Loma Fire

Watershed Emergency Response Team
Final Report

CA-SCU-006912

October 25, 2016

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List of Acronyms

BAER	USFS Burned Area Emergency Response
BARC	Burned Area Reflectance Classification
BOF	California State Board of Forestry and Fire Protection
CAL FIRE	California Department of Forestry and Fire Protection
Cal OES	California Office of Emergency Services
CalVeg	Classification and Assessment with Landsat of Visible Ecological Groupings
Caltrans	California Department of Transportation
CEG	Certified Engineering Geologist
CFS	Cubic Feet per Second
CGS	California Geological Survey
DEM	Digital Elevation Model
DFW	California Department of Fish and Wildlife
DWR	California Department of Water Resources
EHR	Erosion Hazard Rating
EROS	Earth Resources Observation Systems
FEMA	Federal Emergency Management Agency
FRAP	Fire and Resource Assessment Program
FT	Flow Transference Method
GIS	Geographic Information System
GPS	Global Positioning System
HEC-HMS	Hydraulic Engineering Center-Hydraulic Modeling System
HUC	Hydrologic Unit Code
LiDAR	Light Detection and Ranging
NOAA	National Oceanographic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NWS	National Weather Service
PE	Professional Engineer
PG	Professional Geologist
PH	Professional Hydrologist (AIH)
RSAC	Remote Sensing Application Center
RI	Return Interval
RPF	Registered Professional Forester
SCVWD	Santa Clara Valley Water District
USDA	United States Department of Agriculture
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VARs	Values at Risk
WERT	Watershed Emergency Response Team

State of California

Watershed Emergency Response Team (WERT)

LOMA POST-FIRE WERT ASSESSMENT REPORT EXECUTIVE SUMMARY

2016-CASCU-006912 - WERT Evaluation

The Loma Fire started on September 26, 2016 in the western portion of Santa Clara County in the Santa Cruz Mountains and burned a total of 4,474 acres. The fire was contained on October 12, 2016. Twelve residences and 16 outbuildings were destroyed. The vast majority of the fire (98%) burned in the upper Llagas Creek and upper Uvas Creek watersheds that drain to the southeast and feed into Chesbro and Uvas Reservoirs, both of which supply water to groundwater aquifers and provide limited flood control. Land ownership within the Loma Fire burn area includes:

- *Midpeninsula Regional Open Space District -- 127 acres*
- *Santa Clara Valley Open Space Authority -- 1,927 acres*
- *Private Ownership -- 2,420 acres*
- *Total -- 4,474 acres*

The burn area encompasses steep, rugged terrain, with approximately 3,000 feet of vertical relief. Vegetation in the burn area is largely comprised of coastal scrub, oak woodland, chaparral, mixed hardwood/conifer, and coast redwood. There is also a small component of foothill riparian habitat and annual grassland within the fire perimeter. Additionally, there are relatively small stands of knobcone pine (*Pinus attenuata*) within the higher elevation areas of the burn.

The Loma Fire burned area was evaluated by an interagency WERT comprised of geologists, hydrologists, foresters, GIS specialists, and a civil engineer. The WERT evaluated the burned watersheds to rapidly assess post-fire conditions, potential values at risk related to human life-safety and property, and the potential for increased post-fire flooding and debris flows. The team also evaluated potential emergency protection measures to help reduce the risks to those values. A limited wildlife and fisheries evaluation was also included.

Summary of the WERT Key Findings

- There are approximately 1,980 acres (44%) of unburned/low soil burn severity, 1,742 acres (39%) of moderate soil burn severity, and 740 acres (17%) of high soil burn severity.
- Hydrophobic soil conditions were common, though highly variable, within moderate and high burn severity areas.
- 9 sub-watersheds (i.e., pour points) were analyzed for increased post-fire flood hazards, including downstream at the inlets to Uvas and Chesbro Reservoirs. Pre-fire 10-year return interval streamflows were estimated to increase from 6 to 72 percent, while 2-year flows were projected to increase from 15 to 132 percent (higher values for smaller sub-watersheds).
- 41 sub-watersheds were modeled for post-fire debris flow hazards. Using a 0.94 inches/hour (24 mm/hr) threshold, 25 of 41 basins have likelihood of 50% or greater to produce post-fire debris flows.
- The burn area was analyzed with two erosion models. For a 10-year recurrence storm event, the majority of hillslopes burned at moderate to high soil burn severity are expected to have post-fire erosion rates of at least 5-10 tons/acre the first year following wildfire. This would roughly be a 10-fold increase in sedimentation the first post-fire winter compared to pre-fire conditions with this level of probability for the Llagas Creek watershed, and somewhat less in the Uvas Creek basin, where pre-fire erosion rates are higher.
- Several fish, wildlife, and botanical special status species are present within the burned area and downstream drainages; it is likely that only resident fish, amphibian, and reptile species will be

affected by post-fire increases in sediment. Steelhead trout, a state and federally listed species, are present in Uvas Creek and Llagas Creek downstream of the Uvas and Chesbro Reservoirs.

The different soil burn severity categories reflect changes in soil properties and are a key element WERT specialists use to determine if post-fire threats exist. High and moderate soil burn severity categories have evidence of severe soil heating and the consumption of organic material. Increased runoff due to ground cover reduction, burned soils and hydrophobic conditions is reflected in the flood flow analysis conducted for these watersheds. In summary, field observations and modeling of the high and moderately burned area support a general trend of increased flood flows, sedimentation, erosion, debris flows, and shallow landslides due to post-fire effects.

Identified Values at Risk, Threats, and Emergency Conditions

Emergency post-fire conditions for the Loma Fire identified by the WERT include threats to the values at risk resulting from the potential for increased flood flows, increased sediment delivery, debris flow occurrence, and rock fall. Most of the specific observations are reported as points, however 17 areas of potential flooding or debris flow hazards are reported as polygons. Overall, 68 specific values at risk were identified, including:

- 35 homes (many are located in 100-year flood zones previously mapped by FEMA and DWR)
- 11 bridges and 7 culverts
- 7 road-related areas
- 8 miscellaneous structures (e.g., campground areas and trails, outbuildings)

Key areas of concern are the Mountain Home community (Casa Loma Road, Twin Falls Road, and Chual Spur Road), the Sveadel/Croy Road area, lower Llagas Creek above Chesbro Reservoir, and lower Uvas Creek above Uvas Reservoir. These observations are intended to be used as a preliminary indication of some of the most obvious areas of potential concern for follow-up work and more detailed evaluations. Specific observations are summarized in Appendix C.

There are potential impacts to life and safety for people entering the burned area. Generally, increased risk occurs within or directly down-slope and down-stream from high and moderate soil burn severity areas.

General Recommendations

The WERT's objectives for the burned area are to identify post-fire life-safety threats, including those from debris flows and flooding. General recommendations include:

- Utilize early warning systems available to homeowners.
- Perform storm patrols and monitor road drainage infrastructure.
- Close recreational trail access during storm events.
- Improve drainage to unimproved roads.
- Remove vegetation and loose woody debris around drainage structures and bridges.
- Utilize structure protection such as sand bags, K-rails, and Muscle Wall where appropriate.

Large Storm Observations

From October 14 to 17, 2016, 11.97 inches (304 mm) of rain was recorded with a tipping bucket rain gage from two Pacific frontal storms at the Uvas Canyon County Park station. Rainfall intensity ranged from 0.04 in/hr to 0.79 in/hr, with a mean intensity of 0.16 inches per hour. Field observations and reports identified small rockfalls, surface soil erosion (e.g, rilling and gullying), and a general increase in riverine runoff and turbidity, including ash and woody debris movement. Based on our limited review, post-fire debris flows did not occur. These observations generally support the debris flow modeling threshold used in this report (0.94 in/hr).

1.0 Introduction

This report presents the results of a rapid assessment of (1) post-fire geologic and hydrologic hazards to life and safety (i.e., collectively known as “Values at Risk”) for private lands affected by the 2016 Loma Fire in Santa Clara County, California, and (2) potential impacts to fisheries and wildlife resources within the fire perimeter. Wildfire can have profound effects on watershed processes. Wildfire-induced loss of surface cover and enhancement of soil water repellency from wildfire can increase runoff generation and the erosive power of overland flow, resulting in accelerated erosion of material from hillslopes. Increased runoff can also erode significant volumes of material stored within channels. A primary concern for burned watersheds is the increased potential for damaging flood flows and increased probability for debris flow occurrence.

