

Field Observation or Potential Hazard: Small fan with numerous boulders upslope of burned residence. Watercourse channel is shallow and there is potential for debris flow to overflow and impact house site.

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

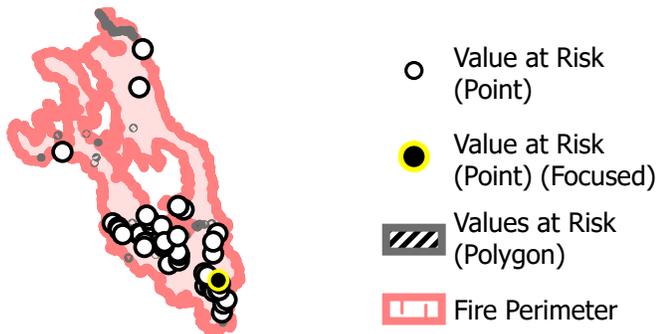
Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

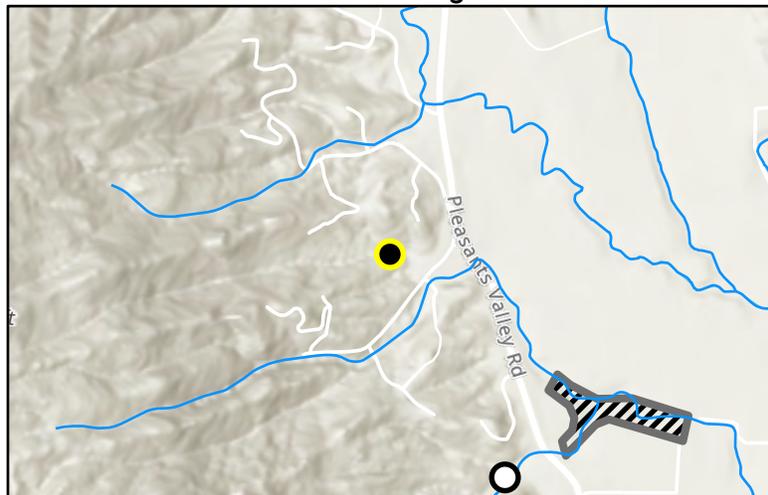
Description: NA

LOCATION AND PHOTO



Latitude: 38.4008

Longitude: -122.0446



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Ulatis Creek and Alamo Creek

Site Number: 23

Feature: House or trailer

Feature Category: home

Field Observation Burned house at confluence of tributary and main watercourse. Dam/pond at
or Potential Hazard: tributary upslope of house. Potential for debris flow or flooding on main
watercourse with potential for diversion toward house at crossings upslope.

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

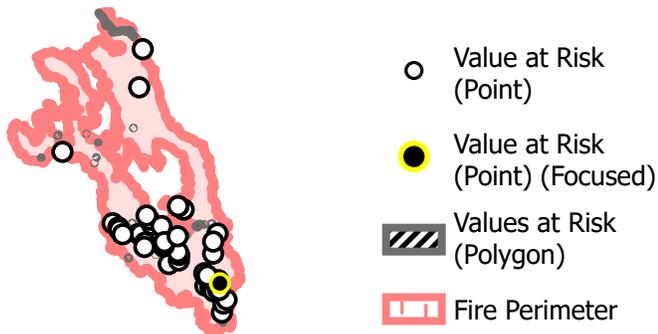
Preliminary Emergency Protective Measures (2): Deflection structure

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

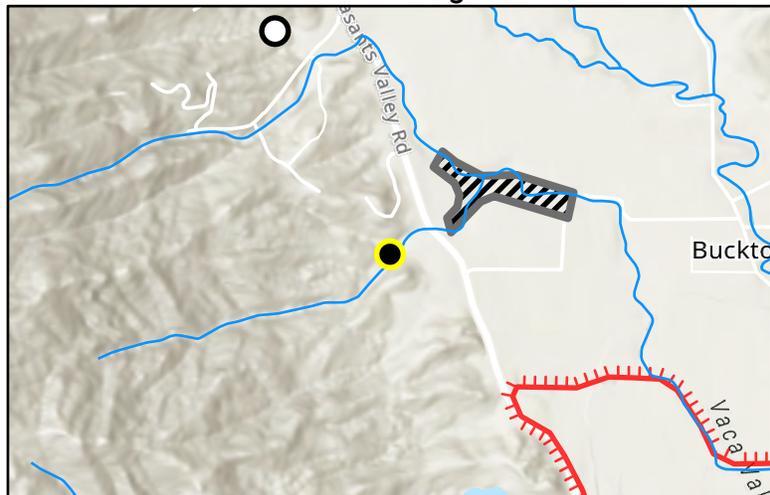
Description: NA

LOCATION AND PHOTO



Latitude: 38.3944

Longitude: -122.0405



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Ulatis Creek and Alamo Creek

Site Number: 24

Feature: House or trailer site

Feature Category: home

Field Observation Burned house immediately adjacent to watercourse. Many large boulders in
or Potential Hazard: watercourse channel. Debris flow and flooding potential.

Potential Hazard to Life: high

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Early Warning

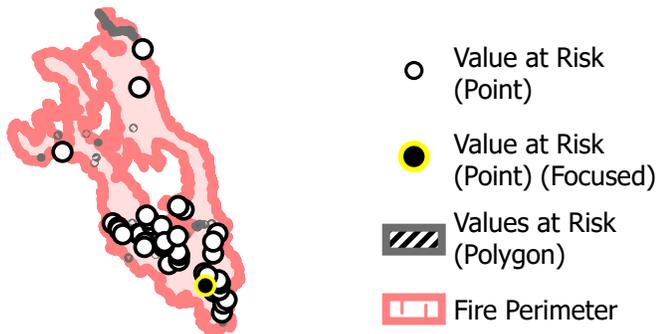
Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

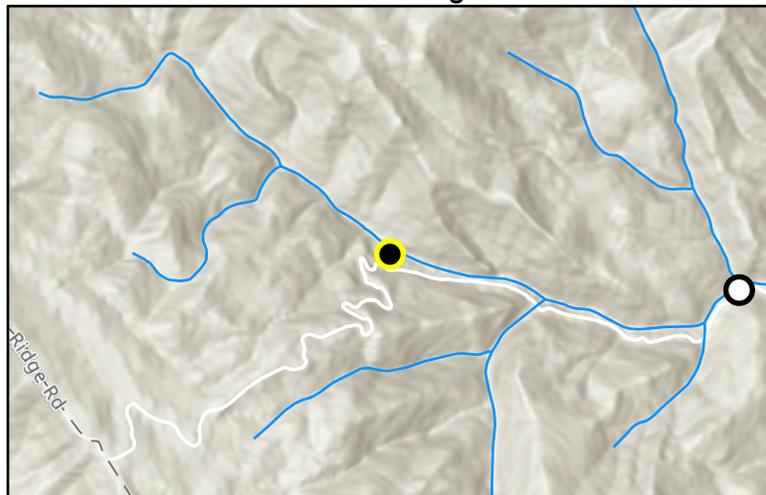
Description: NA

LOCATION AND PHOTO



Latitude: 38.3899

Longitude: -122.0784



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Ulatis Creek and Alamo Creek

Site Number: 25

Feature: House or trailer

Feature Category: home

Field Observation Burned house in floodplain. House pad at confluence of Alamo Creek and side
or Potential Hazard: tributary. Possible trailer site with potential for flooding and debris flow.

Potential Hazard to Life: high

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Early Warning

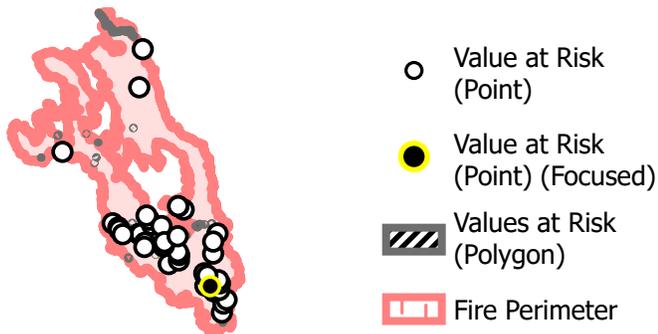
Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

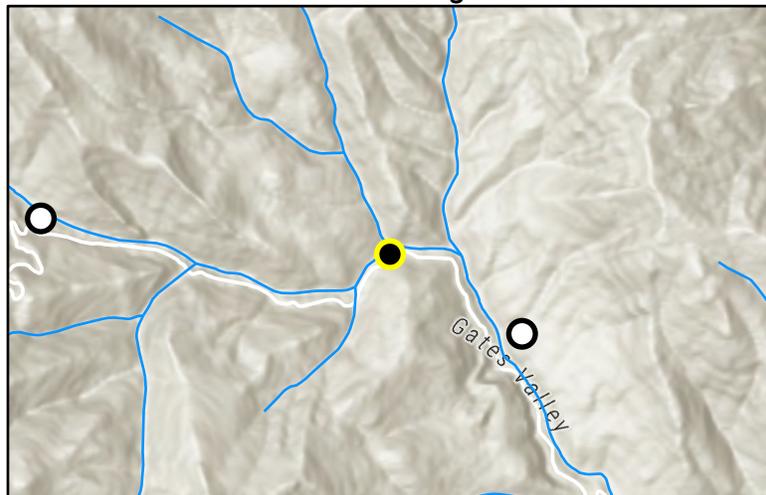
Description: NA

LOCATION AND PHOTO



Latitude: 38.3888

Longitude: -122.0656



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Ulatis Creek and Alamo Creek

Site Number: 26

Feature: House or possible trailer site

Feature Category: home

Field Observation House built on fan with very small poorly defined watercourse channel.
or Potential Hazard: Potential debris flow impact to burned house site or trailer.

Potential Hazard to Life: high

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Early Warning

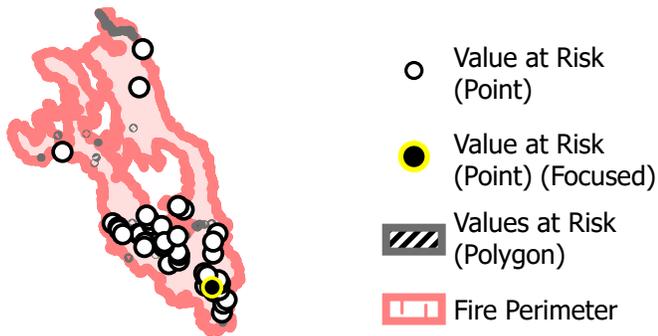
Preliminary Emergency Protective Measures (2): Deflection structure

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

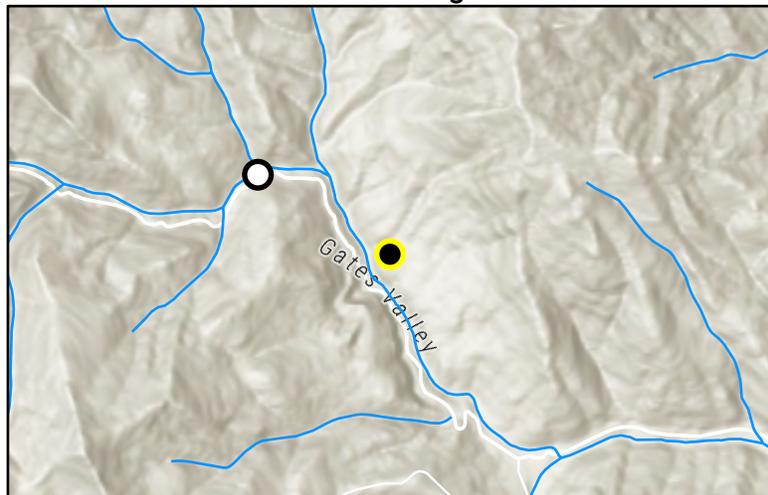
Description: NA

LOCATION AND PHOTO



Latitude: 38.3865

Longitude: -122.0608



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Ulatis Creek and Alamo Creek

Site Number: 27

Feature: House and dam

Feature Category: multiple

Field Observation or Potential Hazard: House next to watercourse in potential floodplain. Steep side tributary with boulders descends to house. Dam upslope likely to act as debris basin. Dam spillway is severely eroded and flooding downstream appears possible. Spillway channel flows to house.

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

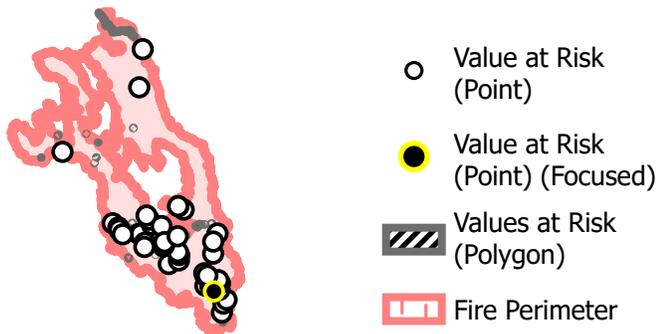
Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

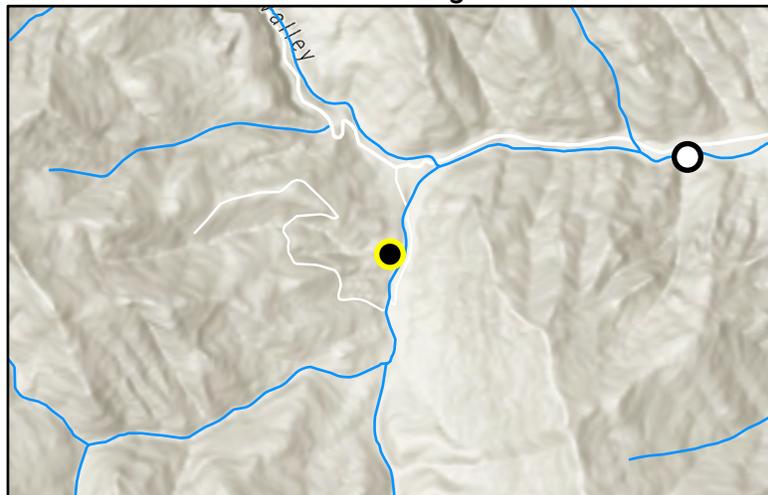
Description: NA

LOCATION AND PHOTO



Latitude: 38.3781

Longitude: -122.0565



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Ulatis Creek and Alamo Creek

Site Number: 28

Feature: House

Feature Category: home

Field Observation House in potential floodplain.
or Potential Hazard:

Potential Hazard to Life: low

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

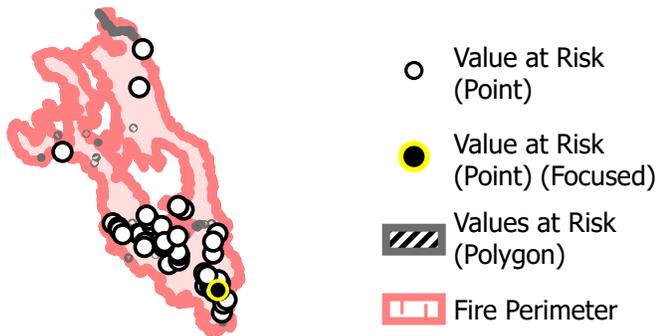
Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

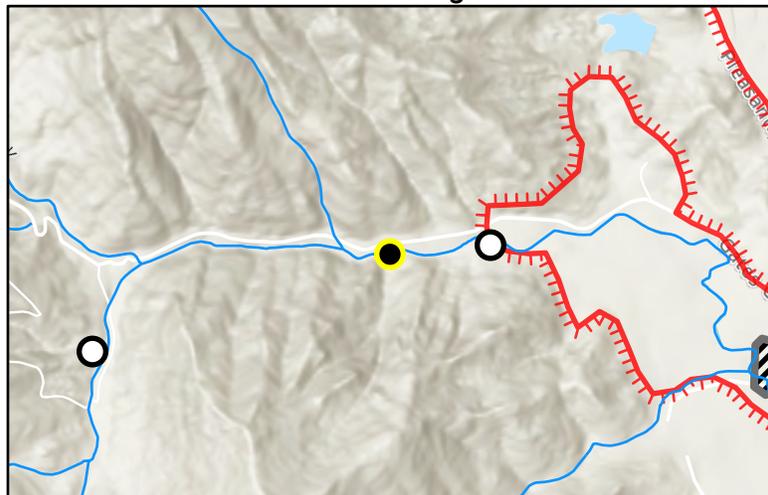
Description: NA

LOCATION AND PHOTO



Latitude: 38.3808

Longitude: -122.0456



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Ulatis Creek and Alamo Creek

Site Number: 29

Feature: House

Feature Category: home

Field Observation Flooding potential. House is somewhat setback from watercourse but is on
or Potential Hazard: edge of mapped floodplain.

Potential Hazard to Life: low

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

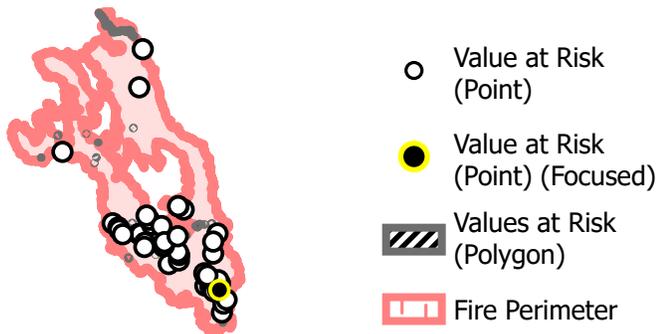
Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

Description: NA

LOCATION AND PHOTO



Latitude: 38.3810

Longitude: -122.0419



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Ulatis Creek and Alamo Creek

Site Number: 32

Feature: House or trailer site

Feature Category: home

Field Observation Burned house in potential floodplain at confluence of watercourses.
or Potential Hazard:

Potential Hazard to Life: low

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

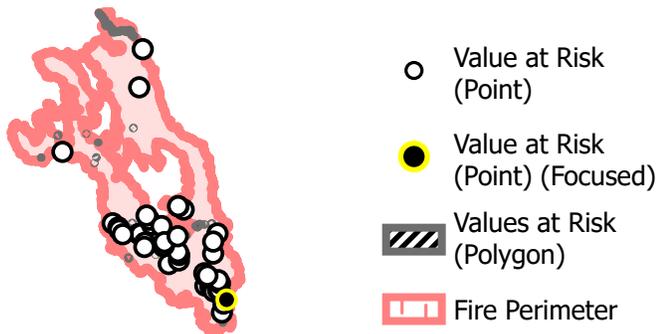
Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

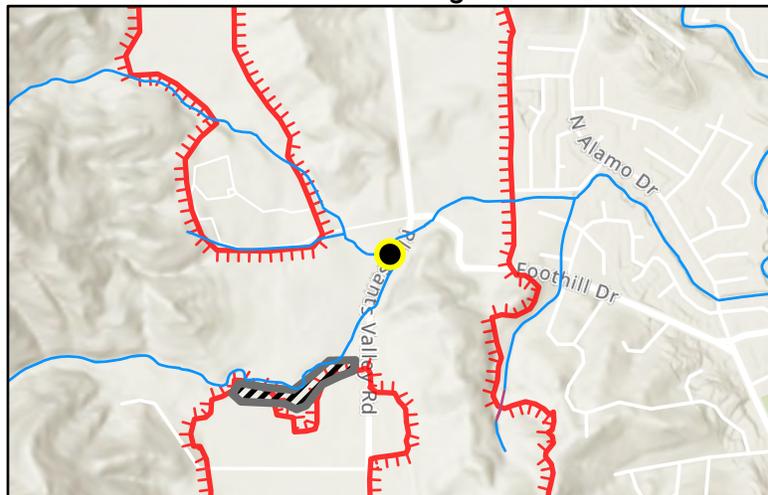
Description: NA

LOCATION AND PHOTO



Latitude: 38.3609

Longitude: -122.0238



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Ulatis Creek and Alamo Creek

Site Number: 34

Feature: House

Feature Category: home

Field Observation House built on fan. Channel directed to right, around house. 3 ft and larger
or Potential Hazard: boulders in watercourse. Potential for debris flow.