Debris flows are among the most hazardous consequences of rainfall on burned hillslopes. Debris flows pose a hazard distinct from other sediment-laden flows because of their unique destructive power. Debris flows can occur with little warning and can exert great impulsive loads on objects in their paths. Even small debris flows can strip vegetation, block drainage ways, damage structures, and endanger human life. Additionally, sediment delivery from debris flows can “bulk” the volume of flood flows, creating an even greater downstream flooding hazard. As winter approaches, it is critical that people who live in and downstream from large fires implement emergency protection measures where appropriate, remain steadfast and alert of weather conditions, and be ready to evacuate if necessary during large storms.

When wildfire-induced threats to life and safety are present, a state team of civil engineers, engineering geologists and California Department of Forestry and Fire Protection (CAL FIRE) staff can be assembled into a Watershed Emergency Response Team (WERT) to assess potential life-safety hazards from post-fire debris flows, hyperconcentrated flows, and flood flows. CAL FIRE senior staff, along with the California Office of Emergency Services (Cal OES), determined that a WERT was needed for the Loma Fire.

1.1 Background

Due to the private land affected by the fire (Figure 1) and the risk to life-safety, a multi-agency WERT comprised of individuals with expertise in engineering geology, geomorphology, hydrology, forestry, fisheries and wildlife biology, GIS, and civil engineering was assembled for the Loma Fire (Table 1).

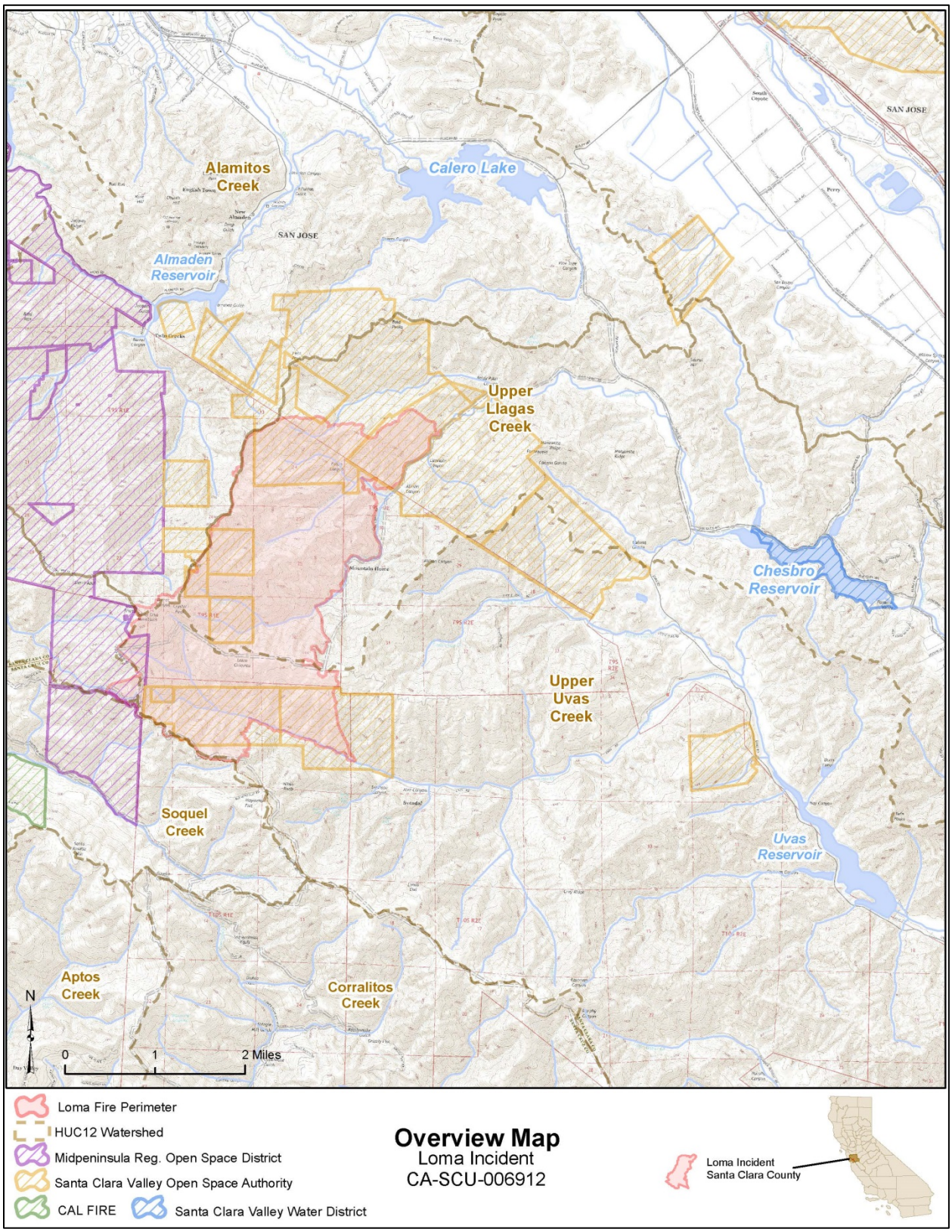


Figure 1. Loma Fire incident overview map.

The WERT field team was supported in the home offices by technical specialists including engineering geologists and GIS analysts.

The WERT arrived at the Loma Incident area on October 12, 2016 and interfaced with the CAL FIRE Santa Clara Unit Forester to obtain information about the affected area and to strategize on how best to carry out the assessment. An aerial helicopter reconnaissance of the Loma Fire was conducted during the afternoon of October 12, 2016. The aerial reconnaissance enabled team members to visually assess potential areas of concern to be evaluated on the ground.

Table 1. Loma Fire WERT members.

Main Team			
Name	**Position**	**Agency**	**Expertise-Position**
Pete Cafferata, PH No.1676 RPF No. 2184	Team Leader	CAL FIRE	Forestry/Hydrology
Jeremy Lancaster, PG No. 7692 CEG No. 2379	Co-Leader	CGS	Engineering Geology
Brian Swanson, PG No. 6494, CEG No. 2055	Team Member	CGS	Engineering Geology
Ed Orre, RPF No. 2292 Santa Clara Unit Forester	Team Member	CAL FIRE	Forestry/Local Knowledge
Trevor Morgan, PE No. 79967	Team Member	DWR	Civil Engineer/Hydrology
Stacy Stanish, RPF No. 3000	Team Member	CAL FIRE	GIS/Forestry/Biology
Kelly Larvie	Team Member	CAL FIRE-FRAP	GIS/Hydrology
Adjunct Team			
Pete Roffers, PG No. 9100	Team Member	CGS	Engineering Geology, GIS
Solomon McCrea, CFM No. 3527	Team Member	CGS	Research Analyst, GIS

1.1 Objectives

Due to the relatively small size of the Loma Fire, a combined Phase I and II WERT effort was conducted.

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

- Identify types and locations of on-site and downstream threats to public health or safety from landsliding, debris flows, flooding, erosion, road hazards, and other fire-related problems.

- Develop preliminary emergency protection measures needed to avoid life-safety threats.

Primary objectives for this Phase II WERT were to evaluate potential impacts to state and federally listed fish and wildlife species, as well as botanical resources.

2.0 Physical Setting

2.1 Loma Fire Summary

The Loma Fire started on September 26, 2016 in the western portion of Santa Clara County in the Santa Cruz Mountains and burned a total of 4,474 acres. The fire was contained on October 12, 2016. Twelve residences and 16 outbuildings were destroyed as a result of the fire. The fire burned primarily in watersheds that drain to the east into Chesbro and Uvas Reservoirs, both of which supply water to underground aquifers. The fire burned 22% of the Upper Llagas Creek watershed and 8% of the Upper Uvas Creek watershed, totaling 4,375 acres. The remaining 99 acres burned in small portions of three other watersheds (Soquel Creek, Los Gatos Creek, and Alamitos Creek). Approximately half of the burn area covered private land ownership and the remainder was public, open space ownership (Table 2).

Table 2. Land ownership within the Loma Fire.

Ownership	Acreage
Midpeninsula Regional Open Space District	127
Santa Clara Valley Open Space Authority	1,927
Private Ownership	2,420
Total	4,474

2.2 Regional Fire History

The burn area has little recently recorded fire history, with only approximately ten (10) percent of the area having been previously burned in the southwest portion of the perimeter since 1950. More recent fires within the last 10-15 years have occurred to the south of the Loma Fire perimeter, leaving the majority of the burn area largely untouched by fire (Figure 2).

2.3 Topography, Rainfall, and Climate

Topography within the burn area ranges from gentle to very steep, with elevations from about 800 feet above mean sea level along Llagas Creek at the northern margin of the fire to an elevation of 3,786 feet at Loma Prieta peak in the southwest portion of

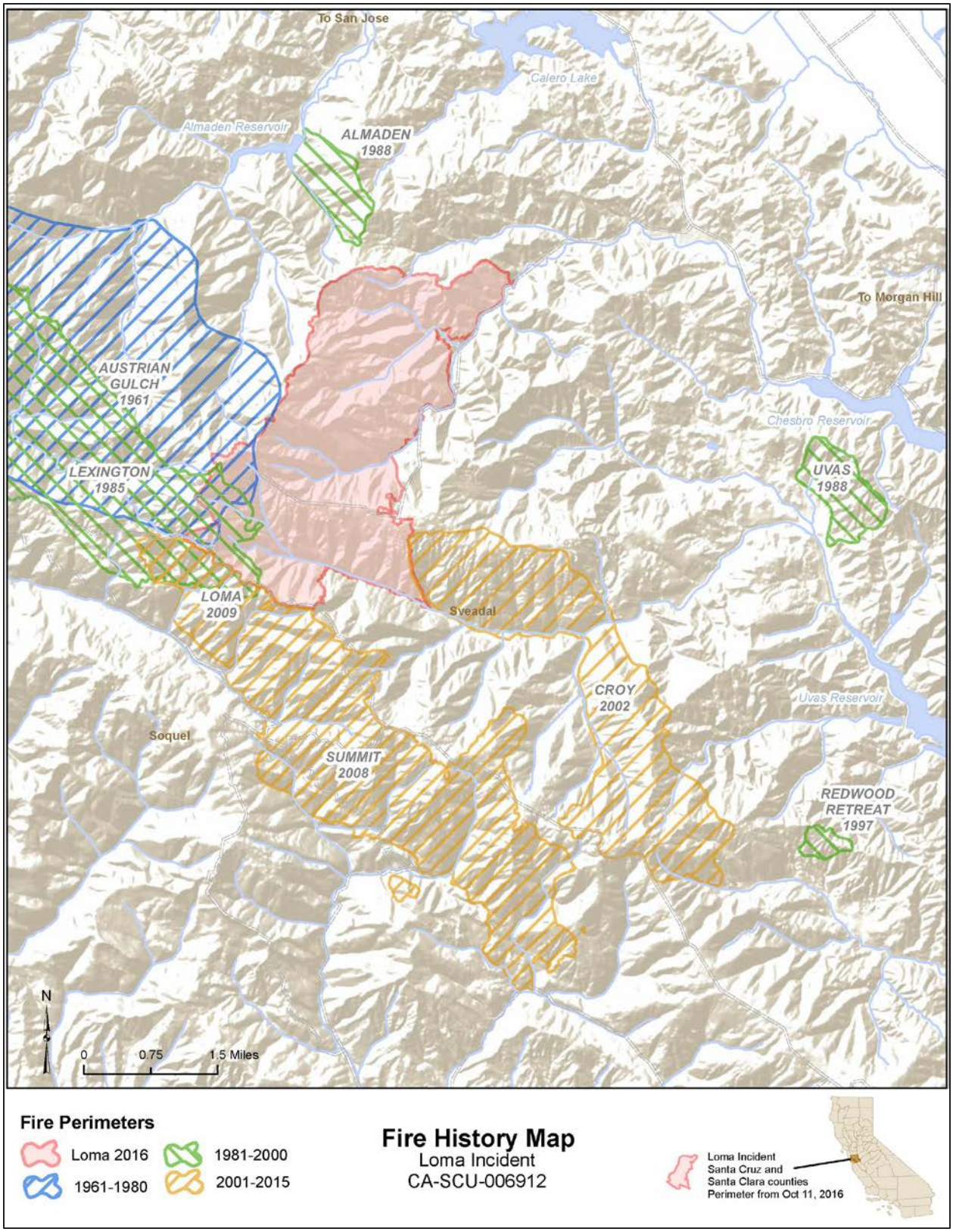


Figure 2. Fire history map.

the burn area. The southern and central portion of the burn area is traversed by the east trending Summit Ridge (2,900 feet) and Loma Chiquita Ridge (2,500 feet), respectively, and drained by Uvas Creek. The northern portion of the burn area is drained by Llagas Creek and its tributary Twin Falls Creek that are bounded by Loma Chiquita Ridge and an unnamed ridge extending north from Mt. Chual. Local extremes in relief occur in small catchments at the headwaters of Uvas and Llagas creeks. For example, south facing slopes of Loma Chiquita Ridge have elevation changes measured from canyon mouth to crest of over 1,500 feet occurring over a map distance of less than one mile.

Average annual rainfall in the burn area is approximately 35 inches, with the highest recorded daily rainfall being 7.75 inches in 1940. Uvas Creek and Llagas Creek watersheds have mean annual precipitation of 36.7 inches and 32.8 inches, respectively. Precipitation occurs almost entirely as rain, with rare occurrences of snow at the highest elevations. The burn area has a typical Mediterranean climate with warm dry summers and cool wet winters. The 1, 10, and 25-year recurrence interval for the 15-minute rainfall magnitude is 0.408, 0.620, and 0.720 inches, respectively (http://hdsc.nws.noaa.gov/hdsc/pfds/).

2.4 Vegetation

Vegetation in the burn area is largely comprised of coastal scrub, oak woodland, chaparral, mixed hardwood/conifer, and coast redwood. There is also a small component of foothill riparian habitat and annual grassland within the fire perimeter. There are relatively small stands of knobcone pine (*Pinus attenuata*) within and around the upper parts of the burn area. Knobcone pine generally occupies the transitional area between chaparral and woodland. They have serotinous (closed) cones, which requires fire to induce cone opening and seed dispersal for the next generation. Sudden oak death (*Phytophthora ramorum*) is known to be present within the adjacent watersheds, but it is not currently identified in the basins encompassing the burn area (http://www.suddenoakdeath.org/).

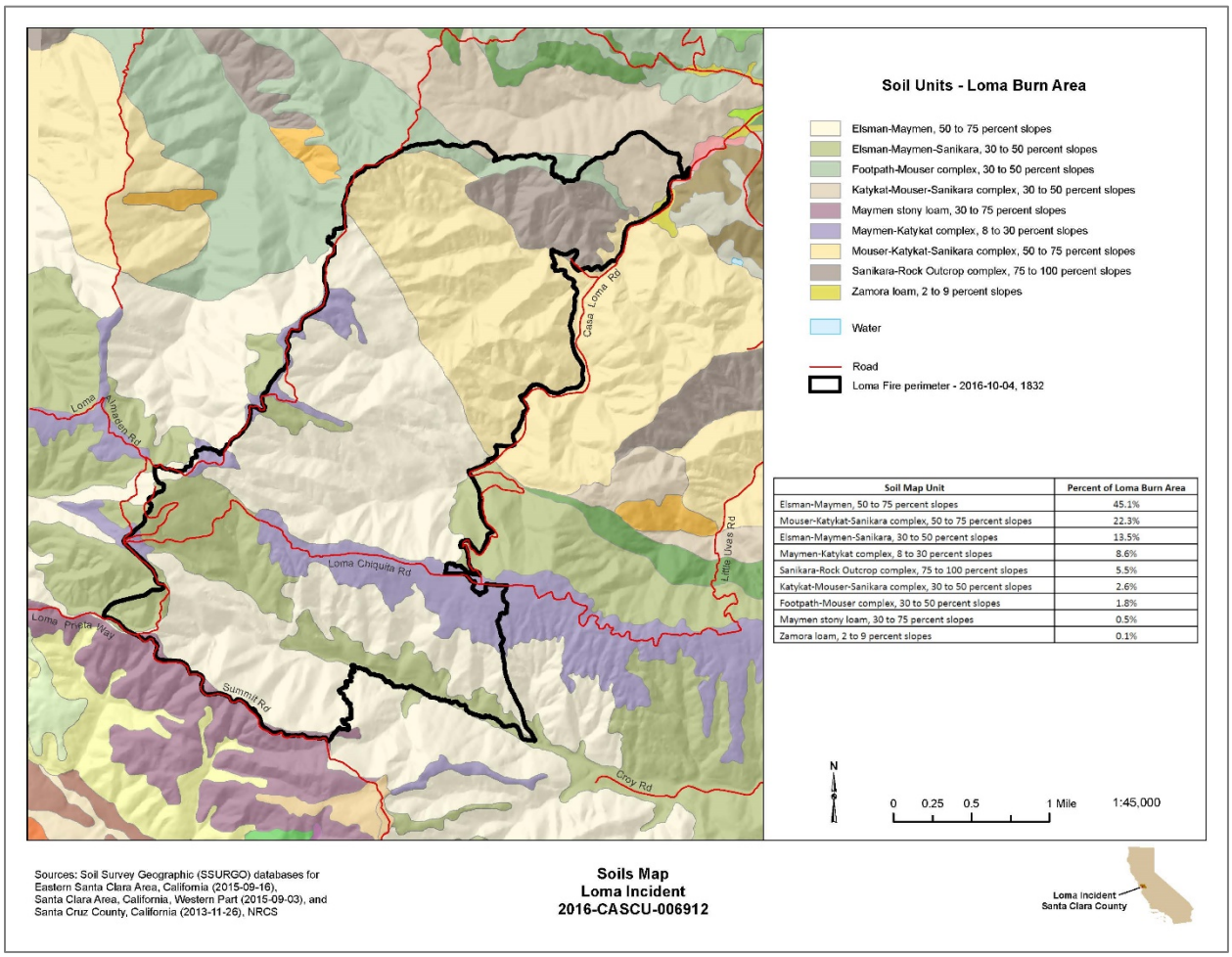
Fortunately, much of the riparian vegetation did not burn at high intensity, and recovery within these areas will likely be more rapid than in many other more intensely burned portions of the fire.