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

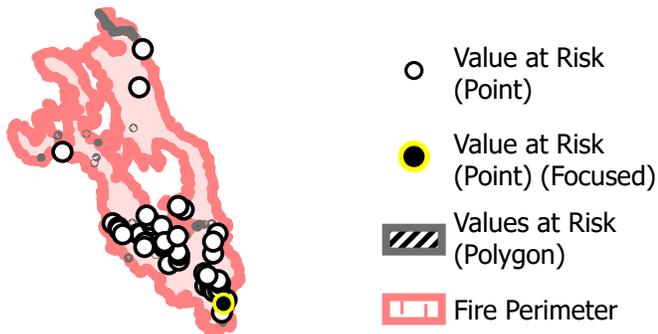
Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

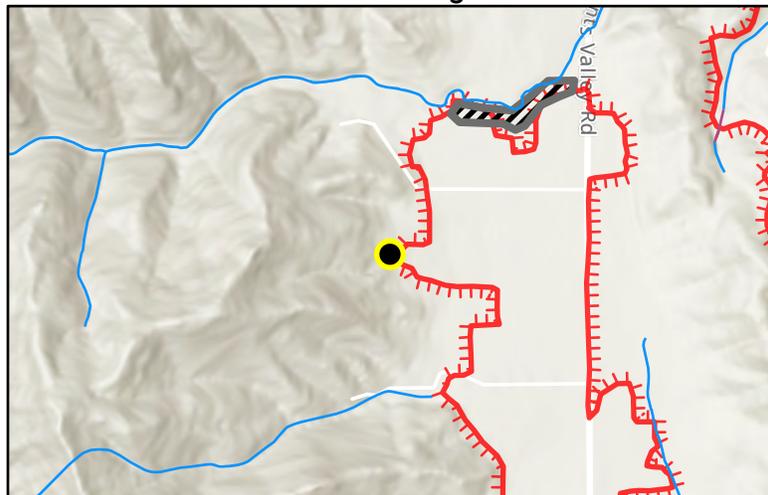
Description: NA

LOCATION AND PHOTO



Latitude: 38.3529

Longitude: -122.0319



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Ulatis Creek and Alamo Creek

Site Number: 36

Feature: House

Feature Category: home

Field Observation Locked gate, not able to access. House is potentially in floodplain.
or Potential Hazard:

Potential Hazard to Life: low

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

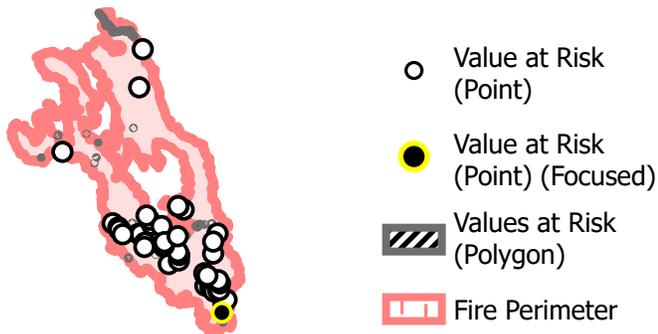
Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

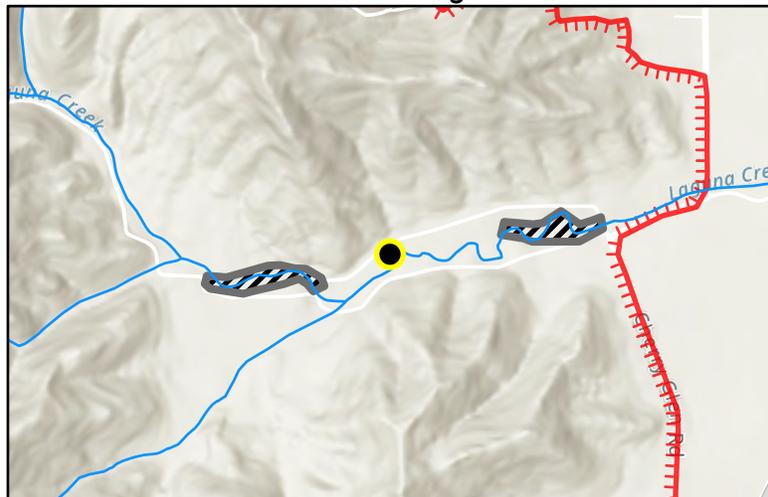
Description: NA

LOCATION AND PHOTO



Latitude: 38.3347

Longitude: -122.0363



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: **Napa Valley**

Site Number: **44**

Feature: **House**

Feature Category: **home**

Field Observation: Burned structure next to watercourse in Sage Canyon. Flooding hazard.
or Potential Hazard:

Potential Hazard to Life: **moderate**

Potential Hazard to Property: **moderate**

Preliminary Emergency Protective Measures (1): **Early Warning**

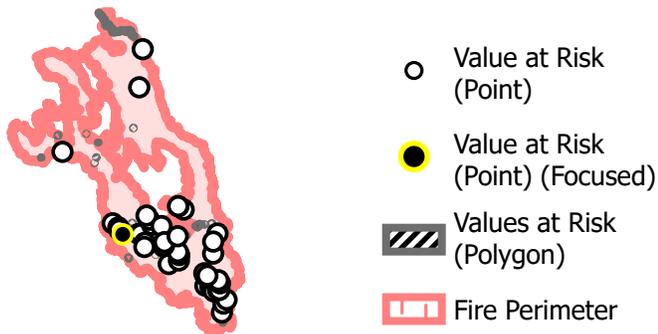
Preliminary Emergency Protective Measures (2): **NA**

Preliminary Emergency Protective Measures (3): **NA**

Preliminary Emergency Protective Measures (4): **NA**

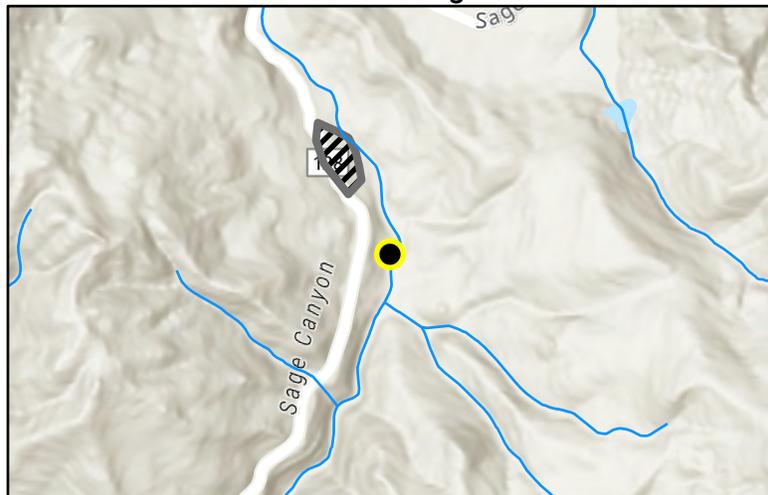
Description: **NA**

LOCATION AND PHOTO



Latitude: 38.4963

Longitude: -122.2916



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: **Napa Valley**

Site Number: **45**

Feature: **House**

Feature Category: **home**

Field Observation House is in path of watercourse. Debris flow and flooding.
or Potential Hazard:

Potential Hazard to Life: **high**

Potential Hazard to Property: **high**

Preliminary Emergency Protective Measures (1): **Early Warning**

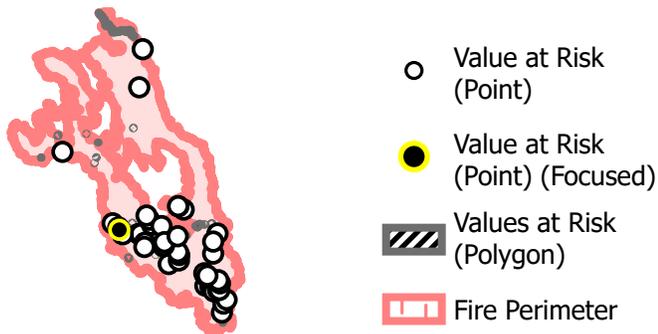
Preliminary Emergency Protective Measures (2): **NA**

Preliminary Emergency Protective Measures (3): **NA**

Preliminary Emergency Protective Measures (4): **NA**

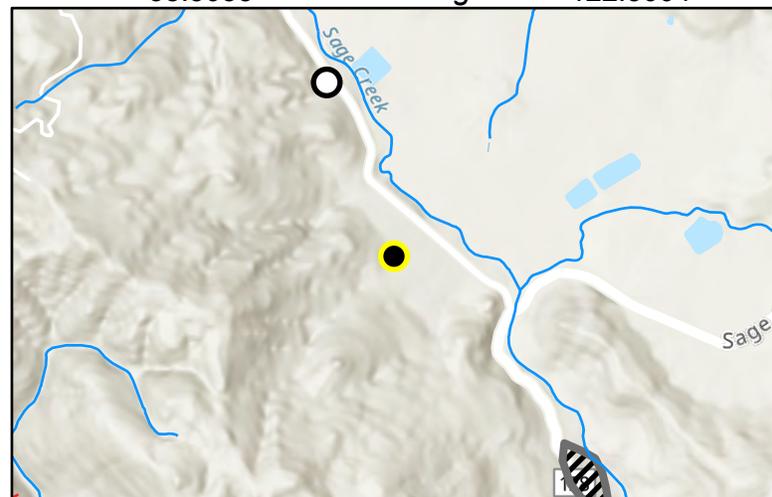
Description: **NA**

LOCATION AND PHOTO



Latitude: 38.5055

Longitude: -122.3004



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: **Napa Valley**

Site Number: **46**

Feature: **House and barn**

Feature Category: **home**

Field Observation Burned structure in path of two smaller watercourses in moderate burn. Barn
or Potential Hazard: across the road is also at risk. Debris flow and flooding hazards.

Potential Hazard to Life: **high**

Potential Hazard to Property: **high**

Preliminary Emergency Protective Measures (1): **Early Warning**

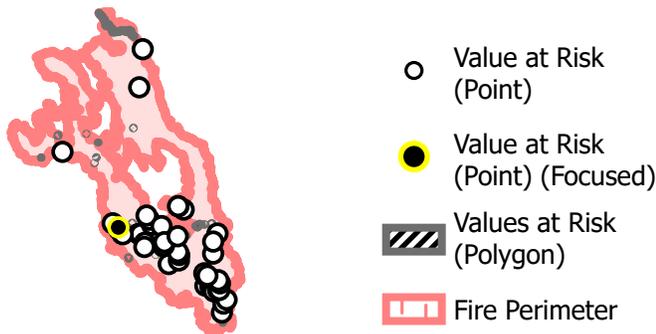
Preliminary Emergency Protective Measures (2): **NA**

Preliminary Emergency Protective Measures (3): **NA**

Preliminary Emergency Protective Measures (4): **NA**

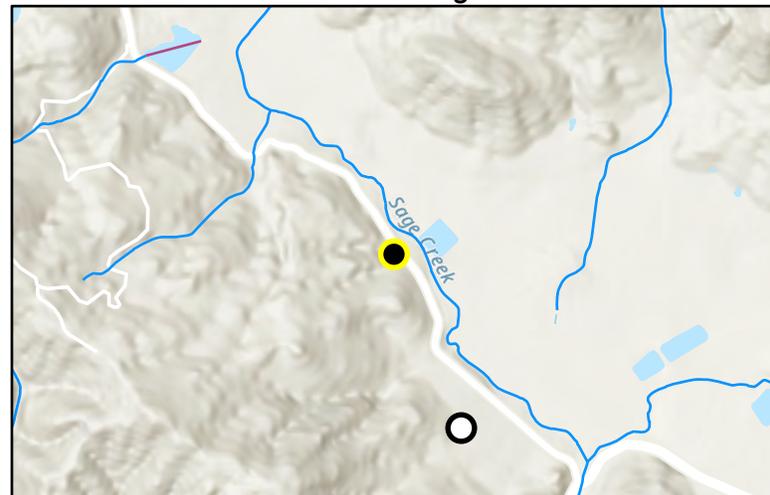
Description: NA

LOCATION AND PHOTO



Latitude: 38.5105

Longitude: -122.3028



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: **Napa Valley**

Site Number: **47**

Feature: **House**

Feature Category: **drainage structure**

Field Observation House sits next to watercourse. Debris flow and flooding.
or Potential Hazard:

Potential Hazard to Life: **moderate**

Potential Hazard to Property: **moderate**

Preliminary Emergency Protective Measures (1): **Early Warning**

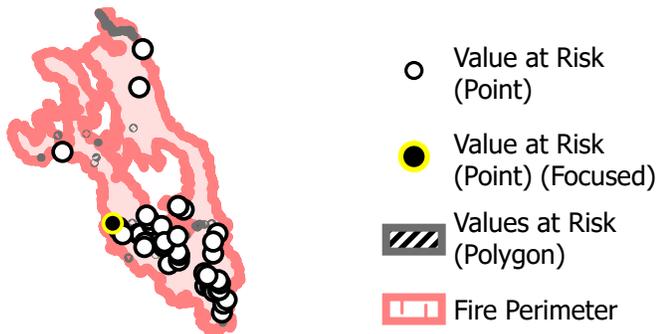
Preliminary Emergency Protective Measures (2): **NA**

Preliminary Emergency Protective Measures (3): **NA**

Preliminary Emergency Protective Measures (4): **NA**

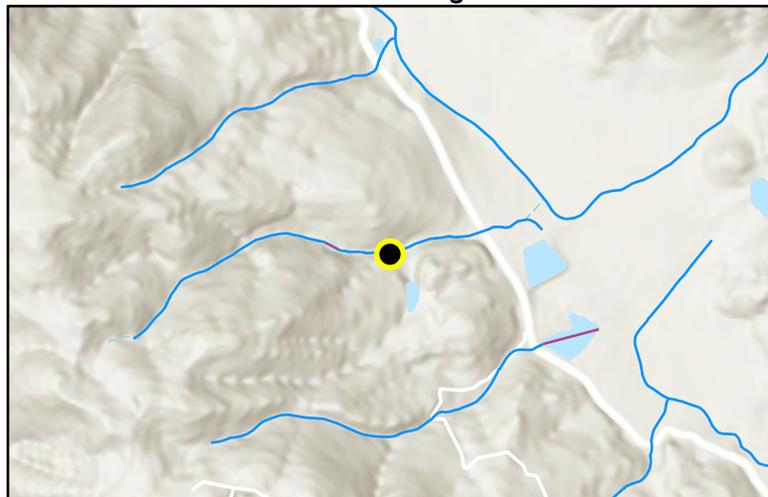
Description: NA

LOCATION AND PHOTO



Latitude: 38.5189

Longitude: -122.3175



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: **Pope Creek**

Site Number: **49**

Feature: **House**

Feature Category: **home**

Field Observation or Potential Hazard: Potential for flooding from main channel, appears outside of mapped flood zone.

Potential Hazard to Life: **low**

Potential Hazard to Property: **moderate**

Preliminary Emergency Protective Measures (1): **Early Warning**

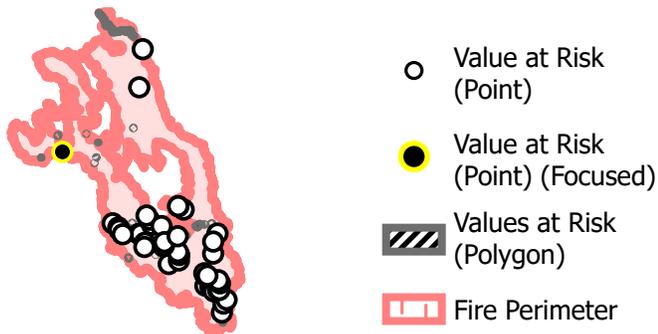
Preliminary Emergency Protective Measures (2): **NA**

Preliminary Emergency Protective Measures (3): **NA**

Preliminary Emergency Protective Measures (4): **NA**

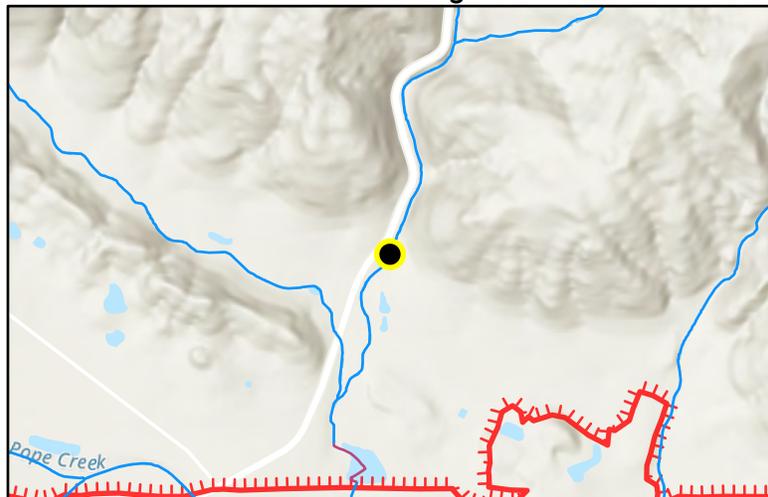
Description: NA

LOCATION AND PHOTO



Latitude: 38.6655

Longitude: -122.4467



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Middle Putah Creek

Site Number: 53

Feature: House

Feature Category: home

Field Observation Debris flow hazard at location of house, identified by damage inspection, based on **Potential Hazard:** on proximity to channel on hillshade. Not able to access.

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

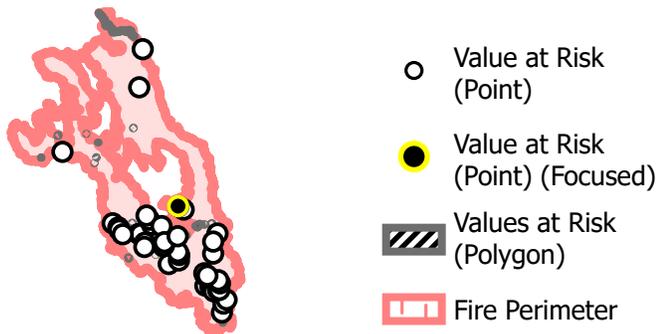
Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

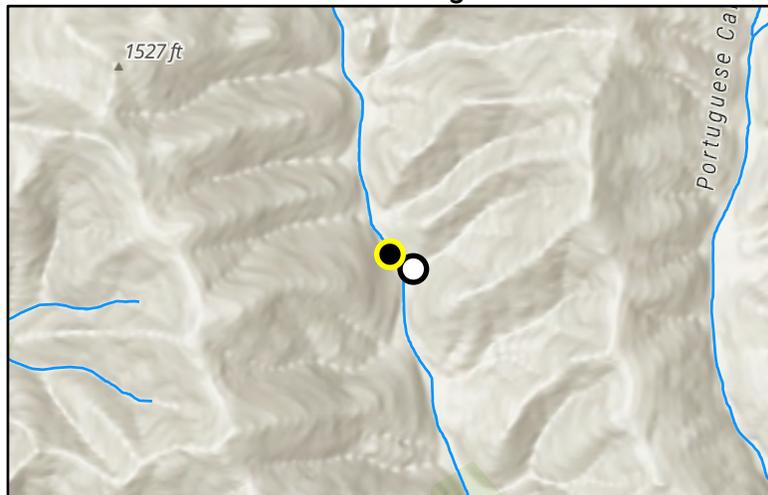
Description: NA

LOCATION AND PHOTO



Latitude: 38.5528

Longitude: -122.1472



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Middle Putah Creek

Site Number: 54

Feature: House

Feature Category: home

Field Observation Debris flow hazard at location of house, identified by damage inspection, based on **Potential Hazard:** on proximity to channel on hillshade. Not able to access.

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

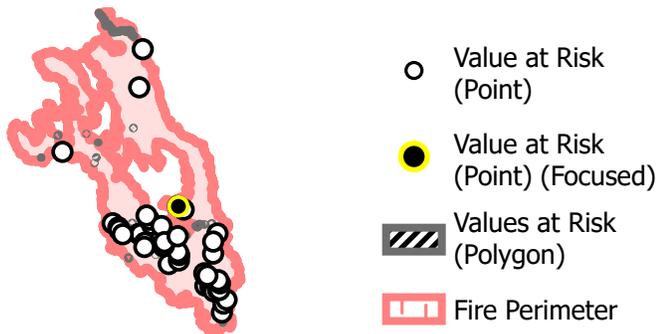
Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

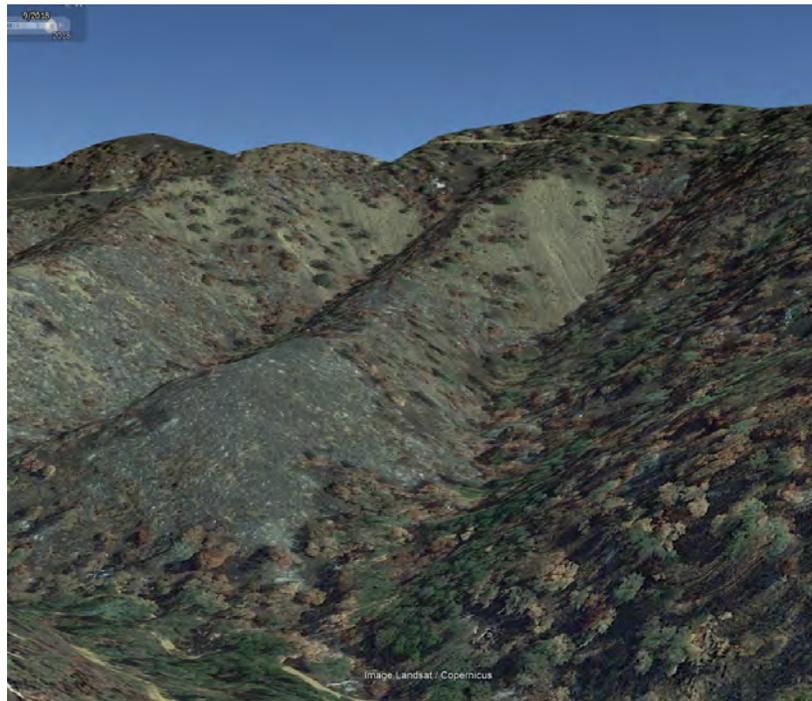
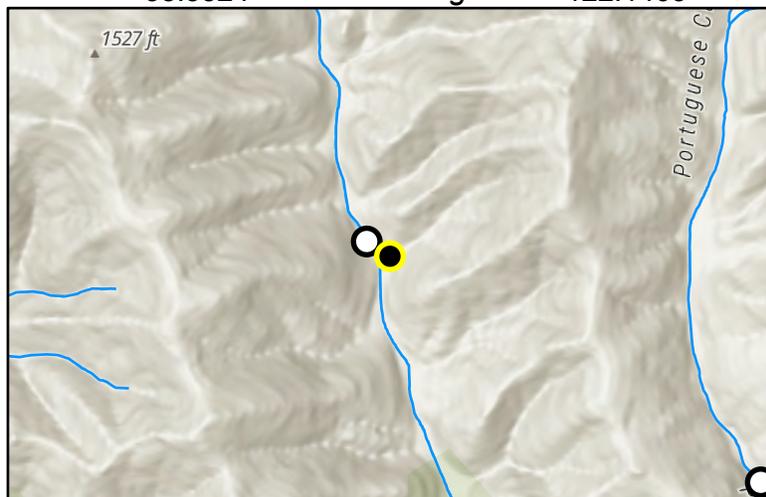
Description: NA

LOCATION AND PHOTO



Latitude: 38.5524

Longitude: -122.1463



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Middle Putah Creek

Site Number: 55

Feature: House

Feature Category: home

Field Observation Debris flow hazard at location of house, identified by damage inspection, based on **Potential Hazard:** on proximity to channel on hillshade. Not able to access.

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

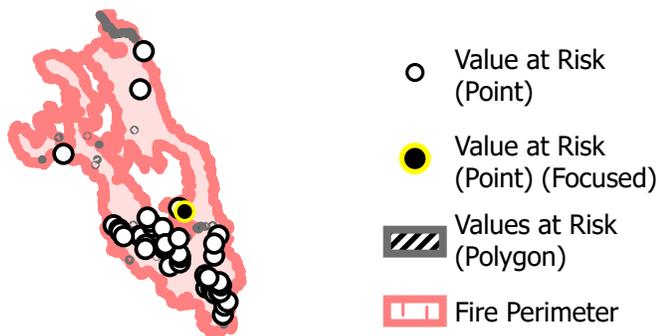
Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

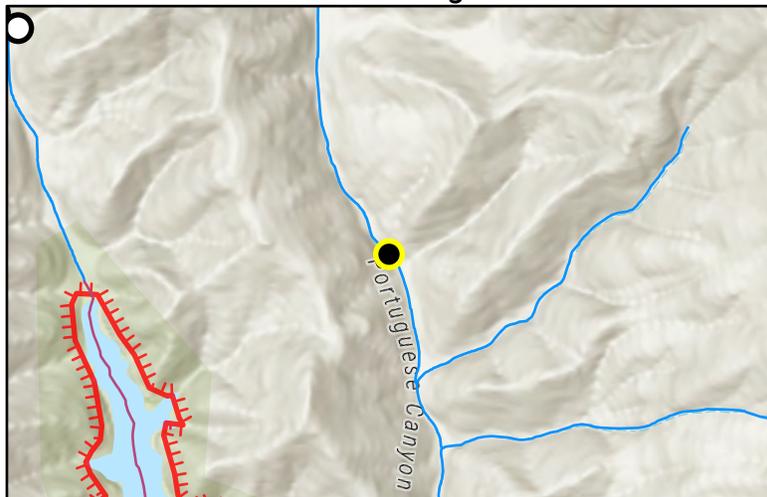
Description: NA

LOCATION AND PHOTO



Latitude: 38.5457

Longitude: -122.1328



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Middle Putah Creek

Site Number: 56

Feature: Structure

Feature Category: other

Field Observation Structure built at confluence of several burned drainages. Two locked gates.
or Potential Hazard: Not able to access.

Potential Hazard to Life: low

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

Description: NA

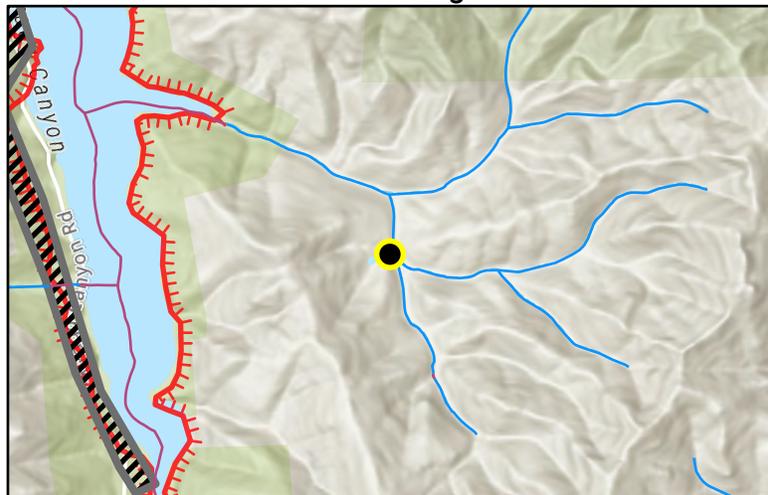
LOCATION AND PHOTO



- Value at Risk (Point)
- Value at Risk (Point) (Focused)
- ▨ Values at Risk (Polygon)
- ▭ Fire Perimeter

Latitude: 38.4914

Longitude: -122.1490



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Middle Putah Creek

Site Number: 57

Feature: Burned structure

Feature Category: home

Field Observation Burned house along edge of potential debris flow drainage. Culvert at upstream
or Potential Hazard: edge of house pad has potential to plug and divert flows to house.

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

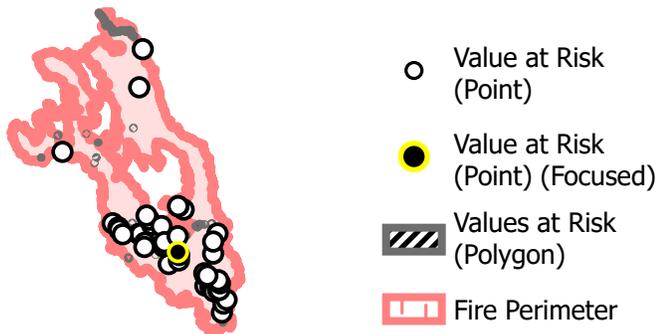
Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

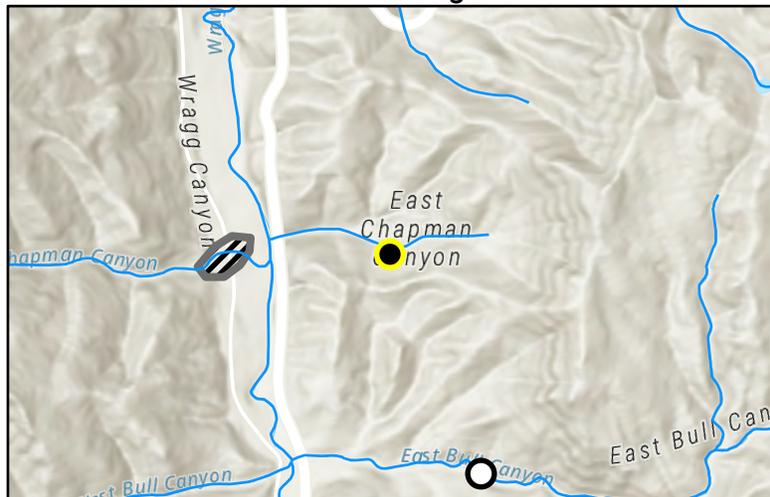
Description: NA

LOCATION AND PHOTO



Latitude: 38.4592

Longitude: -122.1487



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Middle Putah Creek

Site Number: 58

Feature: Burned structure

Feature Category: home

Field Observation or Potential Hazard: Burned house along edge of potential debris flow drainage. 1 to 4-foot diameter boulders in channel. Culvert at upstream edge of house pad has potential to plug and divert flows to house.

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

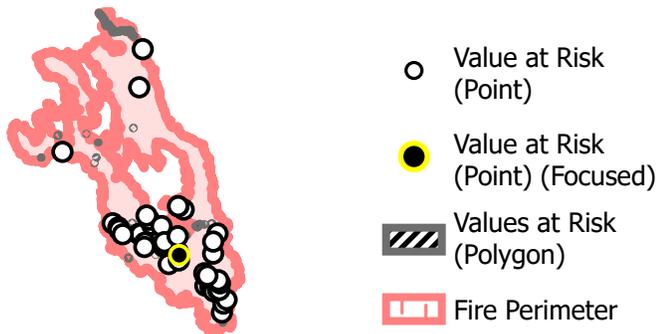
Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

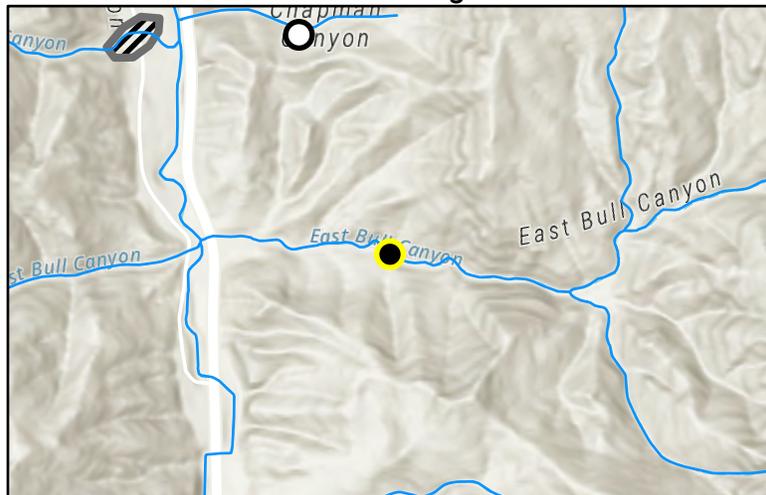
Preliminary Emergency Protective Measures (4): NA

Description: NA

LOCATION AND PHOTO



Latitude: 38.4529 Longitude: -122.1454



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Middle Putah Creek

Site Number: 59

Feature: Burned structure

Feature Category: home

Field Observation Burned house within potential debris flow drainage. Channel diverted around
or Potential Hazard: house pad. Large boulders in channel.

Potential Hazard to Life: high

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Early Warning

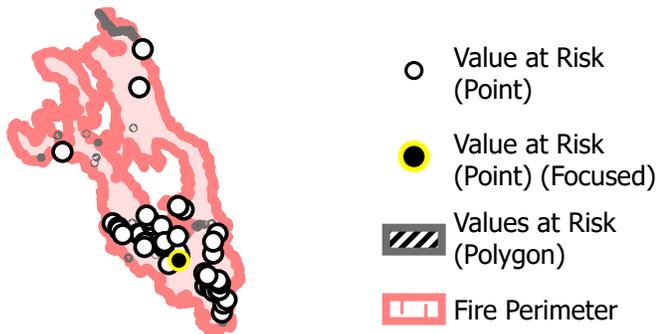
Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

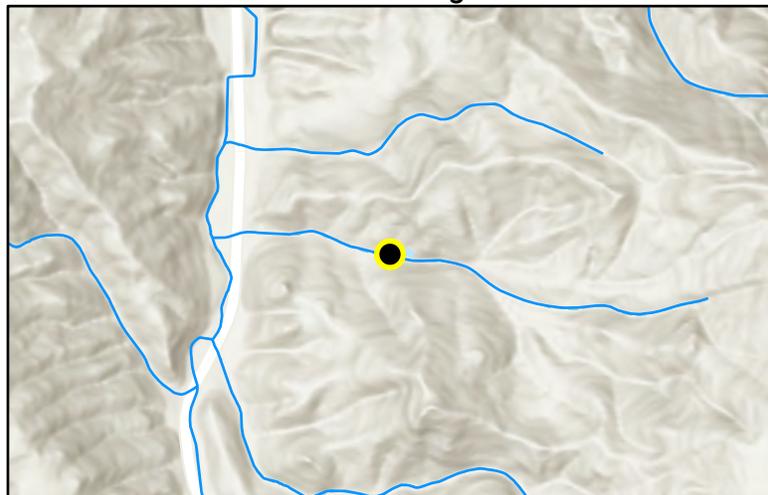
Description: NA

LOCATION AND PHOTO



Latitude: 38.4420

Longitude: -122.1464



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Middle Putah Creek

Site Number: 60

Feature: Burned structure

Feature Category: home

Field Observation Debris flow and flood hazard. Not able to access due to locked gate.
or Potential Hazard:

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

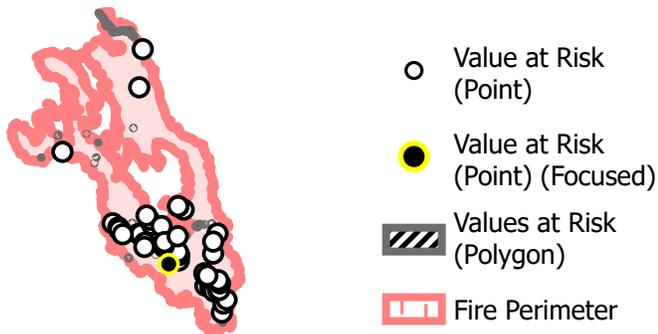
Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

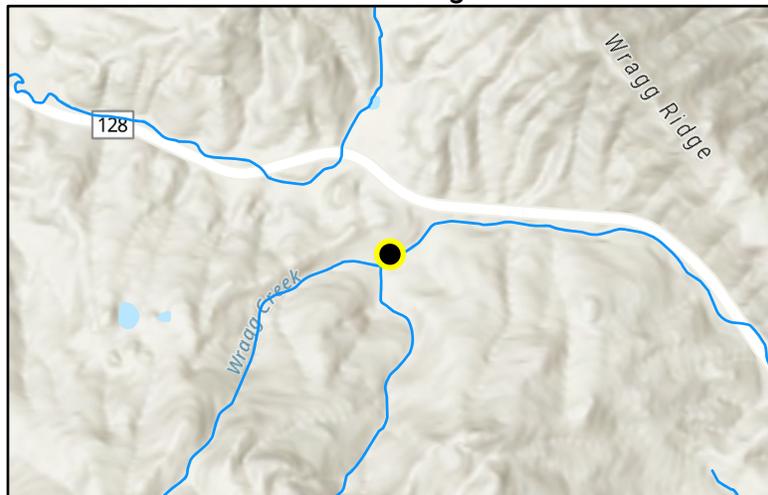
Description: NA

LOCATION AND PHOTO



Latitude: 38.4348

Longitude: -122.1728



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Middle Putah Creek

Site Number: 64

Feature: House

Feature Category: home

Field Observation House near watercourse. Locked gate, not able to access. Debris flow and
or Potential Hazard: flooding potential.

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

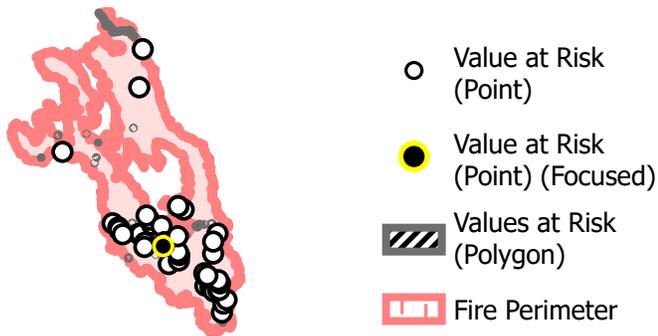
Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

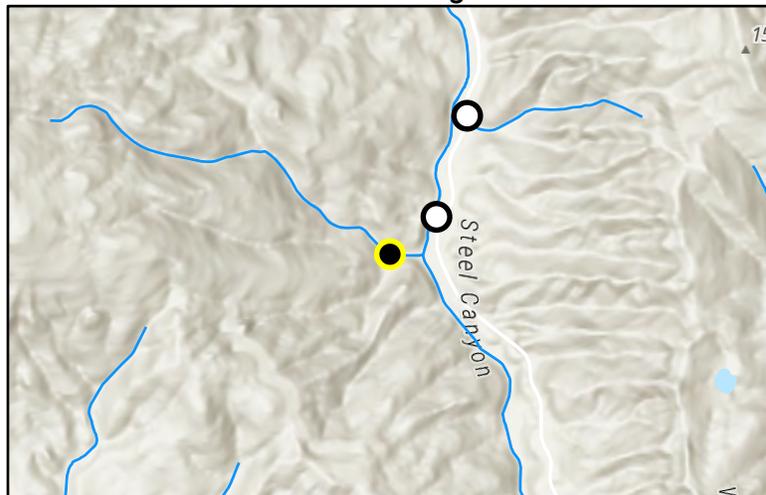
Description: NA

LOCATION AND PHOTO



Latitude: 38.4714

Longitude: -122.1868



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Middle Putah Creek

Site Number: 65

Feature: Residential structure

Feature Category: home

Field Observation House built on low terrace next to watercourse.
or Potential Hazard:

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

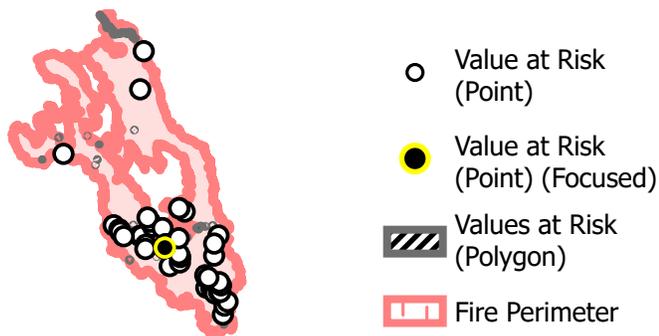
Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

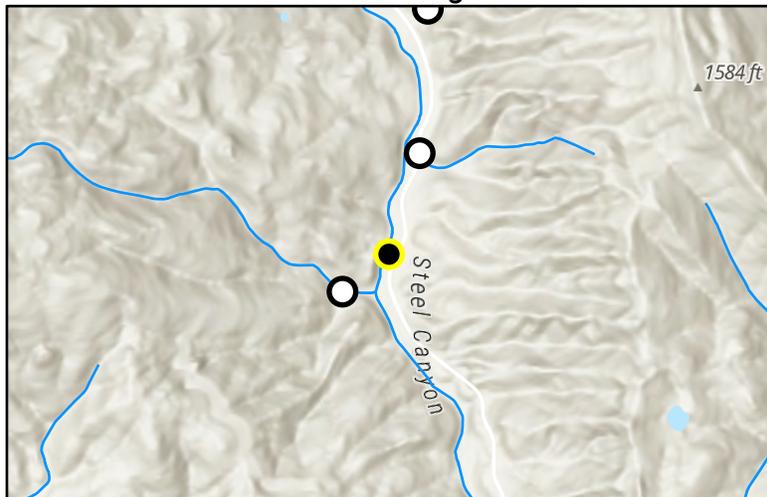
Description: NA

LOCATION AND PHOTO



Latitude: 38.4725

Longitude: -122.1851



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Middle Putah Creek

Site Number: 66

Feature: Burned structure

Feature Category: home

Field Observation Drainage channel has been routed around housing pad. Debris flow and
or Potential Hazard: flooding potential.

Potential Hazard to Life: high

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

Description: NA

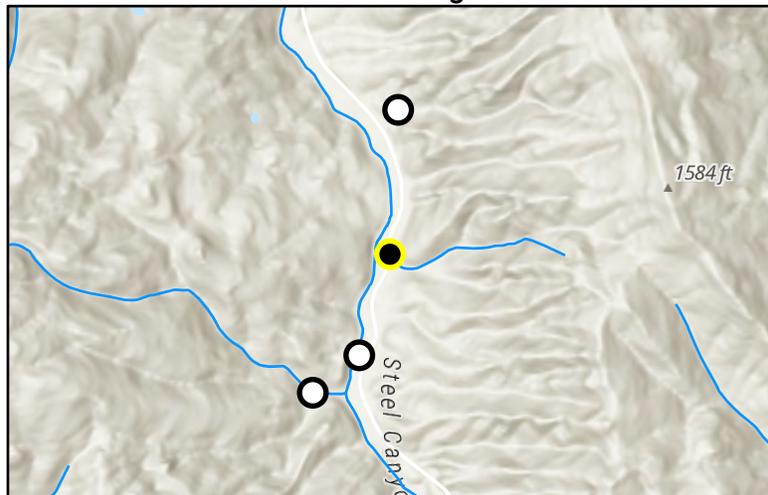
LOCATION AND PHOTO



- Value at Risk (Point)
- Value at Risk (Point) (Focused)
- ▨ Values at Risk (Polygon)
- ▭ Fire Perimeter

Latitude: 38.4754

Longitude: -122.1840



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Middle Putah Creek

Site Number: 67

Feature: Mobile home

Feature Category: home

Field Observation Burned mobile home next to watercourse.
or Potential Hazard:

Potential Hazard to Life: moderate

Potential Hazard to Property: low

Preliminary Emergency Protective Measures (1): Early Warning

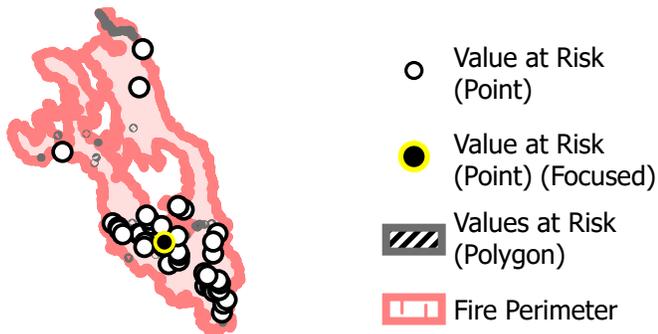
Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

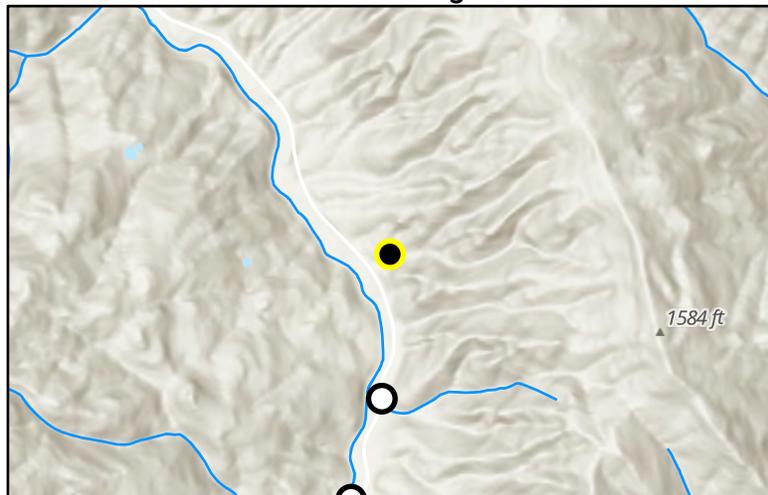
Description: NA

LOCATION AND PHOTO



Latitude: 38.4795

Longitude: -122.1836



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Middle Putah Creek

Site Number: 69

Feature: House

Feature Category: home

Field Observation House built at mouth of potential debris flow channel.
or Potential Hazard:

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

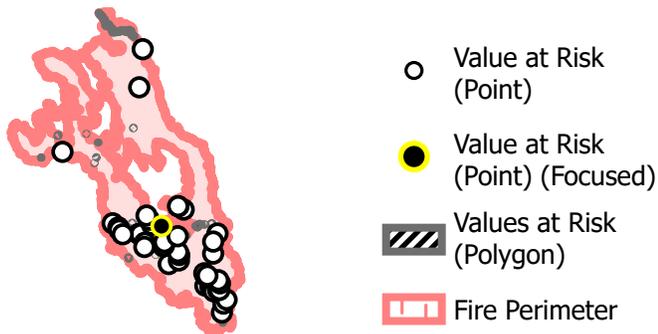
Preliminary Emergency Protective Measures (2): Clear and maintain culvert