2.5 Soils

Soils in the burn area are typically shallow, developed on colluvium derived from weathered bedrock and landslide deposits. The Elsman-Maymen series is the predominant soil type (45 percent of the burned area); it is comprised of gravelly coarse sandy loam to sandy clay loam, and found in both the Llagas and Uvas watersheds. The Mouser-Katykat-Sanikara complex makes up about 22 percent of the burned area and is comprised of gravelly sandy clay loam and fine loam. This unit is mapped primarily within the Llagas Creek watershed. The Elsman-Maymen-Sanikara complex

makes up about 13 percent of the burned area and is composed of gravelly coarse sandy loam, sandy clay loam and fine loam, within the upper Uvas Creek watershed. The Maymen-Katykat complex makes up about 9 percent of the burned area and is comprised of gravelly coarse sandy loam and fine loam. This map unit underlies Loma Chiquita Ridge. The Sanikara-Rock Outcrop complex makes up 5 percent of the northern portion of burn area and is comprised of fine loam and rock outcrops. Several other soil map units are found in lower percentages within the burn area and are shown in Figure 3.

The distribution of soil map units generally correspond to their geologic parent materials. The southern half of the Llagas Creek watershed shares similar soil types with the Uvas Creek watershed. However, due to the presence of Jurassic volcanic rocks and Franciscan Melange, the lower half of the Llagas Creek watershed varies greatly in soil types compared to those found in the Uvas Creek basin.



Soil Map Unit	Percent of Loma Burn Area
Elsman-Maymen, 50 to 75 percent slopes	45.1%
Mouser-Katykat-Sanikara complex, 50 to 75 percent slopes	22.3%
Elsman-Maymen-Sanikara, 30 to 50 percent slopes	13.5%
Maymen-Katykat complex, 8 to 30 percent slopes	8.6%
Sanikara-Rock Outcrop complex, 75 to 100 percent slopes	5.5%
Katykat-Mouser-Sanikara complex, 30 to 50 percent slopes	2.6%
Footpath-Mouser complex, 30 to 50 percent slopes	1.8%
Maymen stony loam, 30 to 75 percent slopes	0.5%
Zamora loam, 2 to 9 percent slopes	0.1%

Figure 3. Soils map for the Loma Fire area.

2.6 Geologic Setting

The Loma Fire burn area is located in the Santa Cruz Mountains, a series of northwest trending mountain ranges within the central part of the Coast Ranges Geomorphic Province (CGS, 2002). The Santa Cruz Mountains are comprised of several ridges roughly parallel to the upper drainage network of Soquel Creek, which is located approximately one mile south of the southern-most portion of the Loma Fire perimeter. Within the burn perimeter, the active Sargent fault runs parallel to the trace of the San Andreas along Uvas Creek and the Berrocal fault trends northwest from the north side of Loma Chiquita Ridge toward the New Almaden Reservoir (Wentworth et al., 1999).

The general area affected by the Loma Fire contains several major bedrock units in two major structural blocks, including the Central Belt Franciscan Complex and the Sierra Azul (Wentworth et al., 1999). Both of these structural blocks lie to the east of the San Andreas fault. Within the burn perimeter, the Central Belt Franciscan Complex underlies the northeastern flank of the southern Santa Cruz Mountains, consisting largely of blocks of blueschist, amphibolite, chert and mafic igneous rocks in a matrix of sheared argillite and lithic sandstone of the Franciscan mélange (fm), and Lower Cretaceous pillow basalt flows and flow breccias (fpv). The Sierra Azul block lies between the San Andreas fault and rocks of the Central Belt Franciscan Complex, and includes Coast Range Ophiolite comprised of basalt, andesite and dacite (Jbk), and cumulate gabbroic and ultramafic rocks (Jdw); Great Valley Sequence, arkosic to feldspathic greywacke sandstone (Kus), massive- to thick-bedded pebble to boulder conglomerate (Kuc), and mudstone (Kjs). Sandstone, shale, and mudstone of Eocene to Miocene age underlie portions of Loma Chiquita Ridge (units Tcm and Tls).

Quaternary alluvial deposits underlie valley floors traversed by Llagas Creek and Uvas Creek. The primary map unit associated with these drainages indicates the presence of alluvial fan deposits (Map unit Qpf). A description of the geologic units within the Loma Fire area are shown on Figure 4.

2.6.1 Landslides

Pre-existing landslides have been recognized within both the Llagas Creek and Uvas Creek drainages. Deep-seated landslides greater than 50 feet deep have occurred locally in several different bedrock units but are most common in the ophiolite unit (Jdw or Jbk), the sandstone and shale unit of Loma Chiquita Ridge (Tls), and locally within the basaltic volcanic rocks of the Franciscan Complex (fpv) (Figure 4). Prominent examples of these large slides occur within the limits of the Loma Fire at the head of Uvas Creek, southeast of Loma Prieta Peak near the Sargent fault, and near the Berrocal fault in a tributary of Twin Falls Canyon near Edson Canyon (Wiegers, 2006; McLaughlin and Helley, 2001; McLaughlin et al., 2001). The locations of deep-seated landslides are controlled primarily by a combination of steep topography and bedrock units that are either naturally weaker or disturbed by tectonic deformation and faulting. With one exception, the large, deep-seated landslides appear to be dormant and no evidence of historic activity was found in the literature (e.g. Wiegers, 2006). One active bedrock landslide was observed on the northwest side of Llagas Creek upstream of