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

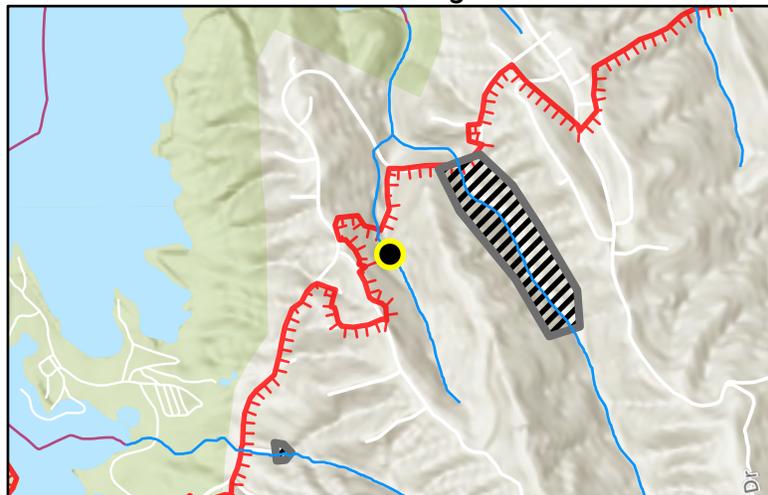
Description: NA

LOCATION AND PHOTO



Latitude: 38.5124

Longitude: -122.1908



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Middle Putah Creek

Site Number: 71

Feature: Teen Center

Feature Category: recreational

Field Observation Teen Center with lots of cabins in path of watercourse. Low soil burn severity.
or Potential Hazard:

Potential Hazard to Life: moderate

Potential Hazard to Property: low

Preliminary Emergency Protective Measures (1): Early Warning

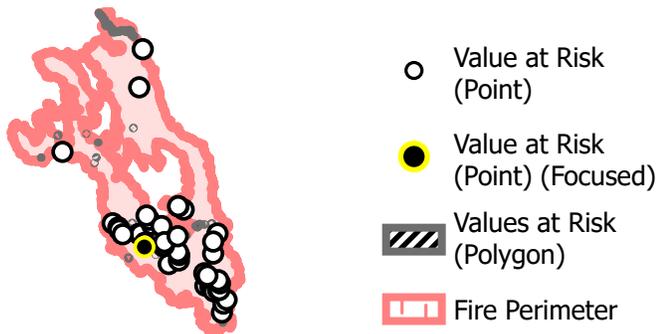
Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

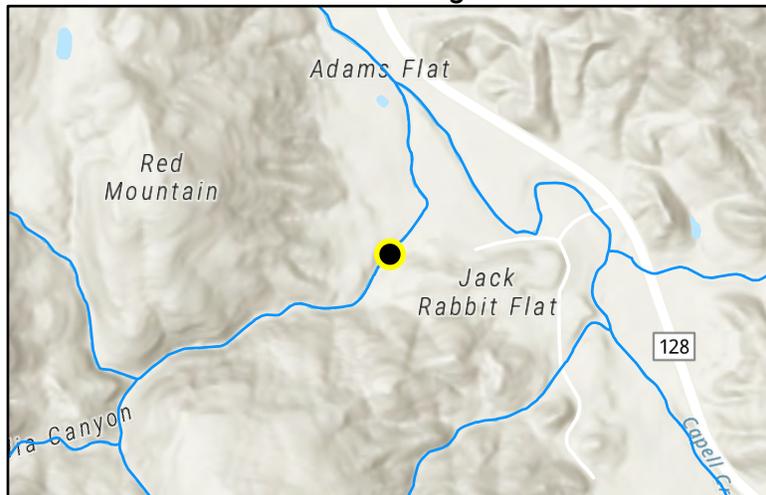
Description: NA

LOCATION AND PHOTO



Latitude: 38.4701

Longitude: -122.2356



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Middle Putah Creek

Site Number: 72

Feature: House

Feature Category: home

Field Observation House in drainage path.
or Potential Hazard:

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

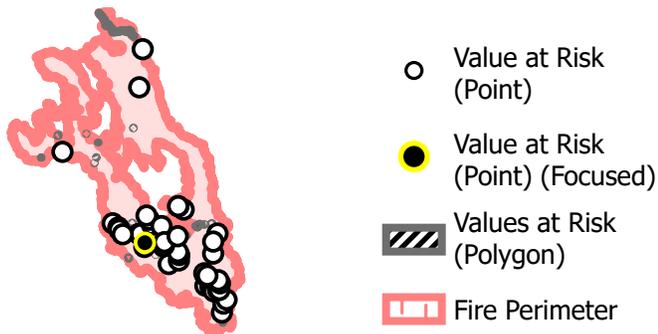
Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

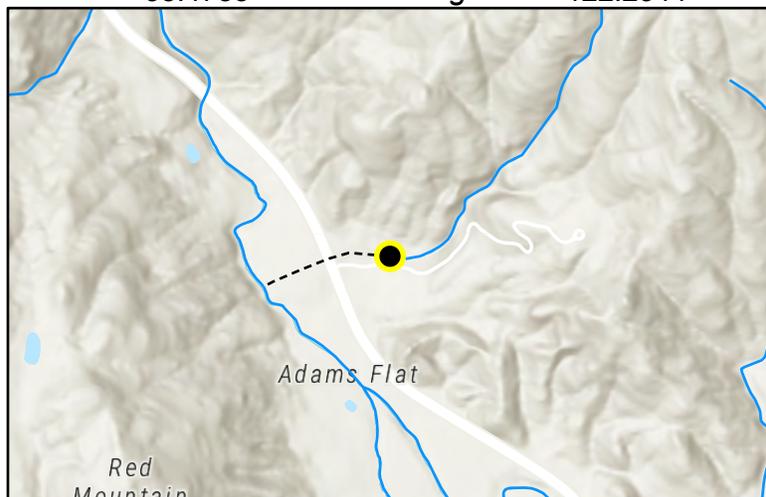
Description: NA

LOCATION AND PHOTO



Latitude: 38.4788

Longitude: -122.2344



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Middle Putah Creek

Site Number: 75

Feature: Garage/stable

Feature Category: home

Field Observation Debris flow outlet where garage/stable is currently sitting. House offset from
Potential Hazard: debris flow path.

Potential Hazard to Life: moderate

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

Description: NA

LOCATION AND PHOTO

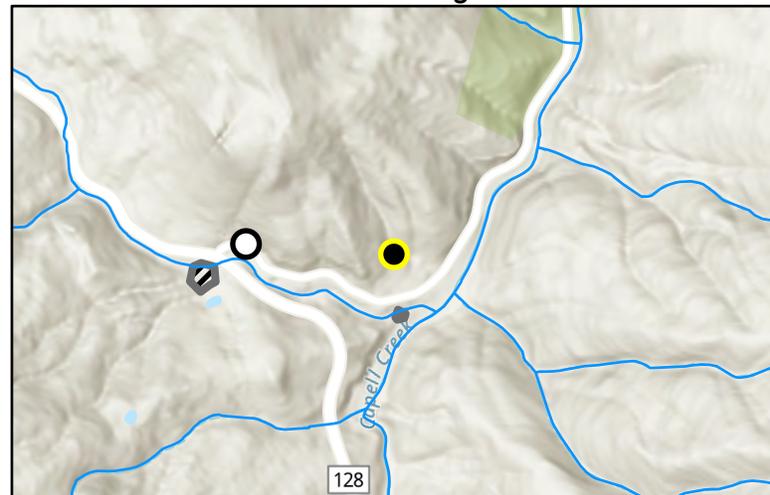


- Value at Risk (Point)
- Value at Risk (Point) (Focused)
- ▨ Values at Risk (Polygon)
- ▭ Fire Perimeter



Latitude: 38.4966

Longitude: -122.2448



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Middle Putah Creek

Site Number: 76

Feature: Road

Feature Category: other

Field Observation Potential rock fall hazards, owner confirms existing nuisance of rock fall
or Potential Hazard: hazards (yearly issues) onto road.

Potential Hazard to Life: high

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Signage

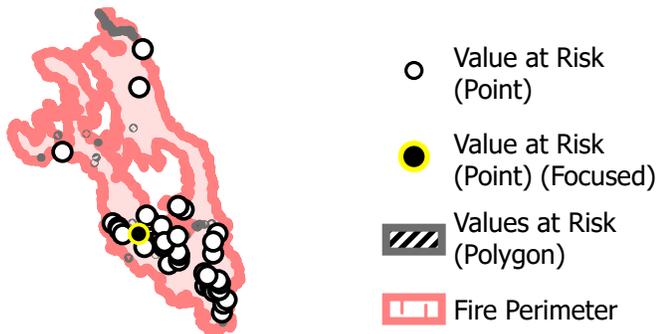
Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

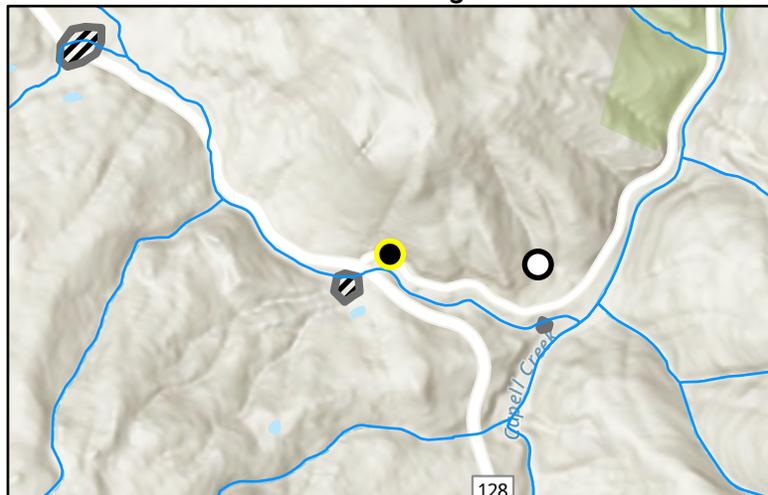
Description: NA

LOCATION AND PHOTO



Latitude: 38.4969

Longitude: -122.2502



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: **Middle Putah Creek**

Site Number: **79**

Feature: **House**

Feature Category: **home**

Field Observation Small bank protecting house but potential for debris flow to plug small culvert
or Potential Hazard: and divert towards house or overtop bank towards house.

Potential Hazard to Life: **moderate**

Potential Hazard to Property: **moderate**

Preliminary Emergency Protective Measures (1): **Early Warning**

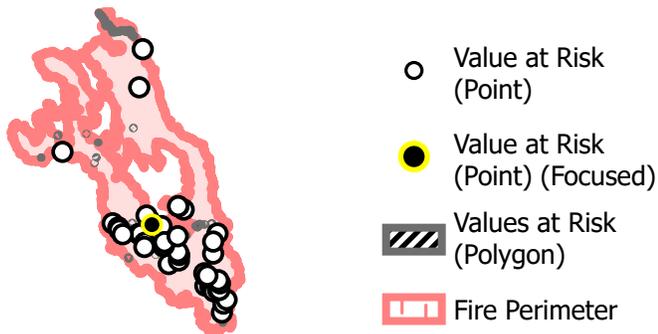
Preliminary Emergency Protective Measures (2): **NA**

Preliminary Emergency Protective Measures (3): **NA**

Preliminary Emergency Protective Measures (4): **NA**

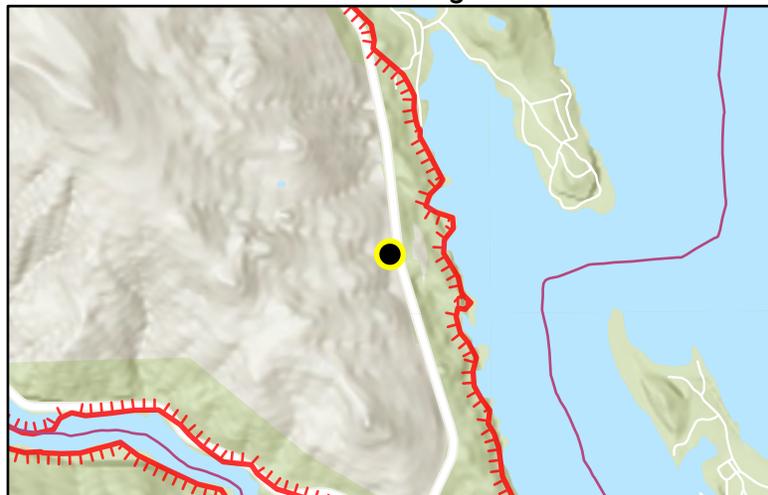
Description: NA

LOCATION AND PHOTO



Latitude: 38.5155

Longitude: -122.2156



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Middle Putah Creek

Site Number: 81

Feature: House

Feature Category: home

Field Observation Potential debris flow avulsion from steep watercourse adjacent to house.
or Potential Hazard:

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

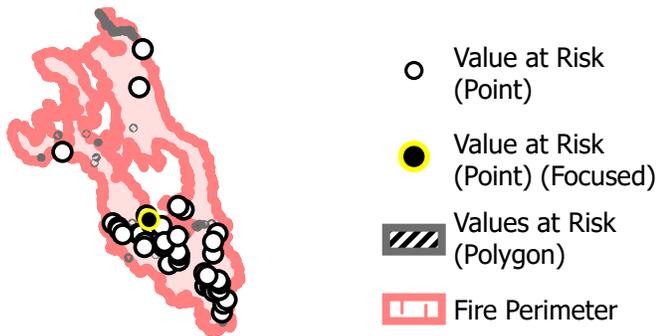
Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

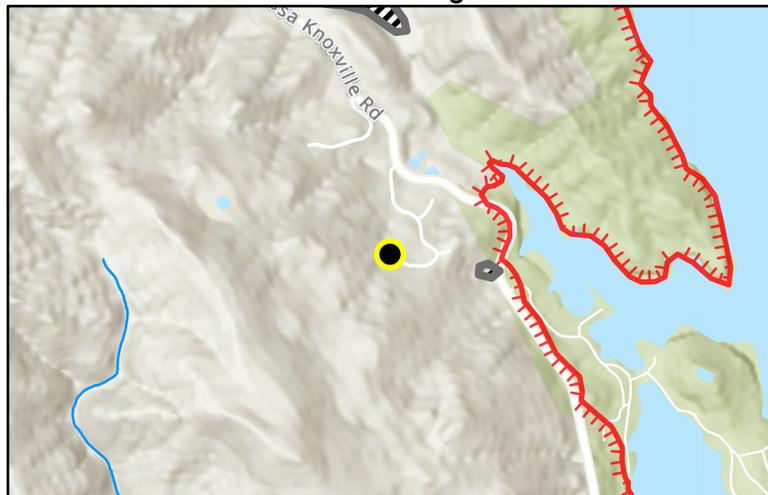
Description: NA

LOCATION AND PHOTO



Latitude: 38.5257

Longitude: -122.2231



VALUE AT RISK DETAIL

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Middle Putah Creek

Site Number: 83

Feature: A couple trailer homes and horse ring.

Feature Category: home

Field Observation Potential for flooding or sediment laden flow to enter property. Small source
or Potential Hazard: material (gravel, sand).

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

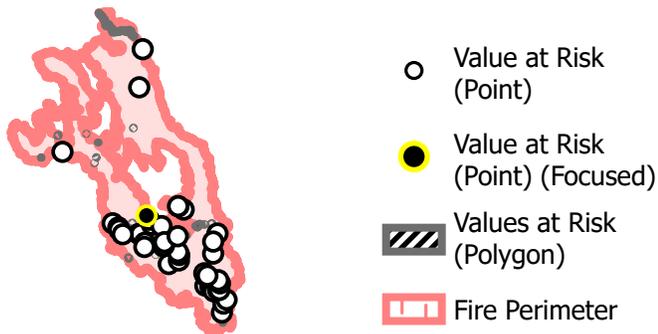
Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

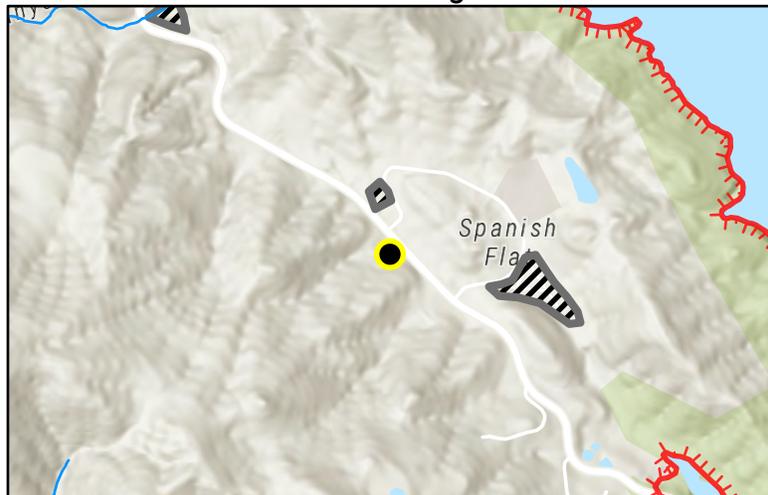
Description: NA

LOCATION AND PHOTO



Latitude: 38.5341

Longitude: -122.2294



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Lower Cache Creek

Site Number: 01

Feature: Traveling vehicles

Feature Category: other

Field Observation Rock fall, debris flow onto State Highway 16.
or Potential Hazard:

Potential Hazard to Life: high

Potential Hazard to Property: low

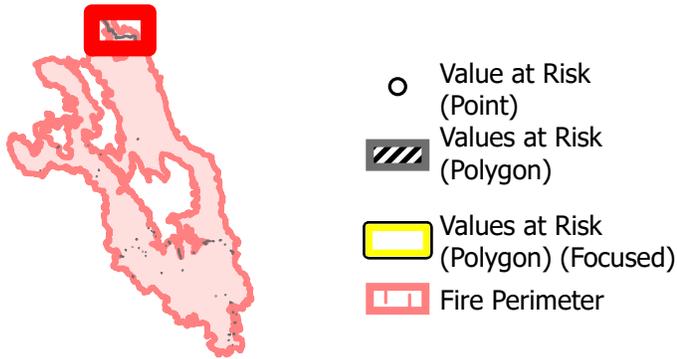
Preliminary Emergency Protective Measures (1): Signage

Preliminary Emergency Protective Measures (2): Debris barrier

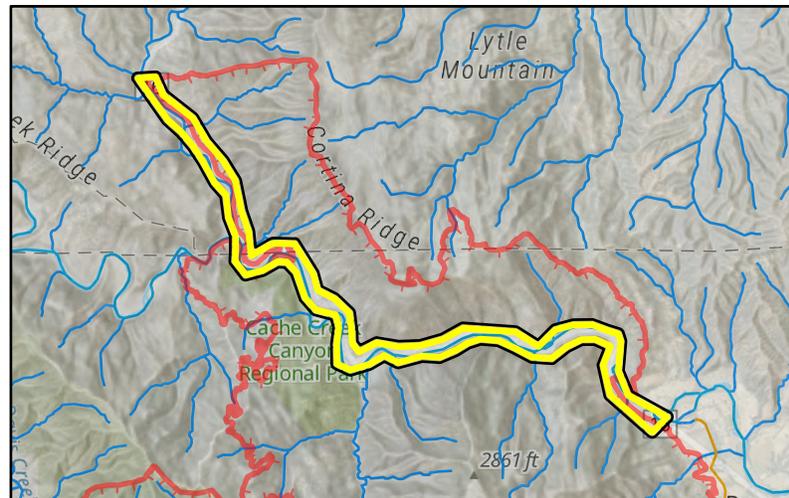
Preliminary Emergency Protective Measures (3): NA

Description: NA

LOCATION AND PHOTO



Scale: 1:117,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Lower Cache Creek

Site Number: 02

Feature: House, farm property

Feature Category: multiple

Field Observation Lots of structures near canal with little room for conveyance. Damage to
Potential Hazard: drainage canal.

Potential Hazard to Life: low

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Monitor and maintain

Preliminary Emergency Protective Measures (3): NA

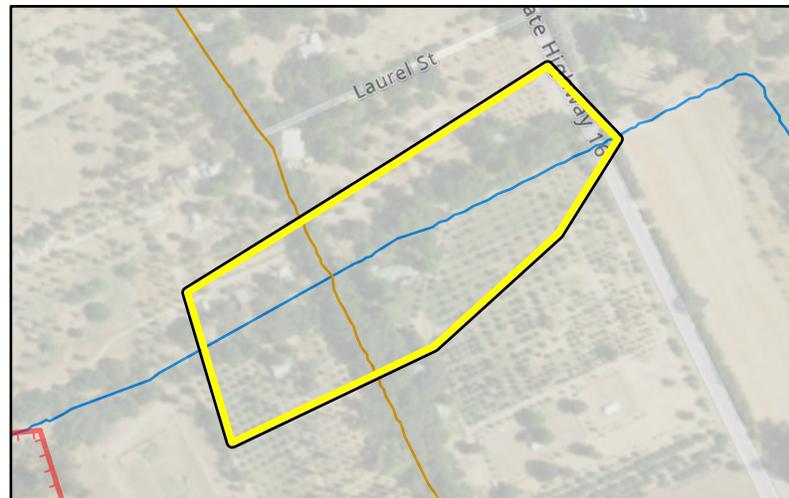
Description: NA

LOCATION AND PHOTO



- Value at Risk (Point)
- ▨ Values at Risk (Polygon)
- ▭ Values at Risk (Polygon) (Focused)
- ▭ Fire Perimeter

Scale: 1:5,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Eticuera Creek

Site Number: 05

Feature: Vacant house, office, garage

Feature Category: multiple

Field Observation or Potential Hazard: Structures at risk of potential flooding from main watercourse. Worker said stream eroded large part of bank a few years ago. House next to main watercourse is currently vacant. Knoxville Wildlife headquarters.