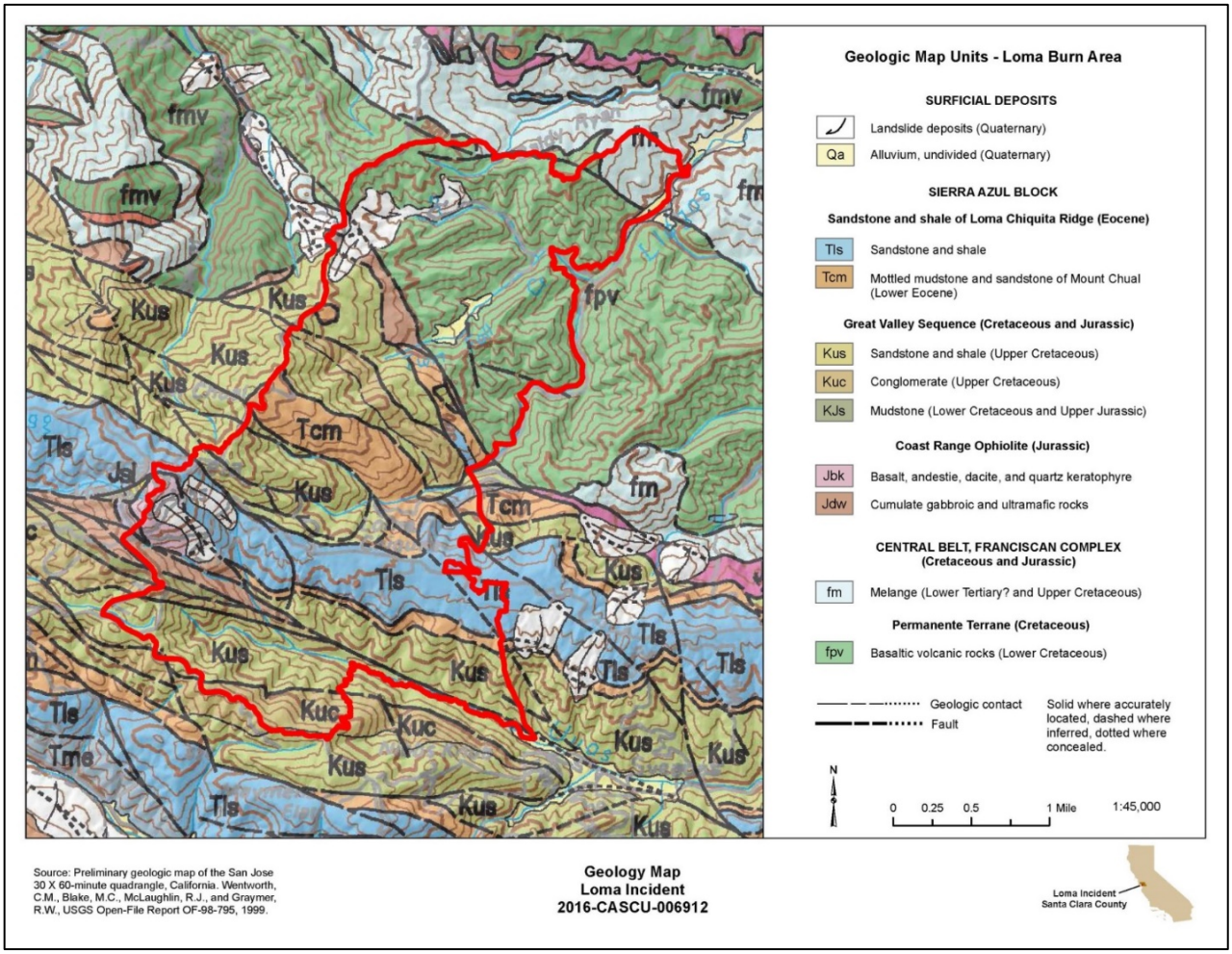


Figure 4. Geologic map for the Loma Fire area.

VAR Station 112 in the mudstone and sandstone unit of Mount Chual (Tcm) along the southwest margin of the Berrocal fault (see Appendix D). The mapped bedding geometry is generally steep and therefore bedrock landslides are likely rotational failures rather than translational. However, landslides mapped southeast of Loma Prieta may have failed along unsupported bedding planes.

Shallow debris slides and debris flow deposits were observed to be more widespread than deep bedrock failures within the fire perimeter. Several dormant young debris slides were mapped in the Twin Falls drainage by Wiegers (2006) and correspond to highly erodible soil units (Sanikara-Rock Outcrop Complex) developed on Franciscan Complex volcanic rocks (fpv). Debris flow and debris slide deposits have been mapped on the flanks of Loma Chiquita Ridge by McLaughlin and Helley (2001) and McLaughlin et al. (2001). Small debris fan deposits were observed at the mouths of several small, steep tributary drainages in Twin Falls Canyon and feeding into Llagas Creek (Photo 1, Appendix B). Numerous source areas for debris flows generated during the intense

rainstorms of January 1982 were mapped within the fire perimeter by Dellen et al. (1997). Aerial and field observations during this assessment indicate the presence of common loose shallow soils and small incipient surficial failures within the areas of moderate to high burn severity (Photo 2, Appendix B). Rock outcrops and boulder slopes were observed to be generally uncommon on natural slopes within the burn area, except below Loma Prieta Peak and in cuts made for Loma Chiquita Road and Casa Loma Road.

Shallow debris slides and local rock falls were also generated within the fire perimeter as a result of the October 17, 1989 Loma Prieta earthquake on the nearby San Andreas fault (Keefer, 1998; Manson et al., 1991). Most of these failures occurred along Loma Chiquita Ridge and along the upper portions of Casa Loma Road. Ground fissuring was also reported along this ridge and ridge-top shatter phenomena due to focusing of seismic waves were reported on other ridge lines located in proximity to this earthquake (Hart et al., 1990; Manson et al., 1991).

The Loma Fire burn area is located in one of the most seismically active areas of the United States. Numerous active faults located within close proximity and in the region are capable of producing damaging earthquakes. The Uniform Earthquake Rupture Forecast Model (Field et al., 2015) estimates that there is a 72% chance of a 6.7 moment magnitude earthquake occurring in the San Francisco Bay Area within the next 30 years, with an average recurrence interval of 29 years, and a 98% chance of a 6.0 magnitude earthquake occurring in the next 30 years, with an average recurrence interval of 8.9 years (Field et al., 2015).

The potential for landslide initiation in burn areas is not well understood; however, the presence of numerous existing landslide debris and loose surficial failures may enhance post-post fire erosion and landslide processes because:

- Landslide deposits are physically weaker than bedrock
- Disturbed debris is more susceptible to additional landslide movement
- Landslide debris is available for erosion and entrainment into new debris flows

High ridge lines within the burn area are potentially susceptible to fissuring, ridge-top shatter and settlement during nearby earthquakes, and marginally stable slopes are likewise susceptible to failure, which will reduce the strength of materials and enhance erosion and landslide susceptibility in burned areas. Keefer (1999) noted increased sediment source volume from earthquake-induced landslides with respect to alluvial fan deposition and it is anticipated that similar impacts will occur in other alluvial systems such as the Llagas and Uvas creek drainages. Associated ground cracking may also allow more rapid infiltration of precipitation into burned slopes, which could potentially reactivate or cause deep-seated landslides. Considering the short recurrence interval estimated for strong earthquakes to occur in proximity to the burn area, there is a moderate to high probability that seismically generated slides or ridge-top shatter/fissuring will occur within the burn area during the recovery period, which could further increase the potential landslide and debris flow hazards, and volume of sediment load during storm events.

2.6.2 Hazardous Minerals

Hazardous minerals in the Coast Ranges Geomorphic Province are often associated asbestos and mercury. Asbestos is classified as a known human carcinogen by state, federal, and international agencies. 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. Based on our limited review of geologic units within the burn area (Figure 4, Geologic Map), ultramafic rock units are present that may contain asbestos from minerals.

The burn area is in the vicinity of the New Almaden mine, where mercury production is associated with host silica carbonate rocks (Bailey and Everhart, 1964). While silica carbonate rocks are not mapped within the perimeter of the Loma Fire, given the proximity of the burn area to mapped host rocks, we cannot preclude the possibility that mercury-bearing rock may be present. For additional information, see:

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

http://www.mindat.org/loc-25791.html

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

For general review information on hazardous minerals, see:

http://www.conservation.ca.gov/cgs/geologic_hazards/hazardous_minerals/Pages/Index.aspx

https://www.arb.ca.gov/toxics/asbestos/geninfo.htm

Bay Area - Air Quality Management District:

http://www.baaqmd.gov/in-your-community/santa-clara-county

http://www.baaqmd.gov/permits/asbestos/naturally-occuring-asbestos

2.6.3 Post-Fire Surficial Processes

The principal concern with the Loma Fire area is an increase in the potential for hillslope and in-channel erosion, increased streamflow, hyperconcentrated flows, debris torrents, and debris flows derived from erosion. The primary mechanisms for this are increases in runoff from: reductions in interception resulting from the loss of live vegetation, reductions in infiltration due to the removal of duff and deposition of soil sealing ash, and from the loss of mechanical support along stream channels. Also of concern is the long-term loss of mechanical support of hillslope materials that was provided by vegetation and vegetative litter.

In areas of high and moderate burn severity, water repellant soils can develop where waxy substances released by plant materials during hot fires follow thermal gradients into the soil and condense onto soil particles. Additionally the headwaters of these watersheds are very steep. Dry ravel (i.e., downslope mobilization of loose bedrock, soils, and sediment wedges accumulated behind vegetation removed during the fire) was observed on very steep slopes in numerous locations in the burn area. The loose materials may become mobilized into sediment-laden runoff during heavy rains, leading to the development of debris flows and debris torrents that may flow downstream from the watershed headwater source areas. The magnitude of post-fire damage will ultimately be determined by the intensity and duration of storms that impact the burn area for several wet seasons until vegetation recovers.

2.7 Hydrology and Flooding

The burn area is predominantly located within two watersheds, the Upper Llagas Creek and the Upper Uvas Creek watersheds. Approximately 35% of the burn area is in the Uvas Creek basin and 63% in the Llagas Creek watershed. Roughly 2% drains to the Los Gatos Creek, Soquel Creek, and Alamitos Creek basins. Both Uvas Creek and Llagas Creek flow southeasterly and are fed by several ephemeral tributaries. The local residents describe the two watercourses as spring-fed with regular continuous flows in the summer, at times going subsurface. Llagas Creek flows into Chesbro Reservoir and Uvas Creek flows into Uvas Reservoir, which were constructed in 1955 and 1957, respectively. Both reservoirs are operated by the Santa Clara Valley Water District for the purpose of recreation, limited flood control, recharge supply for underground aquifers, and to ensure downstream flows for aquatic resources. The two main creeks continue as outflow from the reservoirs where they drain to the Pajaro River, which then drains to Monterey Bay.

Flood history for the affected watersheds was determined from the Santa Clara Valley Water District's flood reports (e.g., Sutcliffe et al., 1982; Maher, 1988). These reports provide an analysis of circumstances that led to individual flood events and document the areas that were flooded. In the last 60 years, the Uvas and Llagas creek watersheds have experienced significant flood events in 1955, 1958, 1962, 1963, 1969, 1982, 1986, 1996, 1997, 1998, 2002, 2008, 2009, and 2011 (SCVWD 2013). Portions of both Llagas Creek and Uvas Creek upstream of the dams have been previously mapped as within the 100-year floodplain by FEMA (FEMA, 2009), or mapped by DWR as within a Special Awareness Flood Zone (DWR, 2016).

Annual peak flow data are available for the Llagas Creek gage upstream of Chesbro Reservoir from 1972 to 2014 (Figure 5), and for the Uvas Creek gage located upstream of the Uvas Reservoir from 1962 to 1982 (Figure 6).

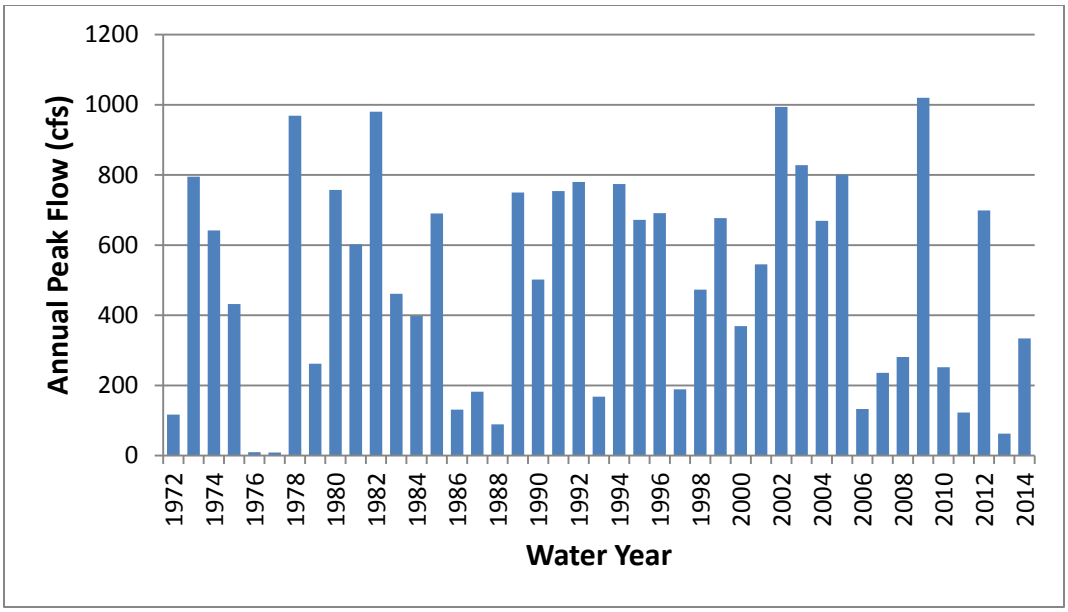


Figure 5. Annual peak flows for USGS 11153470 Llagas Creek above Chesbro Reservoir near Morgan Hill, CA. Data for water years 1972-1982 from USGS, 1983 to 2002 from SCVWD, and 2003 to 2014 from SCVWD/USGS.

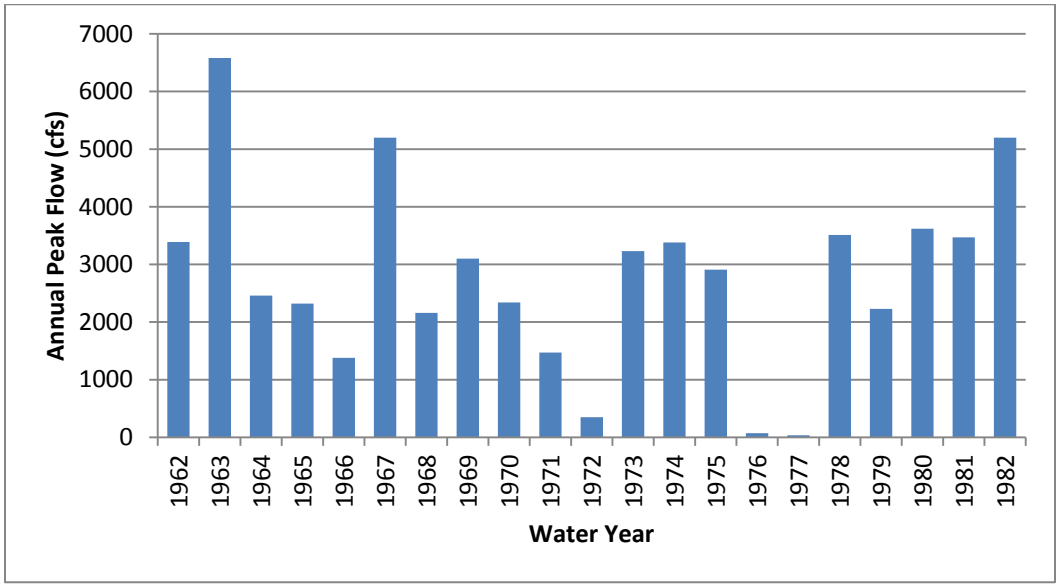


Figure 6. Annual peak flows for USGS 11153900 Uvas Creek above Uvas Reservoir near Morgan Hill, CA. Data from the USGS webpage.

Table 3. Flood frequency analysis for USGS 11153470 Llagas Creek above Chesbro Reservoir near Morgan Hill, CA, using data from water years 1972 to 2014 (provided by Jack Xu, PE, Santa Clara Valley Water District), and for USGS 11153900 Uvas Creek above Uvas Reservoir near Morgan Hill, CA (calculated with the USGS PeakFQ program).

Recurrence Interval (year)	Llagas Creek Discharge (cfs)	Uvas Creek Discharge (cfs)
2	415	2623
5	907	4490
10	1254	5672
25	1670	7042
50	1952	7961
100	2206	8795

2.8 Archeology

No significant archeological sites were identified within the Loma Fire burn area during the fire suppression period (Dr. Garrit Fenenga, CAL FIRE archeologist, personal communication).

2.9 Fish, Wildlife, and Botanical Resources

The Loma Fire burn area and its associated watersheds are home to several fish, wildlife, and botanical special status species.[1] Prior to the team deployment, the WERT conducted a species scoping by accessing the California Natural Diversity Database and identifying all species within a 9 quadrangle search area. Eighty-three special status species were identified in the scoping (see Appendix E for a complete list and maps). While many species may have been affected by the fire, it is likely that only resident fish, amphibian and reptile species may be significantly affected by post-fire erosion impacts. Specifically, these species include:

- California tiger salamander, *Ambystoma californiense*
- California red-legged frog, *Rana draytonii*
- Foothill yellow-legged frog, *Rana boylii*
- Western pond turtle, *Emys marmorata*

[1] Special status species include any species identified as DFW Fully Protected, Watch List, or Species of Special Concern, or any species listed as Threatened or Endangered under the California Endangered Species Act or the federal Endangered Species Act. California Rare Plant Rank 1A, 1B, 2A or 2B also may qualify as special status.