Potential Hazard to Life: low

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Description: NA

LOCATION AND PHOTO



- Value at Risk (Point)
- ▨ Values at Risk (Polygon)
- ▭ Values at Risk (Polygon) (Focused)
- ▭ Fire Perimeter

Scale: 1:4,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: **Lower Putah Creek**

Site Number: **06**

Feature: **Highway 128**

Feature Category: **other**

Field Observation **Rock fall onto Highway.**
or Potential Hazard:

Potential Hazard to Life: **moderate**

Potential Hazard to Property: **low**

Preliminary Emergency Protective Measures (1): **Signage**

Preliminary Emergency Protective Measures (2): **Monitor and maintain**

Preliminary Emergency Protective Measures (3): **NA**

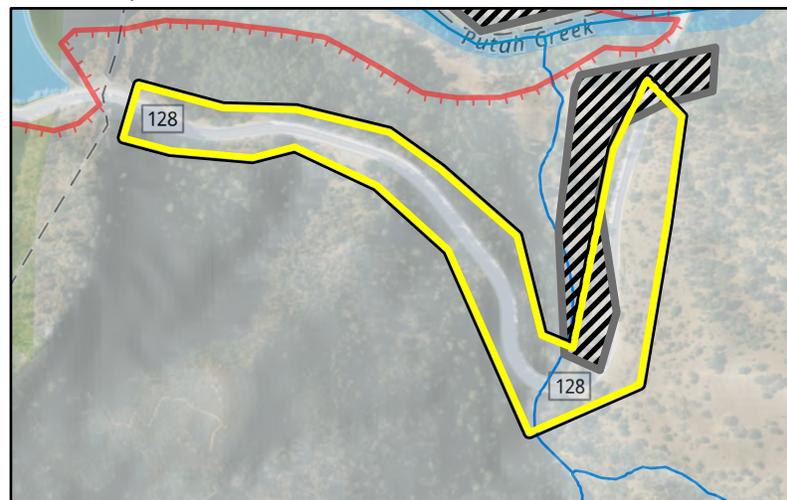
Description: **NA**

LOCATION AND PHOTO



- Value at Risk (Point)
- ▨ Values at Risk (Polygon)
- ▭ Values at Risk (Polygon) (Focused)
- ▨ Fire Perimeter

Scale: 1:9,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Lower Putah Creek

Site Number: 07

Feature: Multiple houses and office

Feature Category: multiple

Field Observation or Potential Hazard: Potential rock fall hazards. Have had a boulder, a few feet across, land on office. Potential debris flows from basins directed at yurt and trailer. Debris retention basin upstream.

Potential Hazard to Life: high

Potential Hazard to Property: high

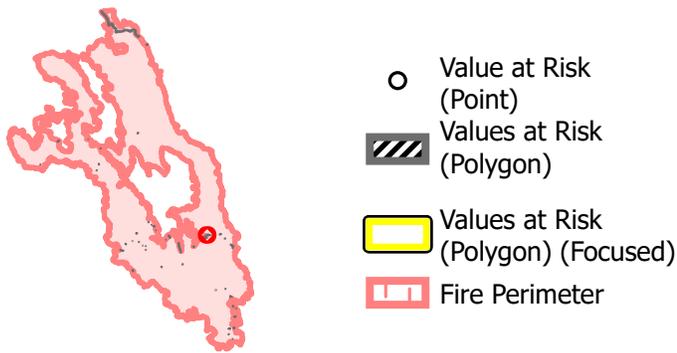
Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Monitor and maintain

Preliminary Emergency Protective Measures (3): NA

Description: NA

LOCATION AND PHOTO



Scale: 1:5,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: **Lower Putah Creek**

Site Number: **08**

Feature: **Hwy 128**

Feature Category: **other**

Field Observation **Rock fall hazards.**
or Potential Hazard:

Potential Hazard to Life: **moderate**

Potential Hazard to Property: **low**

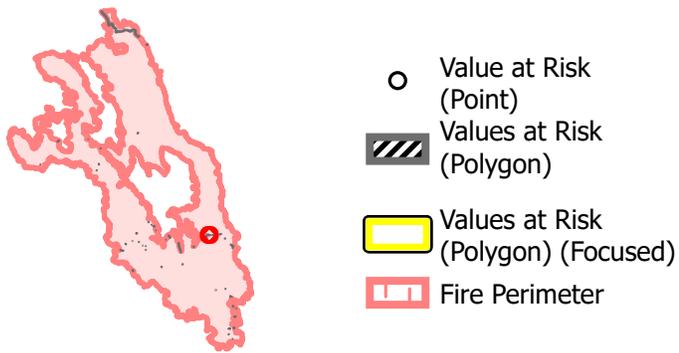
Preliminary Emergency Protective Measures (1): **Early Warning**

Preliminary Emergency Protective Measures (2): **NA**

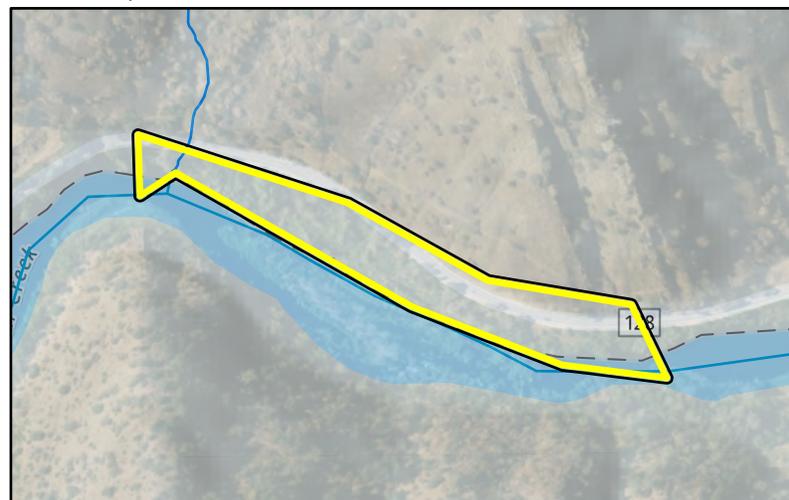
Preliminary Emergency Protective Measures (3): **NA**

Description: **NA**

LOCATION AND PHOTO



Scale: 1:7,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Lower Putah Creek

Site Number: 09

Feature: Ag infrastructure

Feature Category: business

Field Observation Ag buildings in flow path of watercourse. Debris flow and flooding hazards.
Potential Hazard:

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

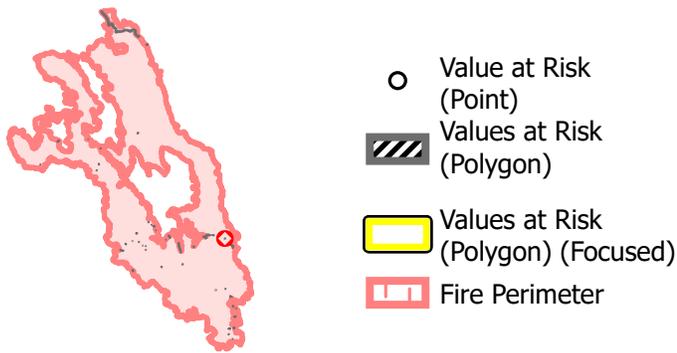
Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

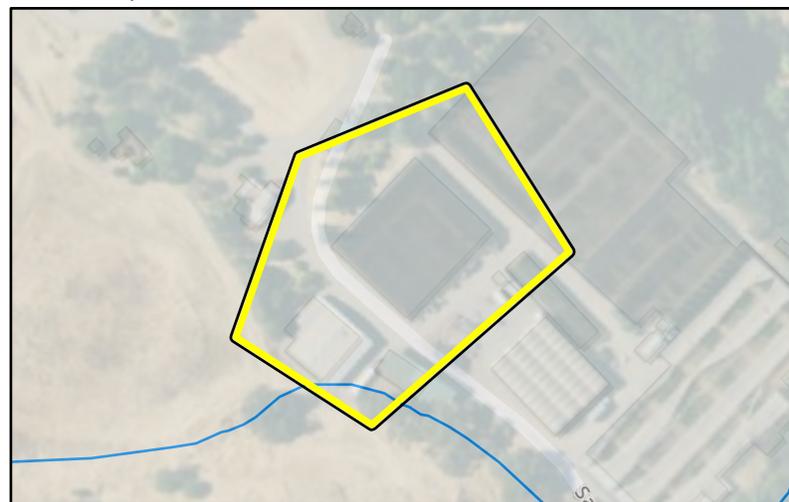
Preliminary Emergency Protective Measures (3): NA

Description: NA

LOCATION AND PHOTO



Scale: 1:3,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Lower Putah Creek

Site Number: 11

Feature: Burned structures

Feature Category: home

Field Observation Burned structures in the confluence of two watercourses. Potential flood risk.
or Potential Hazard:

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

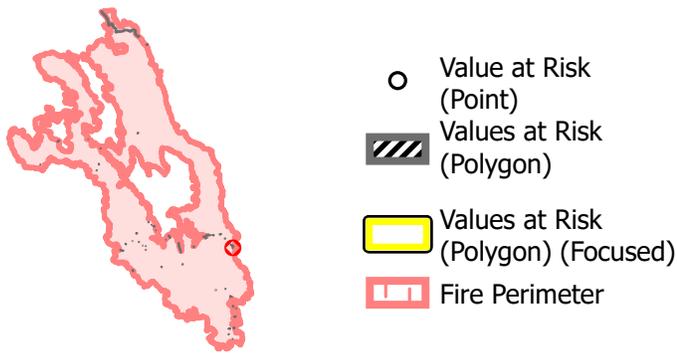
Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Description: NA

LOCATION AND PHOTO



Scale: 1:2,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Ulatis Creek and Alamo Creek

Site Number: 19

Feature: Houses

Feature Category: home

Field Observation House pads next to watercourse.
or Potential Hazard:

Potential Hazard to Life: high

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Description: NA

LOCATION AND PHOTO



- Value at Risk (Point)
- ▨ Values at Risk (Polygon)
- ▭ Values at Risk (Polygon) (Focused)
- ▭ Fire Perimeter

Scale: 1:1,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Ulatis Creek and Alamo Creek

Site Number: 20

Feature: Houses or possible trailer sites

Feature Category: home

Field Observation Ulatis Creek opens from confined channel into braided network on fan like area.
Potential Hazard: Houses constructed here. Potential for debris flow and flooding.

Potential Hazard to Life: high

Potential Hazard to Property: high

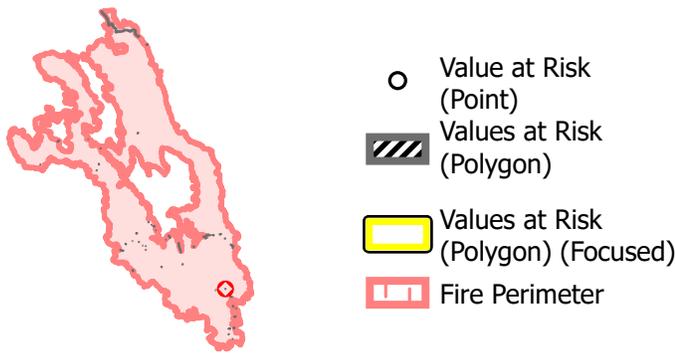
Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

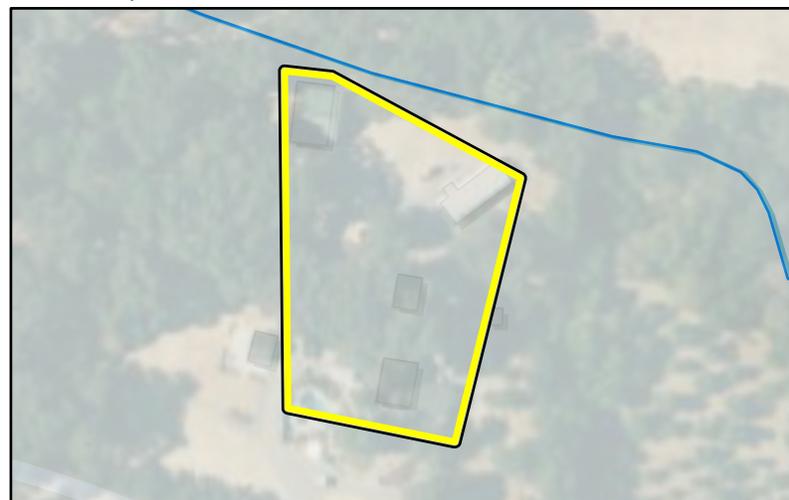
Preliminary Emergency Protective Measures (3): NA

Description: NA

LOCATION AND PHOTO



Scale: 1:2,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Ulatis Creek and Alamo Creek

Site Number: 22

Feature: Houses

Feature Category: home

Field Observation or Potential Hazard: Houses and miscellaneous non-inhabited structures in potential floodplain adjacent to watercourse. Resident reports no major flooding out of incised banks of watercourse in memory. Not able to access.

Potential Hazard to Life: low

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Description: NA

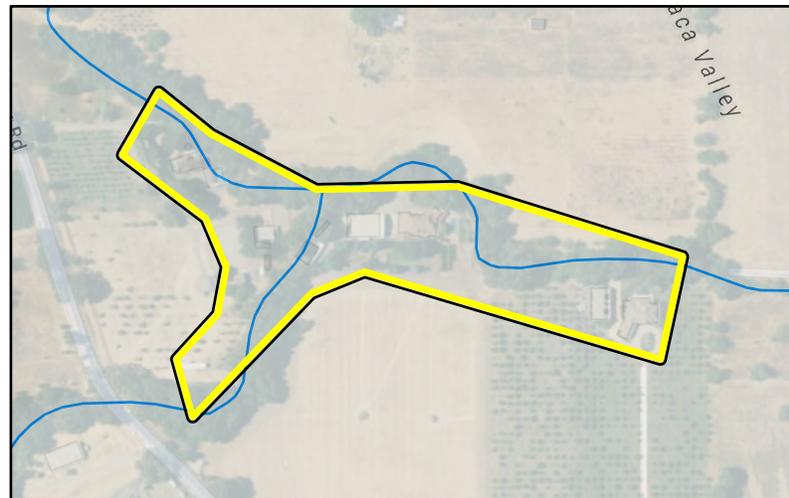
LOCATION AND PHOTO



- Value at Risk (Point)
- ▨ Values at Risk (Polygon)
- ▭ Values at Risk (Polygon) (Focused)
- ▭ Fire Perimeter



Scale: 1:6,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Ulatis Creek and Alamo Creek

Site Number: 30

Feature: Houses

Feature Category: home

Field Observation Houses in potential floodplain. Resident reports past floods close to house, but
Potential Hazard: not to house. Limited to orchard flooding.

Potential Hazard to Life: low

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

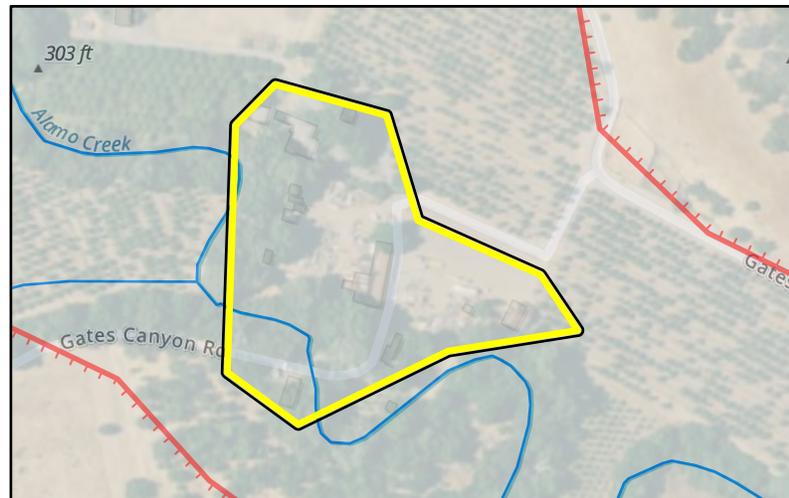
Description: NA

LOCATION AND PHOTO



- Value at Risk (Point)
- ▨ Values at Risk (Polygon)
- ▭ Values at Risk (Polygon) (Focused)
- ▭ Fire Perimeter

Scale: 1:4,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Ulatis Creek and Alamo Creek

Site Number: 31

Feature: House

Feature Category: home

Field Observation House in potential floodplain.
or Potential Hazard:

Potential Hazard to Life: low

Potential Hazard to Property: moderate

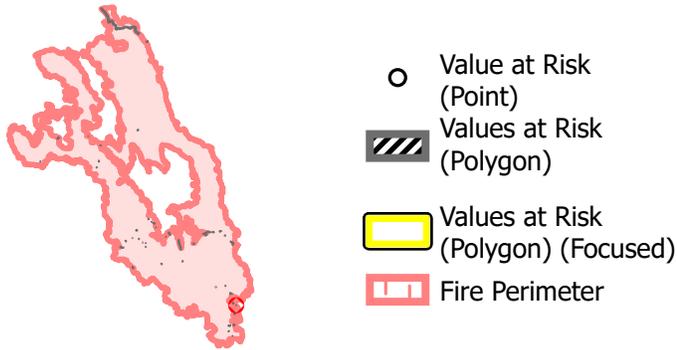
Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Description: NA

LOCATION AND PHOTO



Scale: 1:1,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Ulatis Creek and Alamo Creek

Site Number: 33

Feature: Houses

Feature Category: home

Field Observation Houses close to watercourse in potential floodplain. Local resident reports high or **Potential Hazard:** flows have nearly overtopped watercourse channel in past and flooding post fire is expected. Burned trees observed fallen into the channel.

Potential Hazard to Life: low

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Description: NA

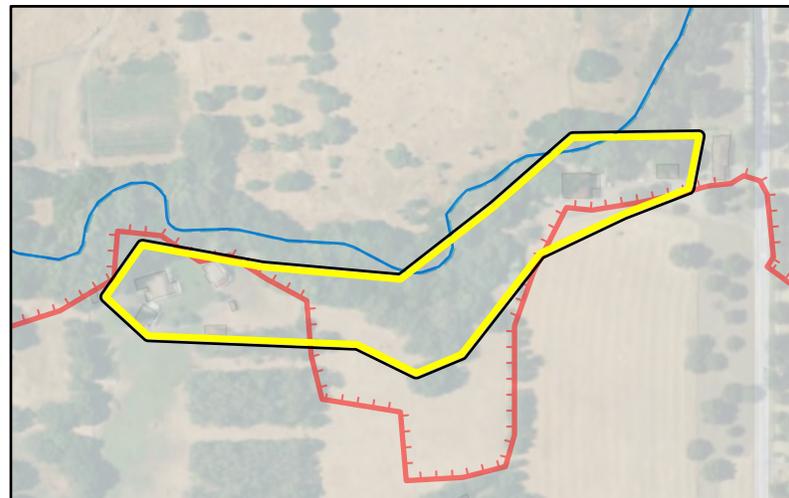
LOCATION AND PHOTO



- Value at Risk (Point)
- ▨ Values at Risk (Polygon)
- ▭ Values at Risk (Polygon) (Focused)
- ▭ Fire Perimeter



Scale: 1:5,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Ulatis Creek and Alamo Creek

Site Number: 35

Feature: Houses

Feature Category: home

Field Observation Houses and structures located in potential floodplain.
or Potential Hazard:

Potential Hazard to Life: low

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

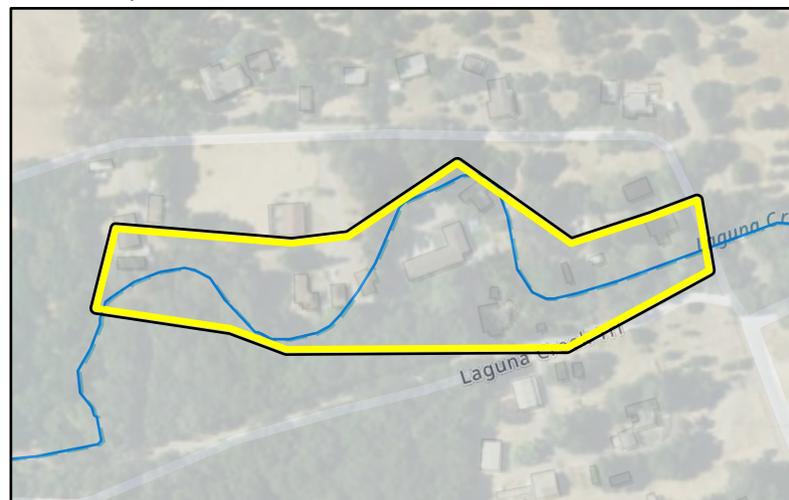
Description: NA

LOCATION AND PHOTO



- Value at Risk (Point)
- ▨ Values at Risk (Polygon)
- ▭ Values at Risk (Polygon) (Focused)
- ▨ Fire Perimeter

Scale: 1:4,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Ulatis Creek and Alamo Creek

Site Number: 37

Feature: Houses

Feature Category: home

Field Observation Houses and structures along edge of channel in potential floodplain.
or Potential Hazard:

Potential Hazard to Life: low

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

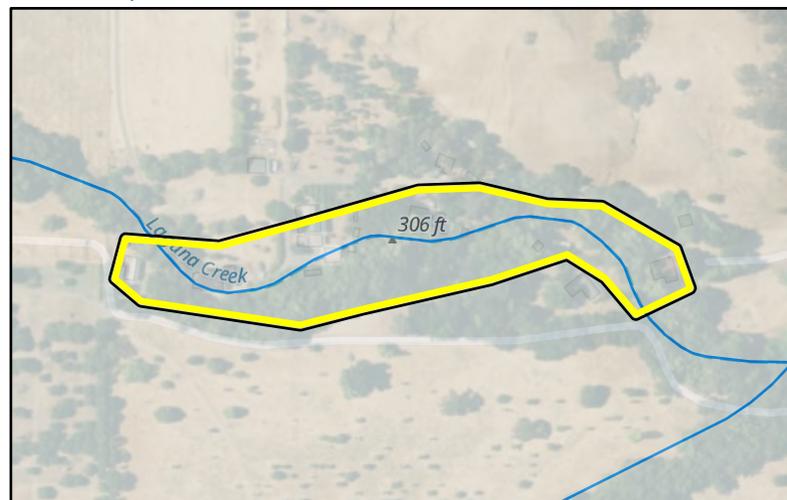
Description: NA

LOCATION AND PHOTO



- Value at Risk (Point)
- ▨ Values at Risk (Polygon)
- ▭ Values at Risk (Polygon) (Focused)
- ▭ Fire Perimeter

Scale: 1:5,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: **Suisun Bay**

Site Number: **38**

Feature: **Residential structures**

Feature Category: **home**

Field Observation Houses at outlet of debris flow channels.
or Potential Hazard:

Potential Hazard to Life: **low**

Potential Hazard to Property: **moderate**

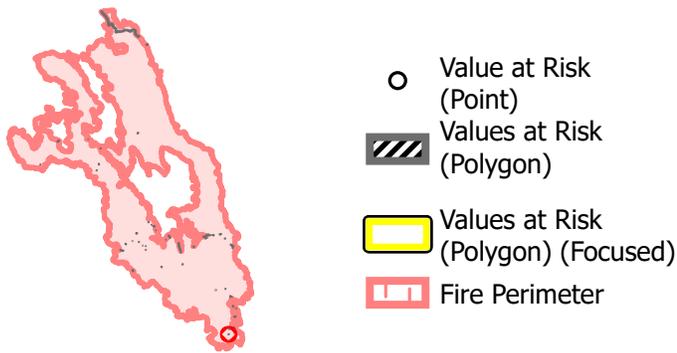
Preliminary Emergency Protective Measures (1): **Early Warning**

Preliminary Emergency Protective Measures (2): **Deflection structure**

Preliminary Emergency Protective Measures (3): **NA**

Description: Evacuate during large rain events, evaluate potential for deflection structure.