- Steelhead trout (central California coast distinct population segment), *Oncorhynchus mykiss irideus*

General recommendations for these species can be found in Section 4.8 of this document. Uvas and Llagas creeks drain into Uvas and Chesbro reservoirs, respectively, and then flow to the Pajaro River and out to the Monterey Bay. The reservoirs are an upstream migration barrier to anadromous fish species.[2] The population extent of central California coast steelhead (federally listed as threatened under the Endangered Species Act) extends to Uvas and Chesbro reservoirs. The reservoirs act as sediment and debris basins, so it is unlikely that sediment and debris flows would cause a significant impact to individuals due to the expected trapping efficiency of these two reservoirs.

3.0 Methods

3.1 Office Methods

To validate the Burn Area Reflectance Classification (BARC) map and to collect values at risk points and associated information, a mobile mapping application was used. The application is an ESRI product called "Collector for ArcGIS[3]" that allowed field observers to use mobile devices to view and use for reference the following information:

- BARC map
- Fire perimeter
- Fire history
- United States Geological Survey (USGS) debris flow model segments and basin probabilities for a 24 mm/hr storm (0.94 in/hr)
- Watershed boundaries (HUC-12)
- Federal Emergency Management Agency (FEMA) Special Flood Hazard Areas
- Department of Water Resources (DWR) Special Awareness Floodplains
- Hydrography
- Roads
- Geology
- Slope gradient
- Topographic hillshade

[2] Anadromous means any species that spawns in freshwater and migrates to the ocean to rear.
[3] http://doc.arcgis.com/en/collector/

3.2 Modelling Methods

3.2.1 USGS Post-Fire Debris Flow Model

The USGS assessment uses results of the soil burn severity map along with empirical models to estimate the likelihood and potential volume of debris flows for selected basins in response to a design storm. The empirical models are based upon historical debris-flow occurrence and magnitude data, storm rainfall conditions, terrain and soils information, and burn severity data from recently burned areas (Staley et al., 2016). Post-fire debris-flow likelihood, volume, and combined hazards are estimated at both the drainage-basin scale and in a spatially distributed manner along the drainage network within each basin. These are described as basin probability and segment probability, respectively. The characteristics of basins affected by the fire were calculated using a geographic information system (GIS) with a minimum area of 0.2 km^2 (49 ac) and a maximum area of 8.0 km^2 (1977 ac). Debris-flow likelihood and volume were estimated for each basin outlet, as well as along the upstream drainage networks.

The U.S. Geological Survey (USGS) preliminary hazard assessment for the Loma Fire can be accessed at:
http://landslides.usgs.gov/hazards/postfire_debrisflow/2016/20160926loma/

3.2.2 Flood Flow Modeling

Research conducted in southern California indicates that post-fire peak flows can increase as much as 10 to 30 fold for low magnitude storms and 2 to 3 fold for larger magnitude storms (Rowe et al. 1949, Moody and Martin 2001). Kinoshita et al. (2014) reported that commonly used flood flow prediction methods have lower confidence with larger return period (25- and 50-year) events; therefore we analyzed pre- and post-fire flows at the 2-year and 10-year recurrence intervals.

Pre-fire flood flows for the Llagas and Uvas Creek watersheds were calculated using flood frequency analyses from the stream gaging station data available for the unregulated portions of these basins (Figures 5 and 6). Local data were determined to be more appropriate for flood modeling than using USGS updated regional regression equations (Gotvald et al., 2012). The flow transference method (Waananen and Crippen, 1977) was used to calculate pre-fire discharge by adjusting the 2-year and 10-year discharge estimate for the difference in drainage area between the ungaged basin and the gaged basins.

“Pour points” were used to analyze the contribution of runoff at basin outlets and at selected locations to assess potential values at risk within the fire perimeter. Nine basins of varying sizes were established and analyzed at the 2-year and 10-year return interval (Figure 7). The Llagas Creek gaging station is denoted as pour point L-4, and the Uvas Creek station is considered pour point U-3.

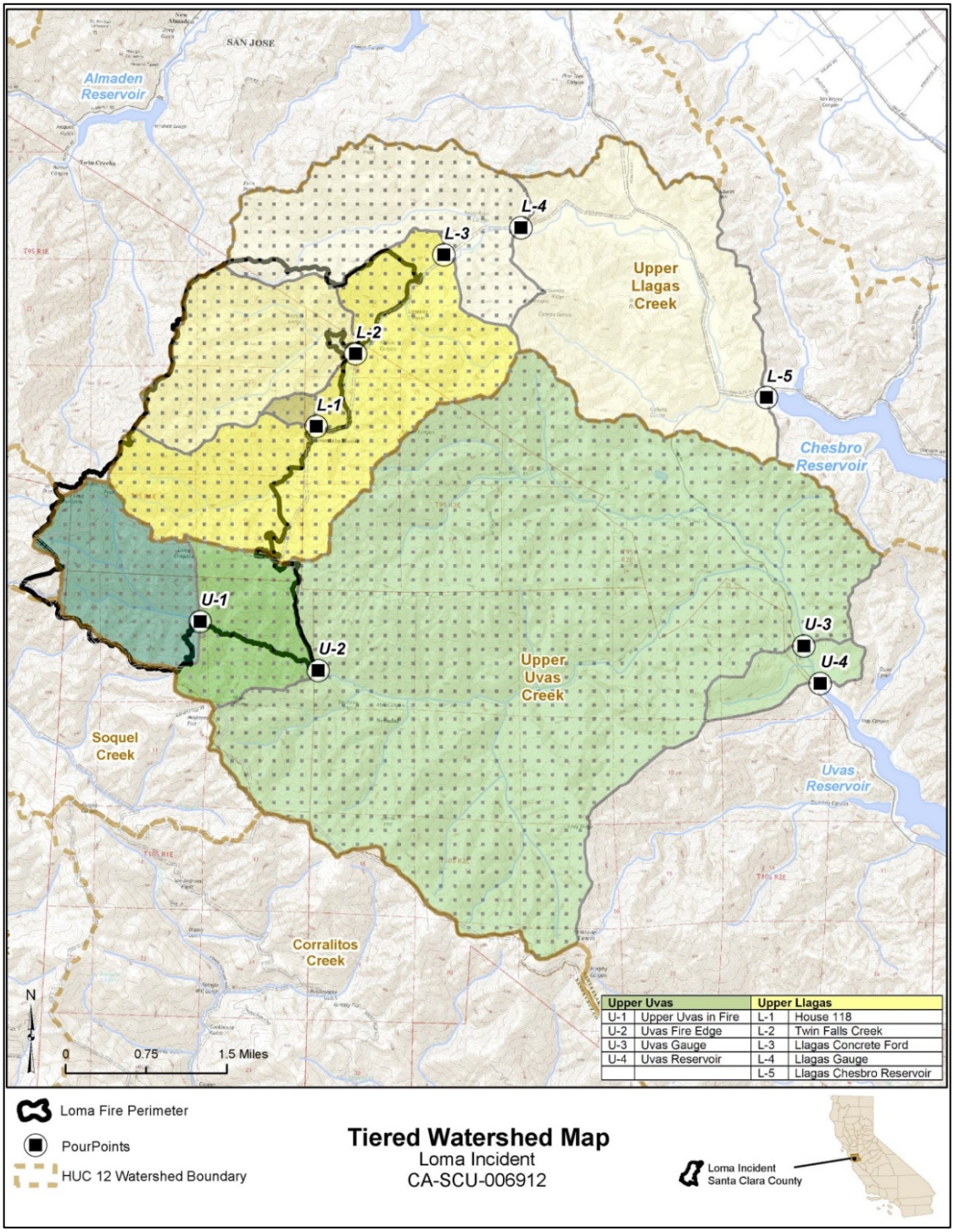


Figure 7. Tiered (pour point) watershed map.