LOCATION AND PHOTO



Scale: 1:3,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: **Suisun Bay**

Site Number: **39**

Feature: **Residential trailers**

Feature Category: **home**

Field Observation Trailers along low terrace near watercourse.
or Potential Hazard:

Potential Hazard to Life: **low**

Potential Hazard to Property: **moderate**

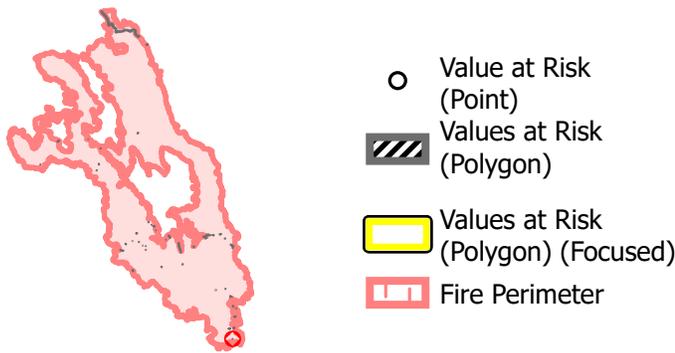
Preliminary Emergency Protective Measures (1): **Early Warning**

Preliminary Emergency Protective Measures (2): **NA**

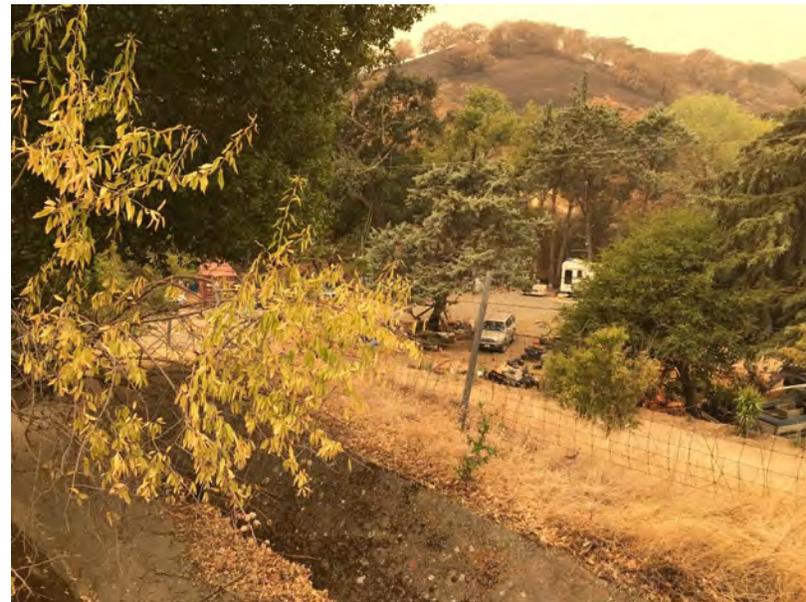
Preliminary Emergency Protective Measures (3): **NA**

Description: Move trailers prior to predicted large rain event.

LOCATION AND PHOTO



Scale: 1:2,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: **Napa Valley**

Site Number: **40**

Feature: **Houses**

Feature Category: **home**

Field Observation Houses on toe/fan of landslide. Not able to access.
or Potential Hazard:

Potential Hazard to Life: **moderate**

Potential Hazard to Property: **moderate**

Preliminary Emergency Protective Measures (1): **Early Warning**

Preliminary Emergency Protective Measures (2): **NA**

Preliminary Emergency Protective Measures (3): **NA**

Description: **NA**

LOCATION AND PHOTO



- Value at Risk (Point)
- ▨ Values at Risk (Polygon)
- ▭ Values at Risk (Polygon) (Focused)
- ▭ Fire Perimeter

Scale: 1:3,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: **Napa Valley**

Site Number: **41**

Feature: **Houses**

Feature Category: **home**

Field Observation Houses on toe/fan of landslide between three drainages. Large boulders in
Potential Hazard: creeks. Owner says lower house has flooded recently.

Potential Hazard to Life: **moderate**

Potential Hazard to Property: **moderate**

Preliminary Emergency Protective Measures (1): **Early Warning**

Preliminary Emergency Protective Measures (2): **NA**

Preliminary Emergency Protective Measures (3): **NA**

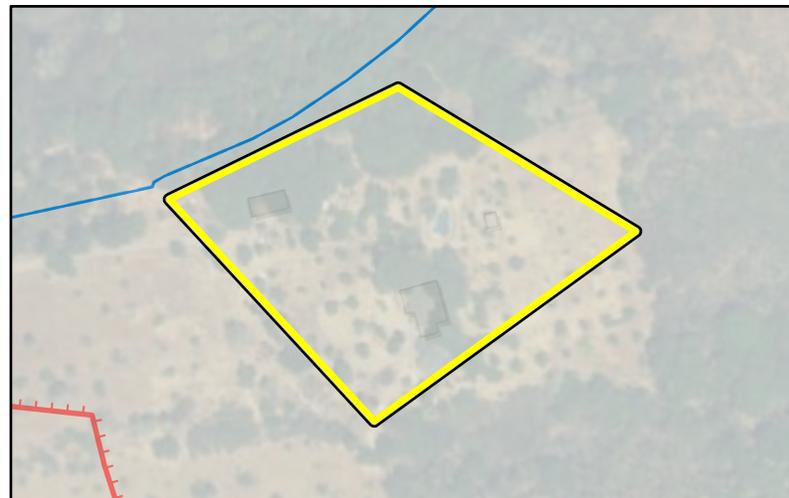
Description: NA

LOCATION AND PHOTO



- Value at Risk (Point)
- ▨ Values at Risk (Polygon)
- ▭ Values at Risk (Polygon) (Focused)
- ▭ Fire Perimeter

Scale: 1:3,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: **Napa Valley**

Site Number: **42**

Feature: **Highway 128**

Feature Category: **other**

Field Observation **Rock fall onto road.**
or Potential Hazard:

Potential Hazard to Life: **moderate**

Potential Hazard to Property: **low**

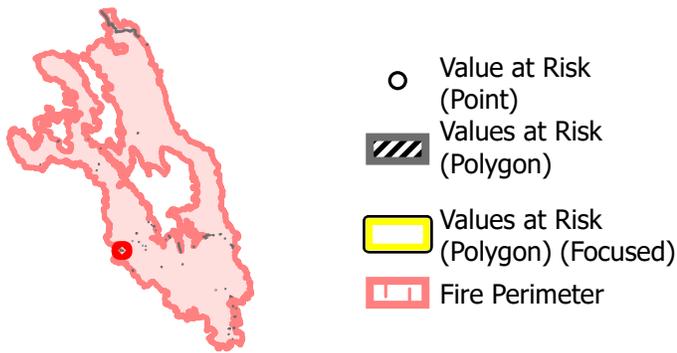
Preliminary Emergency Protective Measures (1): **Early Warning**

Preliminary Emergency Protective Measures (2): **Signage**

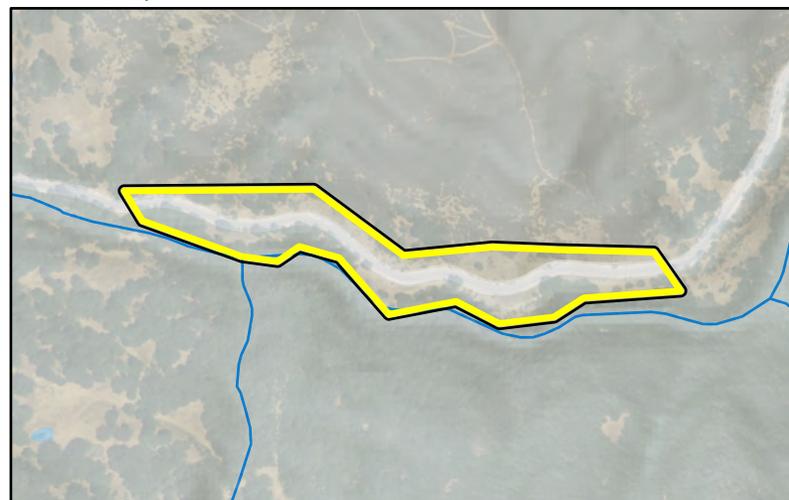
Preliminary Emergency Protective Measures (3): **NA**

Description: Consider closing road segment during lage rain events.

LOCATION AND PHOTO



Scale: 1:10,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Napa Valley

Site Number: 43

Feature: Winery infrastructure

Feature Category: business

Field Observation Trailers, barn, and winery infrastructure in path of watercourse. Debris flow and
Potential Hazard: flooding hazards.

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

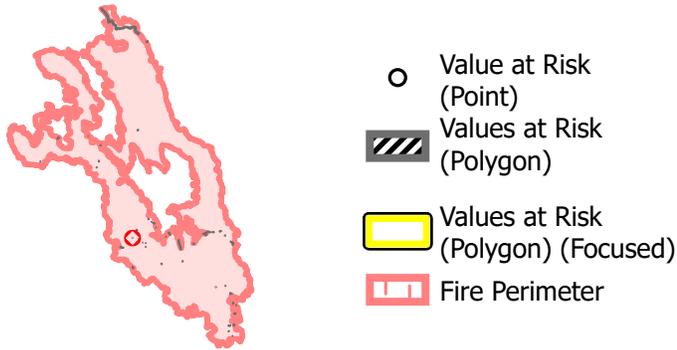
Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

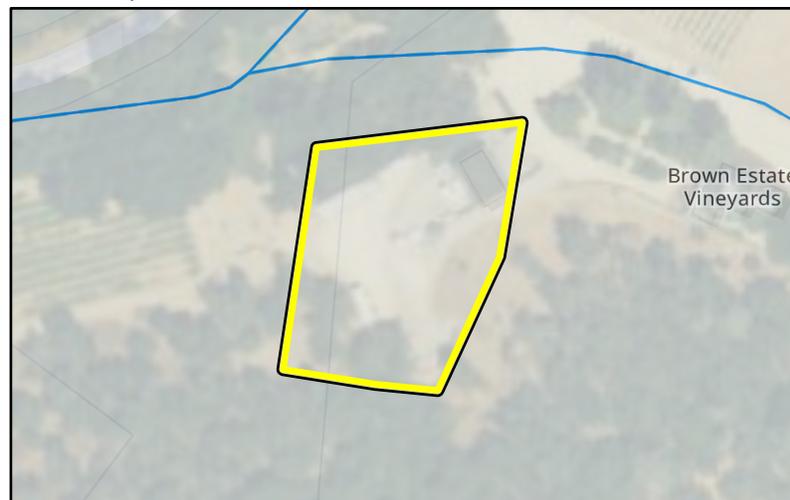
Preliminary Emergency Protective Measures (3): NA

Description: NA

LOCATION AND PHOTO



Scale: 1:2,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: **Pope Creek**

Site Number: **48**

Feature: **Center structures and houses**

Feature Category: **multiple**

Field Observation Debris flow and rock fall hazards for buildings at Center.
or Potential Hazard:

Potential Hazard to Life: **high**

Potential Hazard to Property: **high**

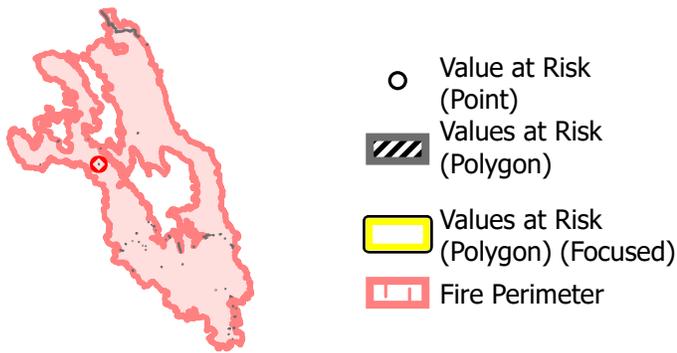
Preliminary Emergency Protective Measures (1): **Early Warning**

Preliminary Emergency Protective Measures (2): **NA**

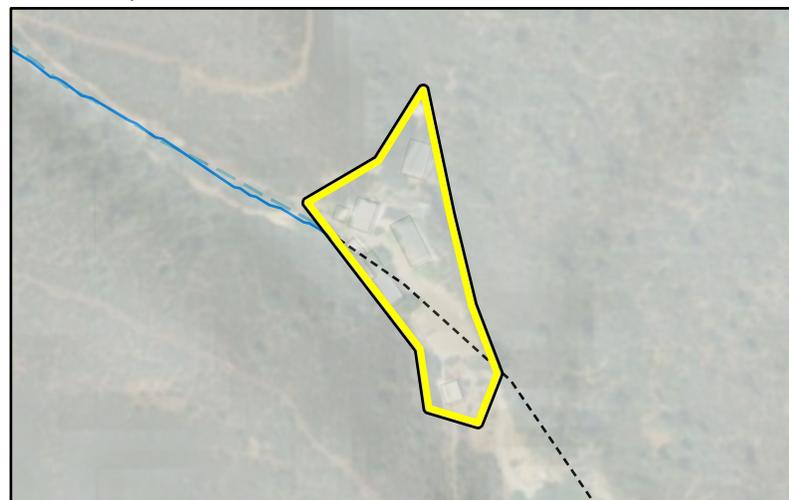
Preliminary Emergency Protective Measures (3): **NA**

Description: NA

LOCATION AND PHOTO



Scale: 1:4,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Upper Putah Creek

Site Number: 50

Feature: House and shop/barn

Feature Category: home

Field Observation Potential debris flow may impact shop/barn. Houses at risk for rock fall hazards.
or Potential Hazard:

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

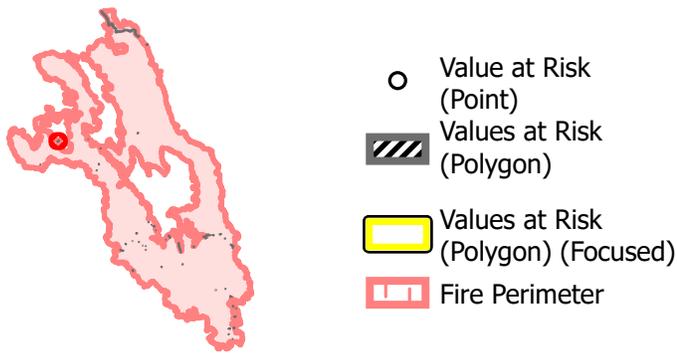
Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

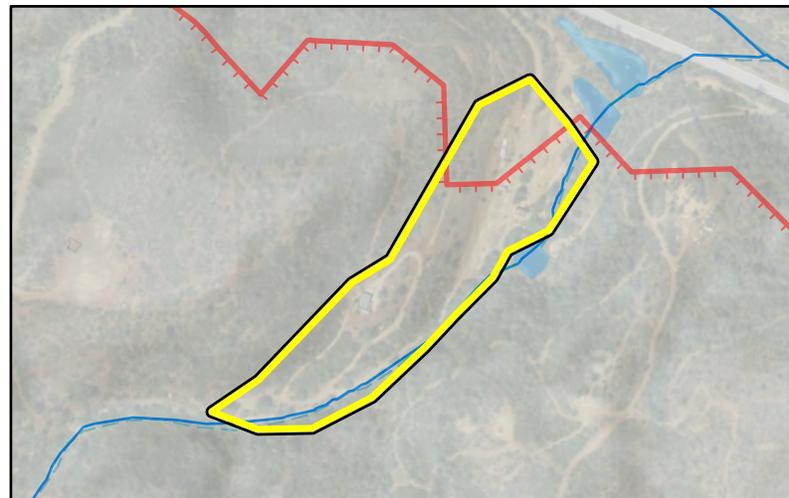
Preliminary Emergency Protective Measures (3): NA

Description: NA

LOCATION AND PHOTO



Scale: 1:7,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Upper Putah Creek

Site Number: 51

Feature: Houses

Feature Category: multiple

Field Observation Potential flooding from road toward houses.
or Potential Hazard:

Potential Hazard to Life: low

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Description: NA

LOCATION AND PHOTO



- Value at Risk (Point)
- ▨ Values at Risk (Polygon)
- ▭ Values at Risk (Polygon) (Focused)
- ▭ Fire Perimeter

Scale: 1:1,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Upper Putah Creek

Site Number: 52

Feature: Trailer home

Feature Category: home

Field Observation Potential for debris flow from watercourse, low burn severity.
or Potential Hazard:

Potential Hazard to Life: low

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

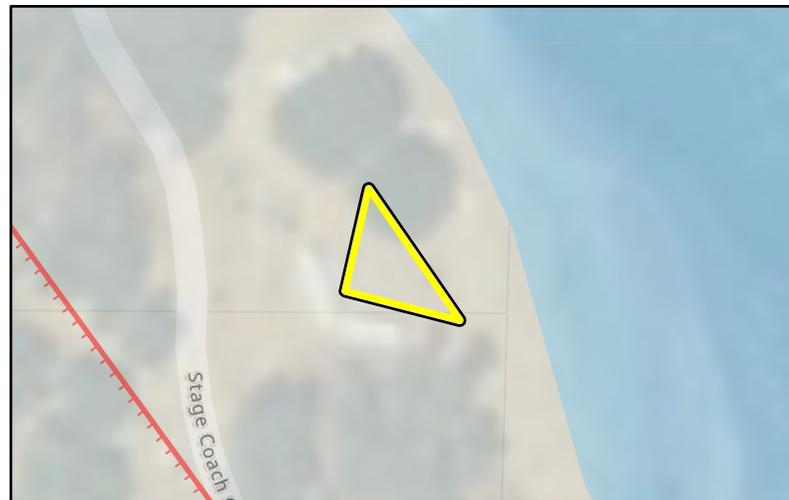
Description: NA

LOCATION AND PHOTO



- Value at Risk (Point)
- ▨ Values at Risk (Polygon)
- ▭ Values at Risk (Polygon) (Focused)
- ▭ Fire Perimeter

Scale: 1:1,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Middle Putah Creek

Site Number: 61

Feature: Houses

Feature Category: home

Field Observation Houses adjacent to watercourses, creek filled with small to large boulders.
Potential Hazard: Culvert could plug and watercourse could avulse.

Potential Hazard to Life: high

Potential Hazard to Property: high

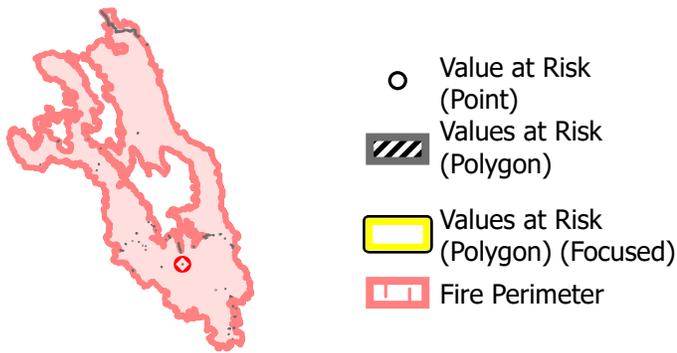
Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

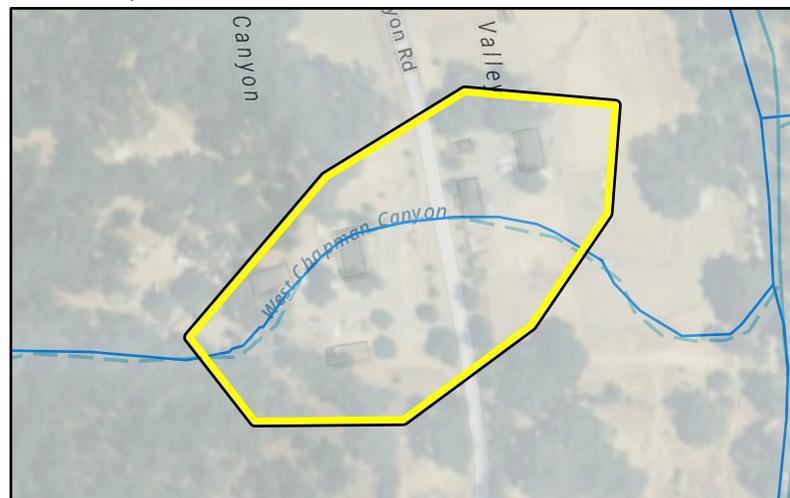
Preliminary Emergency Protective Measures (3): NA

Description: NA

LOCATION AND PHOTO



Scale: 1:3,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: **Middle Putah Creek**

Site Number: **62**

Feature: **Houses**

Feature Category: **home**

Field Observation House built next to watercourse. Debris flow and flooding potential.
or Potential Hazard:

Potential Hazard to Life: **high**

Potential Hazard to Property: **high**

Preliminary Emergency Protective Measures (1): **Early Warning**

Preliminary Emergency Protective Measures (2): **NA**

Preliminary Emergency Protective Measures (3): **NA**

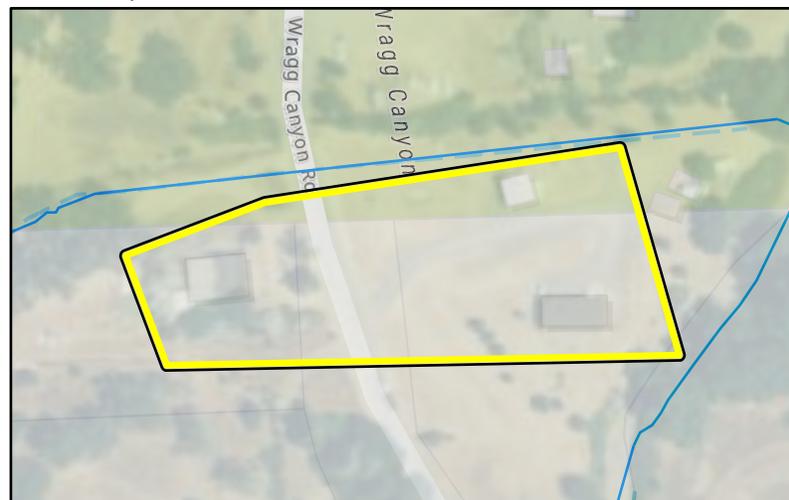
Description: **NA**

LOCATION AND PHOTO



- Value at Risk (Point)
- ▨ Values at Risk (Polygon)
- ▭ Values at Risk (Polygon) (Focused)
- ▭ Fire Perimeter

Scale: 1:2,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Middle Putah Creek

Site Number: 63

Feature: Structures and campsites

Feature Category: recreational

Field Observation Campsites and cabins in debris flow and flooding path.
or Potential Hazard:

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

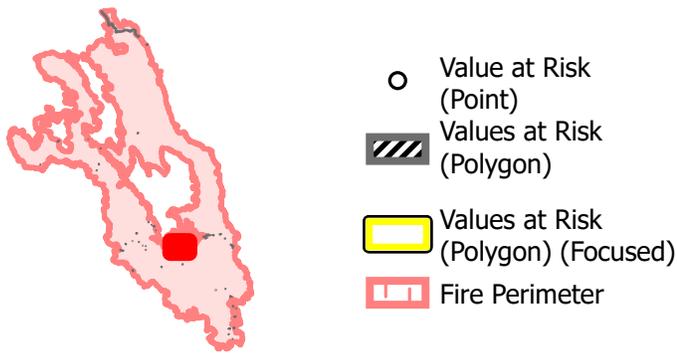
Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

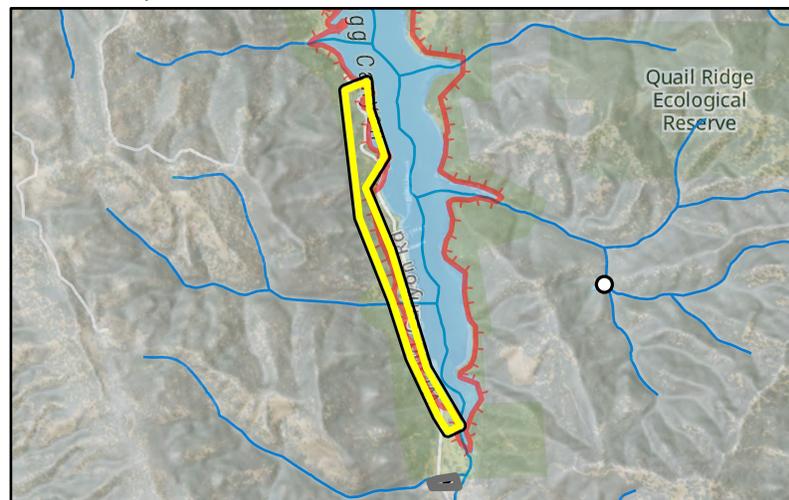
Preliminary Emergency Protective Measures (3): NA

Description: Close campground during rain events.

LOCATION AND PHOTO



Scale: 1:39,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Middle Putah Creek

Site Number: 68

Feature: Houses

Feature Category: home

Field Observation or Potential Hazard: Houses and drainage structures at mouth of potential debris flow canyon. Home owner says drainage structure aggrades and plugs. Flow has been directed through his driveway before.

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

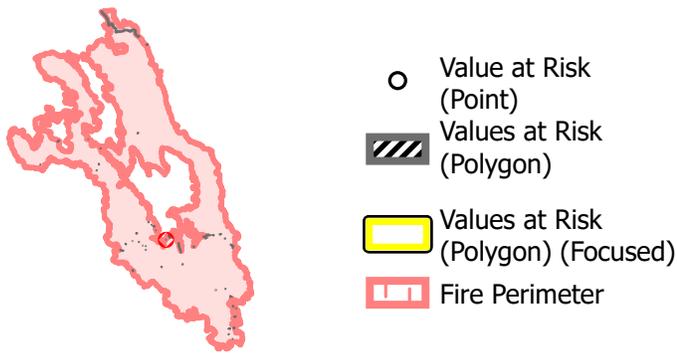
Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Clear and maintain culvert

Preliminary Emergency Protective Measures (3): NA

Description: NA

LOCATION AND PHOTO



Scale: 1:1,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Middle Putah Creek

Site Number: 70

Feature: Houses

Feature Category: home

Field Observation House pads in watercourse channels and below steep rocky side tributaries.
Potential Hazard: Small debris basin at top of road.

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Clear and maintain basin

Preliminary Emergency Protective Measures (3): NA

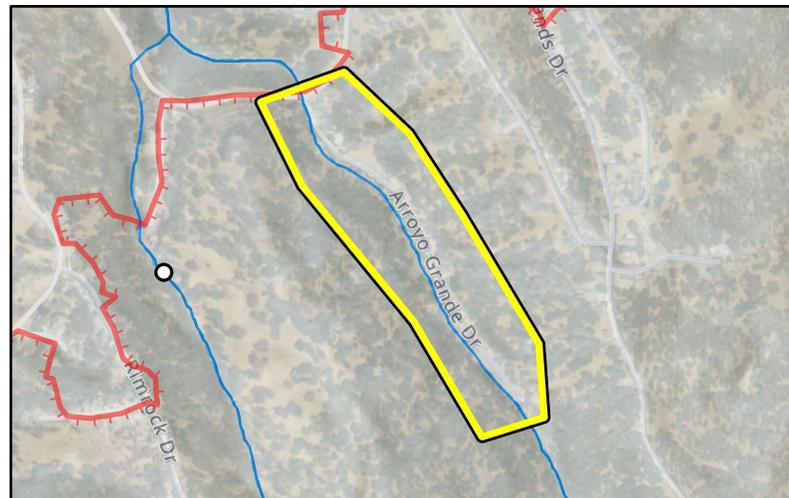
Description: NA

LOCATION AND PHOTO



- Value at Risk (Point)
- ▨ Values at Risk (Polygon)
- ▭ Values at Risk (Polygon) (Focused)
- ▭ Fire Perimeter

Scale: 1:12,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Middle Putah Creek

Site Number: 73

Feature: Burned structure and outbuilding

Feature Category: home

Field Observation Burned structure and outbuilding in a floodway. Flood hazards.
or Potential Hazard:

Potential Hazard to Life: low

Potential Hazard to Property: moderate

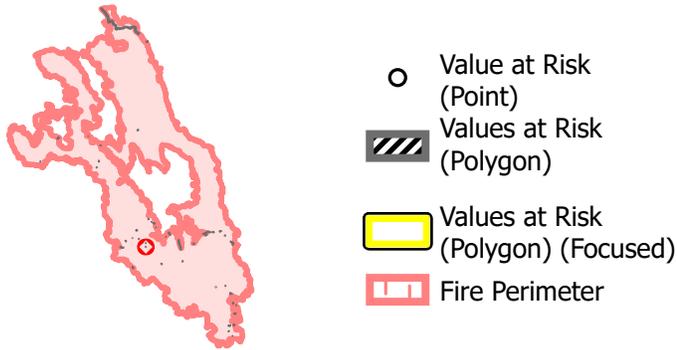
Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Description: NA

LOCATION AND PHOTO



Scale: 1:3,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Middle Putah Creek

Site Number: 74

Feature: Houses

Feature Category: home

Field Observation Potential for northern watercourse to overtop (bends towards house), will likely
Potential Hazard: be directed towards driveway.

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

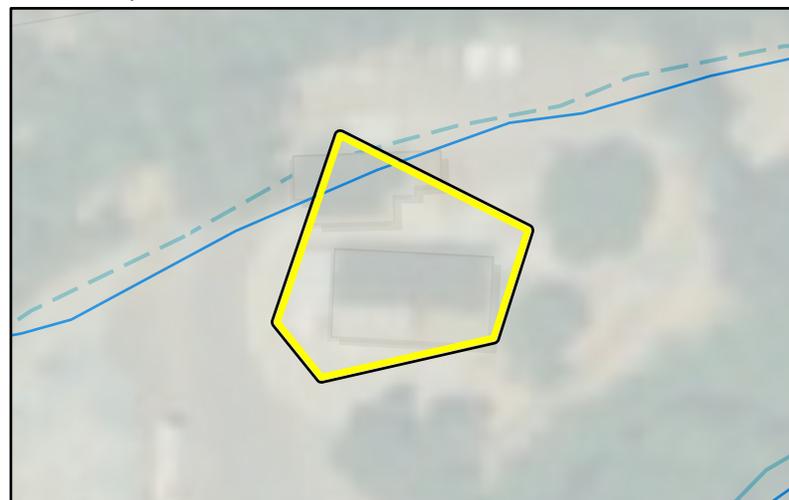
Description: NA

LOCATION AND PHOTO



- Value at Risk (Point)
- ▨ Values at Risk (Polygon)
- ▭ Values at Risk (Polygon) (Focused)
- ▭ Fire Perimeter

Scale: 1:1,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Middle Putah Creek

Site Number: 77

Feature: Trailers and storage structures

Feature Category: home

Field Observation Complex of trailers and storage structures in path of drainage. Debris flow and
Potential Hazard: flooding hazards.

Potential Hazard to Life: high

Potential Hazard to Property: high

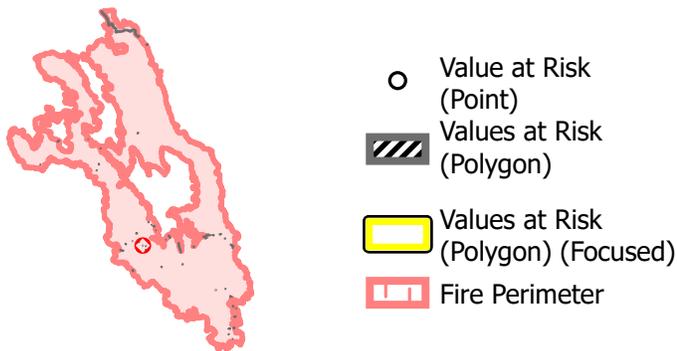
Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Description: NA

LOCATION AND PHOTO



Scale: 1:2,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: **Middle Putah Creek**

Site Number: **78**

Feature: **House and shed**

Feature Category: **home**

Field Observation House is built below mouth of watercourse channel. House is across highway
or Potential Hazard: but drainage includes moderate and high soil burn severity.

Potential Hazard to Life: **moderate**

Potential Hazard to Property: **moderate**

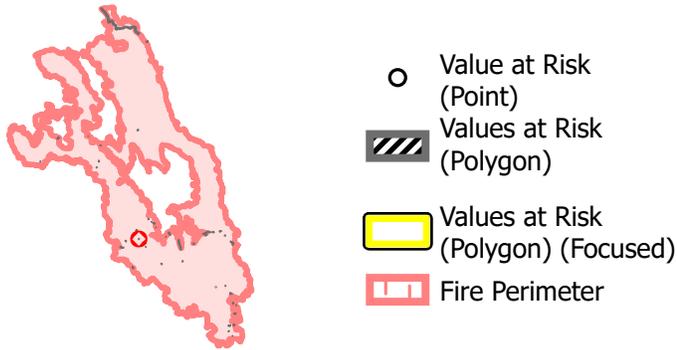
Preliminary Emergency Protective Measures (1): **Early Warning**

Preliminary Emergency Protective Measures (2): **NA**

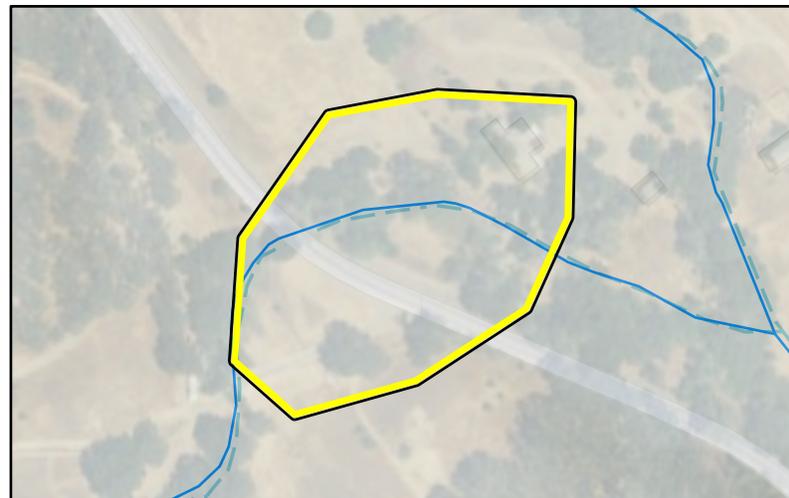
Preliminary Emergency Protective Measures (3): **NA**

Description: NA

LOCATION AND PHOTO



Scale: 1:3,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Middle Putah Creek

Site Number: 80

Feature: House and garage

Feature Category: home

Field Observation House between downstream small watercourse channel with cobble and small or **Potential Hazard:** boulders. Larger watercourse is likely to travel down road and avoid house, with exception of nuisance debris. Garage is downstream of road.

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

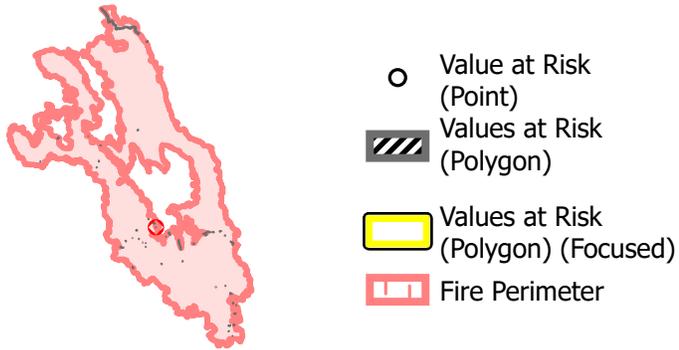
Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Description: NA

LOCATION AND PHOTO



Scale: 1:1,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Middle Putah Creek

Site Number: 82

Feature: Mobile home park

Feature Category: multiple

Field Observation Potential flooding and hyper concentrated flows from watercourse adjacent to
Potential Hazard: mobile home facility.

Potential Hazard to Life: low

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Description: NA

LOCATION AND PHOTO



- Value at Risk (Point)
- ▨ Values at Risk (Polygon)
- ▭ Values at Risk (Polygon) (Focused)
- ▭ Fire Perimeter

Scale: 1:5,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Middle Putah Creek

Site Number: 84

Feature: Boat yard maybe shop

Feature Category: business

Field Observation Repair yard and shop has potential for debris flow or flood to enter yard, mostly
Potential Hazard: small material but a few large cobbles were noted. No capacity for water flow in channel.

Potential Hazard to Life: low

Potential Hazard to Property: moderate

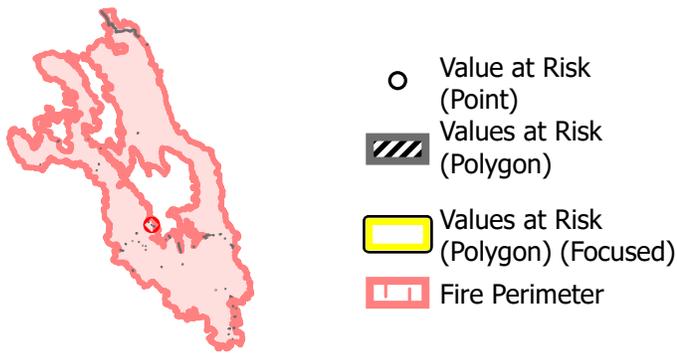
Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Description: NA

LOCATION AND PHOTO



Scale: 1:2,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Middle Putah Creek

Site Number: 85

Feature: Mobile home and storage yard

Feature Category: multiple

Field Observation Mobile home and storage area downstream of active watercourse containing
or Potential Hazard: large material, at risk for debris flows.

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

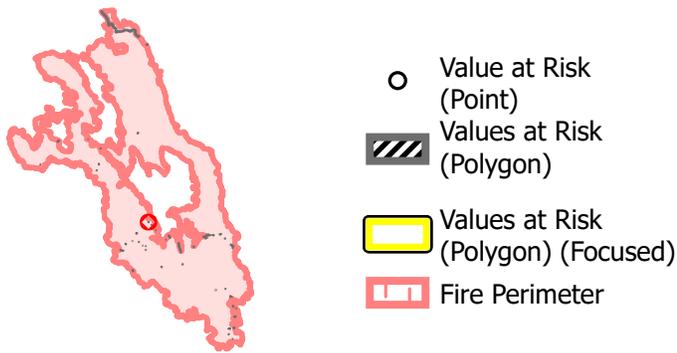
Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

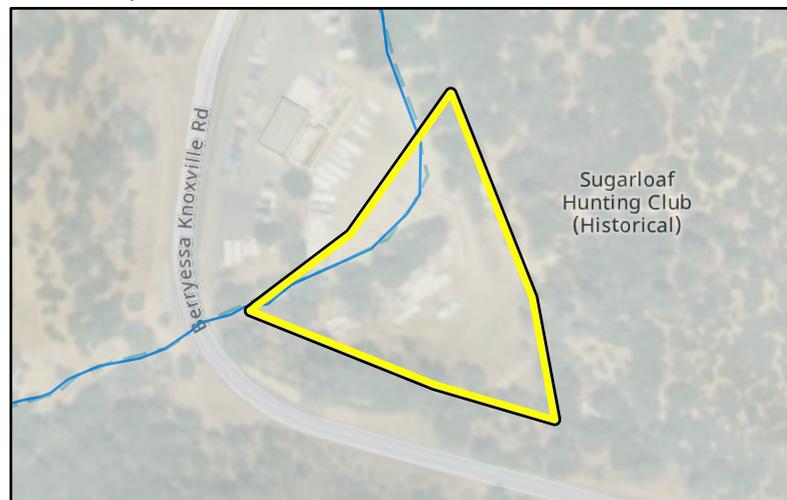
Preliminary Emergency Protective Measures (3): NA

Description: Move trailer to higher ground to mitigate risk.

LOCATION AND PHOTO



Scale: 1:3,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Lower Putah Creek

Site Number: 86

Feature: parking and recreation area

Feature Category: recreational

Field Observation Day use area and parking. Potential for debris flow and/or flooding from Cold
or Potential Hazard: Canyon.

Potential Hazard to Life: high

Potential Hazard to Property: low

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Signage

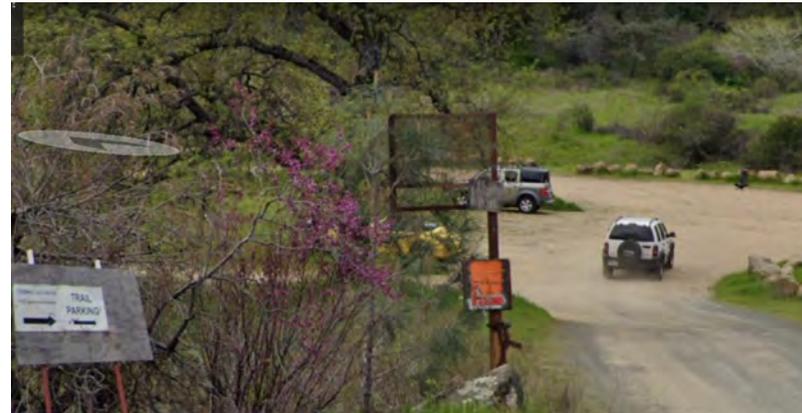
Preliminary Emergency Protective Measures (3): NA

Description: Close area prior to and during large storm events

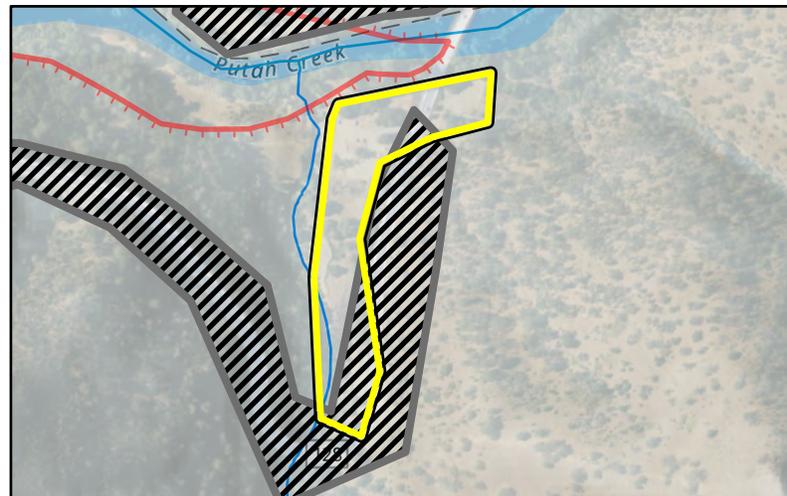
LOCATION AND PHOTO



- Value at Risk (Point)
- ▨ Values at Risk (Polygon)
- ▭ Values at Risk (Polygon) (Focused)
- ▨ Fire Perimeter



Scale: 1:8,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Lower Putah Creek

Site Number: 87

Feature: occupied RV's and resort buildings

Feature Category: multiple

Field Observation Resort and RV parking in floodplain of Putah Creek opposite mouth of Cold
or Potential Hazard: Canyon. Potential for debris flow and flooding.

Potential Hazard to Life: high

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Description: NA

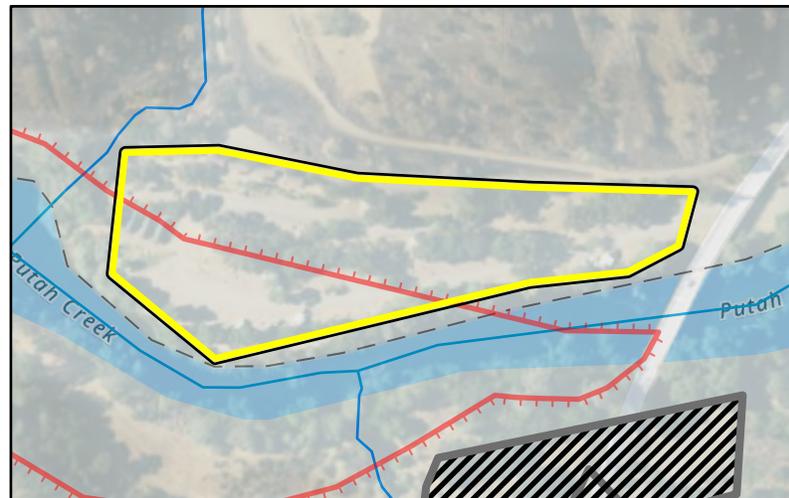
LOCATION AND PHOTO



- Value at Risk (Point)
- ▨ Values at Risk (Polygon)
- ▭ Values at Risk (Polygon) (Focused)
- ▭ Fire Perimeter



Scale: 1:4,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Lower Putah Creek

Site Number: 88

Feature: day use facility

Feature Category: recreational

Field Observation Day use area and facilities downslope of Bray Canyon and other steep tributary
or Potential Hazard: canyon. Potential for debris flow or flooding.

Potential Hazard to Life: moderate

Potential Hazard to Property: low

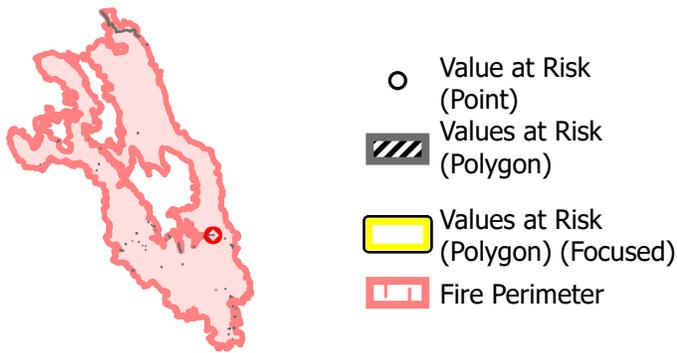
Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Signage

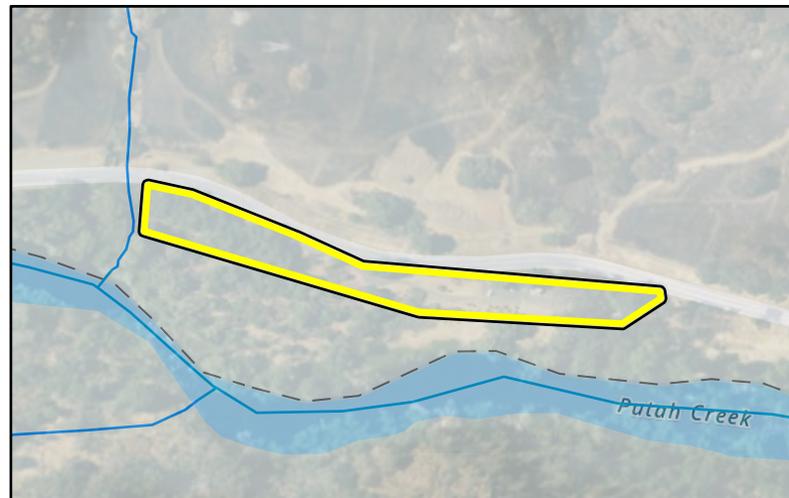
Preliminary Emergency Protective Measures (3): NA

Description: close site prior to and during large storm events

LOCATION AND PHOTO



Scale: 1:5,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Lower Putah Creek

Site Number: 89

Feature: day use area

Feature Category: recreational

Field Observation Day use area parking located downslope of several potential debris flow or **Potential Hazard:** channels.

Potential Hazard to Life: moderate

Potential Hazard to Property: low

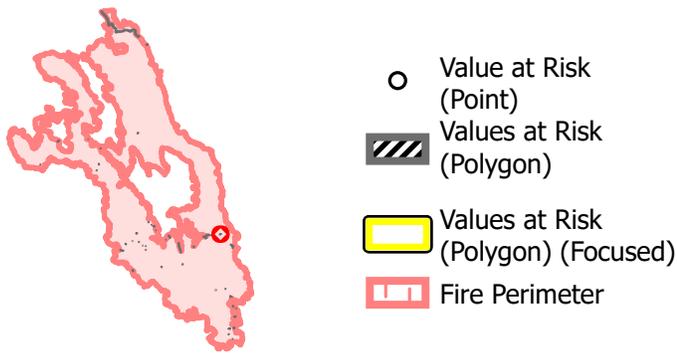
Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Signage

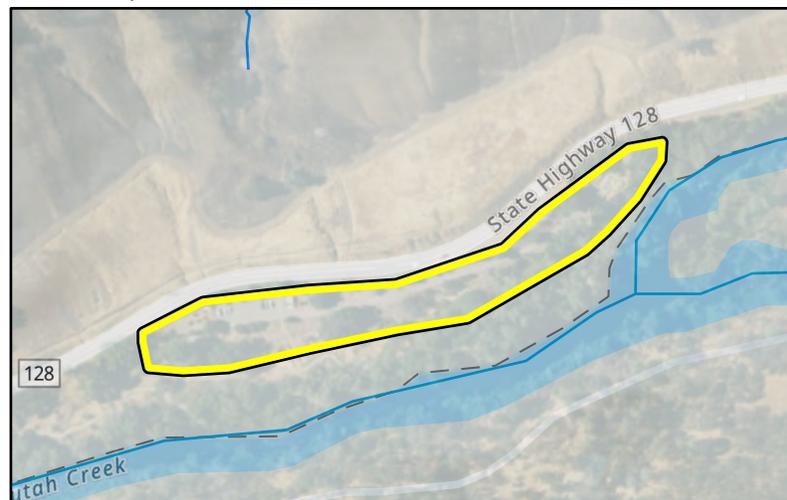
Preliminary Emergency Protective Measures (3): NA

Description: close area prior to and during large storm events

LOCATION AND PHOTO



Scale: 1:5,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Lower Putah Creek

Site Number: 90

Feature: campground

Feature Category: recreational

Field Observation Campground low on banks of Putah Creek. Potential for flooding due to runoff
Potential Hazard: from drainages downstream of Monticello Dam.

Potential Hazard to Life: moderate

Potential Hazard to Property: low

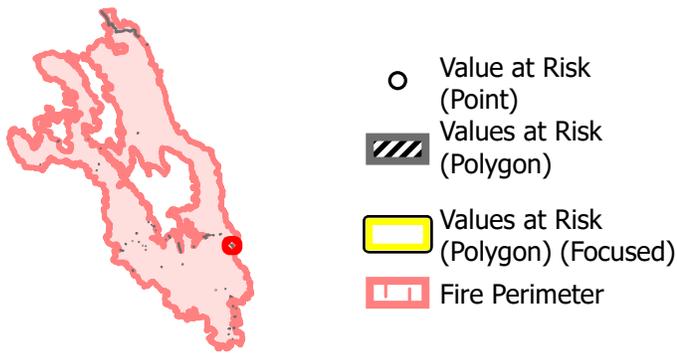
Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Signage

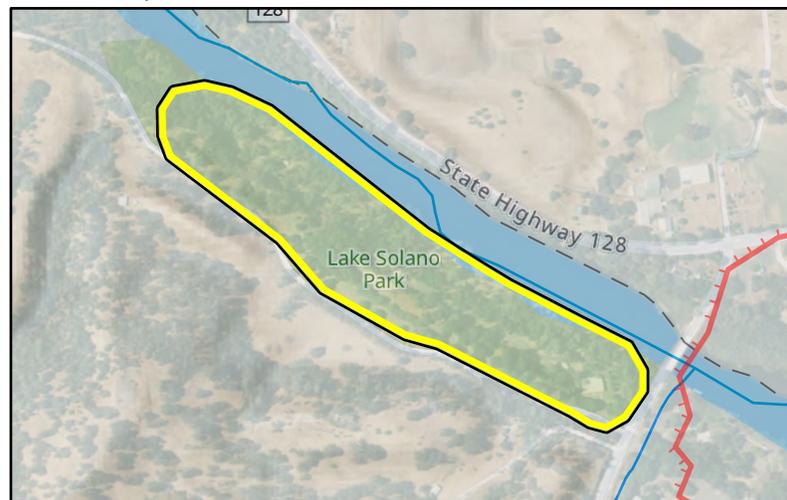
Preliminary Emergency Protective Measures (3): NA

Description: close facility prior to and during large storm events

LOCATION AND PHOTO



Scale: 1:10,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Upper Putah Creek

Site Number: 91

Feature: School and Firehouse

Feature Category: other

Field Observation Capell Valley Elementary and Capell Valley Volunteer Fire Department low-lying
or Potential Hazard: below the mouth of a debris flow channel

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

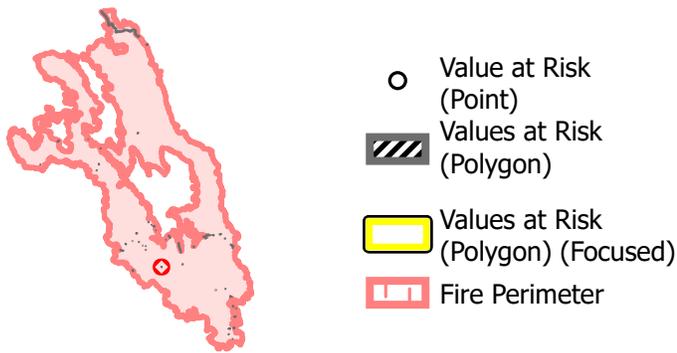
Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

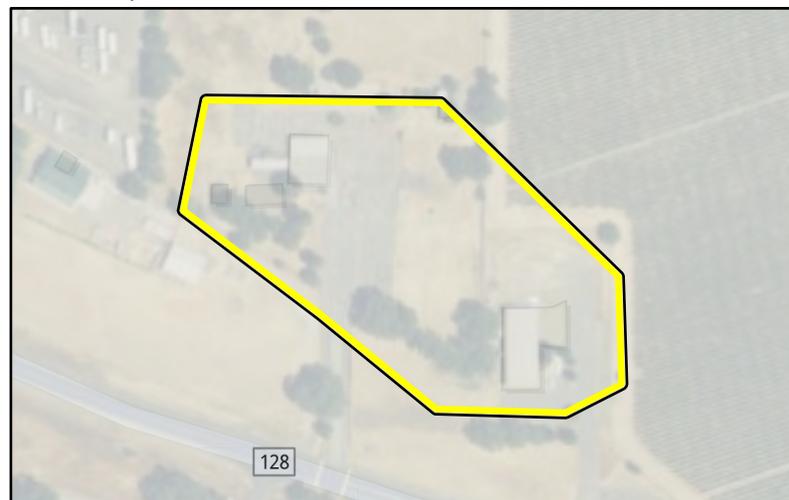
Preliminary Emergency Protective Measures (3): NA

Description: NA

LOCATION AND PHOTO



Scale: 1:3,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: **Napa Valley**

Site Number: **92**

Feature: **Winery and infrastructure**

Feature Category: **business**

Field Observation Winery, parking area and terraced picnic area below mouth of debris flow
or Potential Hazard: catchment

Potential Hazard to Life: **moderate**

Potential Hazard to Property: **moderate**

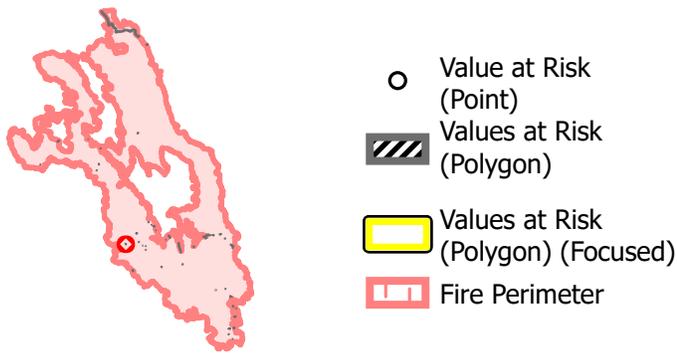
Preliminary Emergency Protective Measures (1): **Early Warning**

Preliminary Emergency Protective Measures (2): **NA**

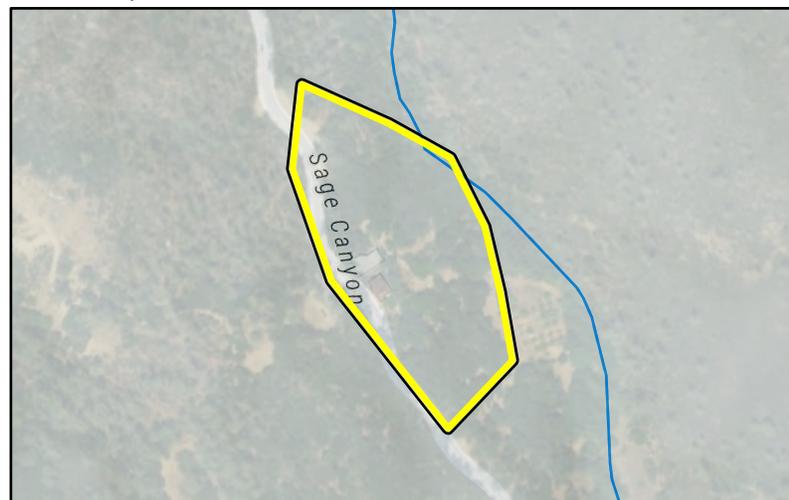
Preliminary Emergency Protective Measures (3): **NA**

Description: **NA**

LOCATION AND PHOTO



Scale: 1:5,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Middle Putah Creek

Site Number: 93

Feature: Resort and infrastructure

Feature Category: recreational

Field Observation Resort at mouth of two potential debris flow drainages
or Potential Hazard:

Potential Hazard to Life: high

Potential Hazard to Property: high

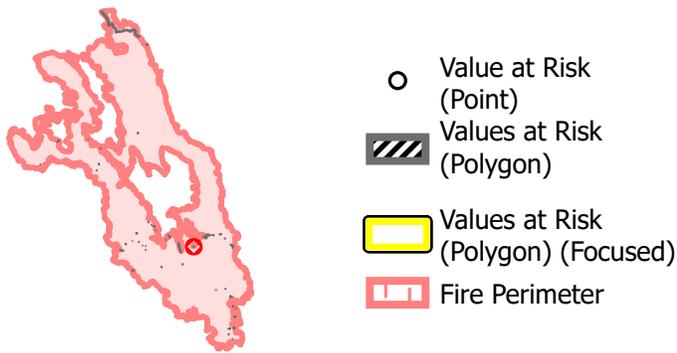
Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

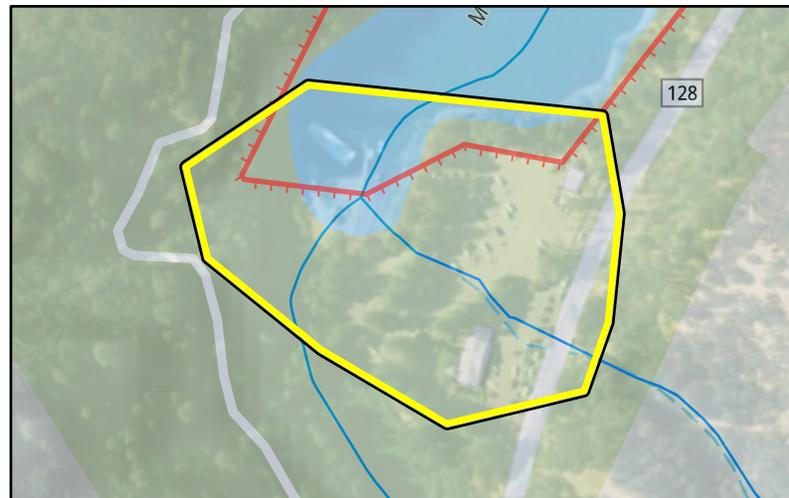
Preliminary Emergency Protective Measures (3): NA

Description: NA

LOCATION AND PHOTO



Scale: 1:4,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Middle Putah Creek

Site Number: 94

Feature: Winery structures

Feature Category: business

Field Observation Somerston Winery and related structures at mouth of potential debris flow
or Potential Hazard: drainage

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

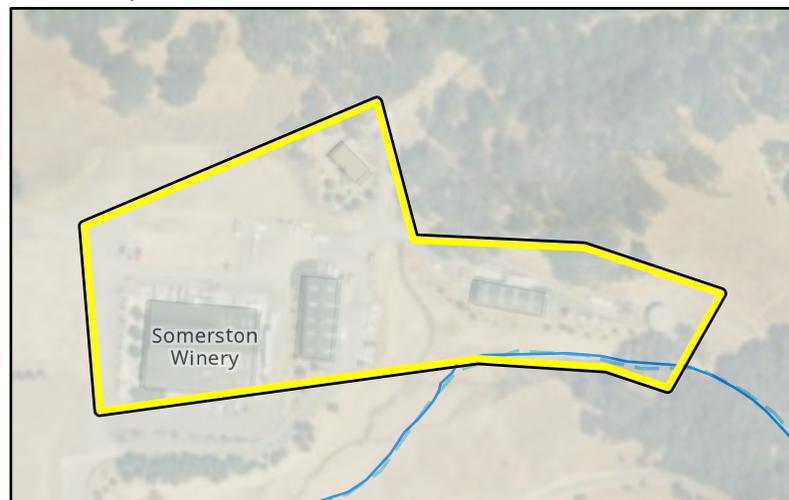
Description: NA

LOCATION AND PHOTO



-  Value at Risk (Point)
-  Values at Risk (Polygon)
-  Values at Risk (Polygon) (Focused)
-  Fire Perimeter

Scale: 1:3,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: **Pope Valley**

Site Number: **95**

Feature: **Houses**

Feature Category: **home**

Field Observation Houses located within and below the mouth of potential debris flow drainage
or Potential Hazard:

Potential Hazard to Life: **high**

Potential Hazard to Property: **high**

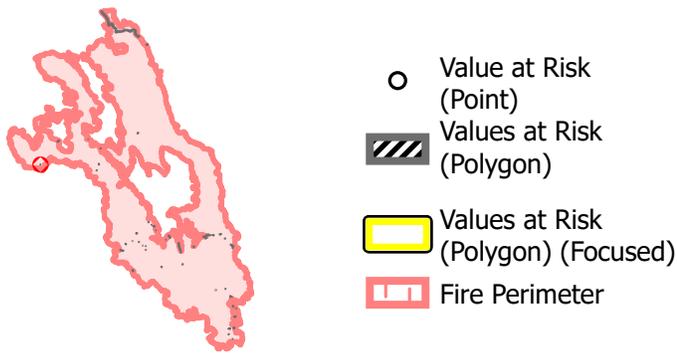
Preliminary Emergency Protective Measures (1): **Early Warning**

Preliminary Emergency Protective Measures (2): **NA**

Preliminary Emergency Protective Measures (3): **NA**

Description: **NA**

LOCATION AND PHOTO



Scale: 1:1,000



VALUE AT RISK DETAIL - Polygons

**Incident: LNU Lightning Complex
Hennessey Fire**

Incident Number: CA-LNU-013407

Community: Pope Creek

Site Number: 96

Feature: House, trailer and building

Feature Category: multiple

Field Observation Houses and commercial building below mouth of potential debris flow drainage
or Potential Hazard:

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

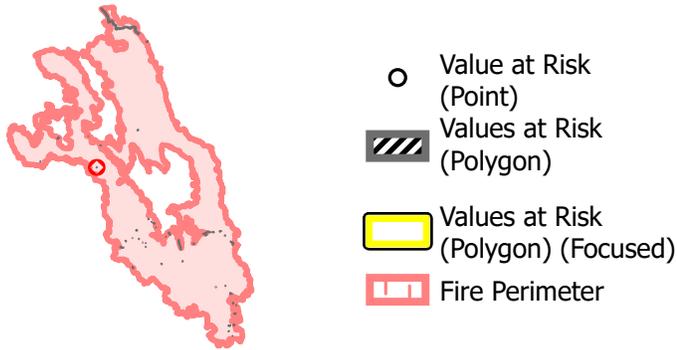
Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

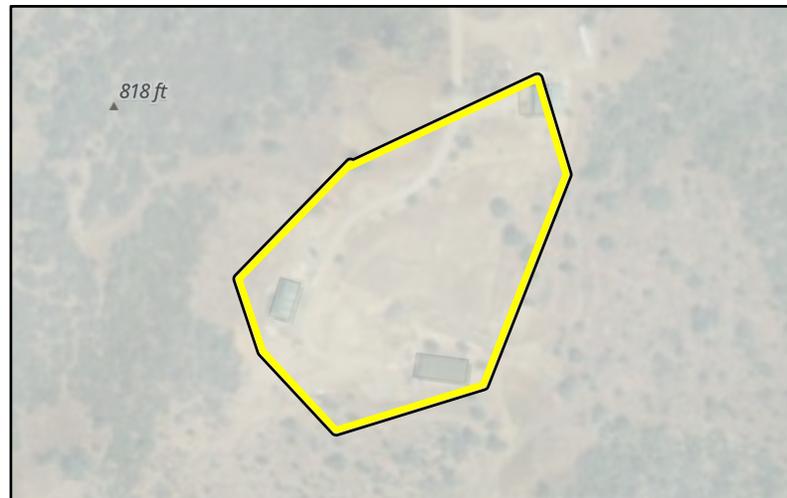
Preliminary Emergency Protective Measures (3): NA

Description: NA

LOCATION AND PHOTO



Scale: 1:3,000



APPENDIX E: HENNESSEY FIRE WERT PHOTOGRAPHS



Photograph E01: Burned residence and pad across Gates Canyon (VAR 24).



Photograph E02: Burned residence at the mouth of a steep channel (VAR 15).



Photograph E03: Unburned residence at mouth of a steep channel (VAR 62).



Photograph E04: Burned residence within a steep channel (VAR 59). The channel is diverted around the house.



Photograph E05: Teen center cabin protruding into the channel (VAR 71).