To determine the impact of the wildfire on first year post-fire peak flows, the total acres and acres burned at high, moderate, and low soil burn severity for each defined watershed was determined (Table 4). A simple equation included in Foltz et al. (2009) was modified to predict first year increases following the fire for 10-year return interval flows:

$$M = 1 + \left[\frac{Percent\ Runoff\ Increase_{(H+M)}}{100\%} \times \frac{(A_h + A_m)}{A_T}\right] + \left[\frac{Percent\ Runoff\ Increase_{(L)}}{100\%} \times \frac{A_L}{A_T}\right]$$

$$Q_{T10} = 2.0(Q_{10})\left[\frac{A_h + A_m}{A_T}\right] + \left(\frac{Q_{10} + Q_{25}}{2}\right)\left[\frac{A_L}{A_T}\right] + (Q_{10})\left[\frac{A_U}{A_T}\right]$$

where:

A_h = High burn severity area within the watershed (acre or mi^2)
A_m = Moderate burn severity area within the watershed (acre or mi^2)
A_L = Low burn severity area within the watershed (acre or mi^2)
A_U = Unburned area within the watershed (acre or mi^2)
A_T = Total watershed area (acre or mi^2)
Q_{T10} = Total post-fire adjusted discharge
Q_{10} = 10-year return interval flow
Q_{25} = 25-year return interval flow
M = Flow modifier

Limited studies and guidelines exist to determine the appropriate modifier or percent runoff increase for high and moderate soil burn severity. As stated in Foltz et al. (2009), U.S. Forest Service BAER specialists have used a 100% runoff increase (i.e., a doubling of the runoff amount) for high/moderate soil burn severity areas the first year after a severe wildfire. For low soil burn severity areas, 10-year peak flows were calculated as the average between the 10- and 25-year flows, or an average of a 20% increase in runoff.

To calculate the increase in discharge for 2-year return interval flows, we used the approach described by Weaver et al. (2007). A 5-fold increase was assigned to areas with high soil burn severity; a 2.5 fold increase for moderately burned areas, and no increase for areas with low burn severity.

$$Q_{T2} = 5.0(Q_2)\left[\frac{A_h}{A_T}\right] + 2.5(Q_2)\left[\frac{A_m}{A_T}\right] + (Q_2)\left[\frac{A_L}{A_T}\right] + (Q_2)\left[\frac{A_U}{A_T}\right]$$

where:

Q_{T2} = Total post-fire adjusted discharge, 2 year return interval
Q_2 = 2-year return interval flow

Additionally, SCVWD estimated pre- and post-fire flow at pour points L-4 and U-3 (stream gaging stations on Llagas Creek and Uvas Creek, respectively) using the HEC-HMS model (Kinoshita et al., 2013, http://www.hec.usace.army.mil/software/hec-hms/). This model uses the NRCS curve number methodology.

Table 4. Loma Fire watershed and soil burn severity data.

Watershed	Watershed Data			Burn Severity			
	Watershed Acres	Watershed Mi^2	Watershed Area Burned	Mi^2 High	Mi^2 Moderate	Mi^2 Low	Mi^2 Unburned
L-1	71	0.11	86.7%	0.01	0.07	0.02	0.01
L-2	1,388	2.17	73.2%	0.22	1.03	0.34	0.58
L-3	4,376	6.84	45.5%	0.60	1.81	0.71	3.72
L-4	6,204	9.69	32.8%	0.60	1.85	0.73	6.51
L-5	9,340	14.59	21.8%	0.60	1.85	0.73	11.41
U-1	1,079	1.69	70.3%	0.40	0.51	0.28	0.50
U-2	1,949	3.05	56.5%	0.50	0.84	0.38	1.32
U-3	13,668	21.36	8.1%	0.50	0.84	0.39	19.63
U-4	14,049	21.95	7.9%	0.50	0.84	0.39	20.22

3.2.3 Pre- and Post-Fire Erosion and Sedimentation Modeling

Pre-fire Erosion Hazard Ratings (EHRs) for soils in the Loma Fire burn area were calculated based on the procedure described in the California Forest Practice Rules (BOF Technical Rule Addendum No. 1, CAL FIRE 2016) and using an assumed post-fire vegetative cover that ranged from 0 to 95 percent. The EHR model uses the slope, percent vegetative cover, percent coarse fragments (>2 mm), 2-year 1-hour precipitation intensity, soil texture, and depth to restrictive layer or bedrock to determine if the surface erosion hazard is extreme, high, moderate, or low.

Pre-fire sedimentation rates were investigated in two ways. We requested reservoir bathymetric data for Chesbro and Uvas Reservoirs from Santa Clara Valley Water District engineers, as well as investigation of USGS reservoir sedimentation records. Bathymetric data provided for Uvas Reservoir surveys conducted in 1979 and 2007 were utilized, as were USGS bathymetric data for Chesbro Reservoir from 1955-1976. Additionally, we obtained total sediment and suspended sediment yield information for USGS gaging stations 11153470 Llagas Creek above Chesbro Reservoir near Morgan Hill, CA, and 11153900 Uvas Creek above Uvas Reservoir near Morgan Hill, CA, respectively. Data were obtained from the USGS webpage: http://waterdata.usgs.gov/nwis/annual/?referred_module=qw.

Post-fire hillslope sedimentation rates were modeled by U.S. Forest Service Soil Scientist Eric Nicita in the Loma Fire burn area using Batch ERMiT (Erosion Risk Management Tool).[4] ERMiT is a web-based tool developed to predict surface erosion from post-fire hillslopes, and to evaluate the potential effectiveness of various erosion mitigation practices (Robichaud et al., 2011). ERMiT requires input for climate parameters based on location, vegetation type (forest, range, chaparral), soil type (clay

[4] http://forest.moscowfsl.wsu.edu/fswepp/batch/bERMiT.html

loam, silt loam, sandy loam, loam and rock content), topography (slope length and gradient), and soil burn severity class (low, moderate, high). This model provides probabilistic estimates of single-storm post-fire hillslope erosion by incorporating variability in rainfall characteristics, soil burn severity, and soil characteristics into each prediction (Robichaud et al., 2011).

The WERT selected ERMiT for post-fire erosion modeling over other models such as WEPP (Water Erosion Prediction Project), GeoWEPP, and AGWA (Automated Geospatial Watershed Assessment tool) due to past experience with the model and realistic results obtained using the model.

3.3 Field Methods

3.3.1 Soil Burn Severity

The degree to which fire affects soil properties, along with other controlling factors, is important for predicting the potential for increased runoff and sedimentation (Keeley, 2009). Soil burn severity mapping reflects the spatial distribution of the fire's effects on the ground surface and soil conditions, and is needed in order to rapidly assess fire effects, identify potential values at risk, and prioritize field assessment (Parsons et al., 2010). Soil burn severity is determined using Landsat satellite imagery-derived Burned Area Reflectance Classification (BARC) maps, followed by field verification work. (http://www.fs.fed.us/eng/rsac/baer/barc.html).

The initial BARC map was created by the USGS EROS for the Loma Fire on October 11, 2016, and modified by the WERT for field verification. A BARC map is composed of satellite-derived data layers of post-fire vegetation conditions. A BARC map has four classes: high, moderate, low, and unburned. The Loma Fire BARC map was field-verified using methodology developed by Parsons et al. (2010). These methods included soil hydrophobicity testing, as well as assessments of fine root structure, soil structure, and amount of ground cover.

Soil hydrophobicity testing and vegetation burn severity observations were conducted at nine sites. Soil water repellency testing took place on both the soil surface and at depth (Photo 3, Appendix B). Surface water repellency testing was completed by scraping away the ash layer to expose bare mineral soil at the surface and then timing how long it took for a drop of water to infiltrate the soil. Subsurface water repellency testing was completed in the same fashion as surface testing, but with excavation of the surface soil to a depth approximately ½ inch to one inch below the surface.

Field testing revealed that soil water repellency was not a reliable indicator for determining soil burn severity, as water repellant conditions were highly variable. Parsons et al. (2010) reported that the connection between soil burn severity and soil water repellency is neither universally consistent nor well defined (i.e., it does not necessarily correlate well with burn severity). To validate the BARC map, information on

ash thickness and color, ground cover, soil structure, fine root consumption, surface rock fragment percentage, pre-fire vegetation density, and vegetation type was collected in conjunction with soil water repellency to determine the overall soil burn severity for comparison with the BARC map (Parsons et al., 2010).

3.3.2 Field Observations of Values at Risk

The WERT conducted a site-specific evaluation of Values at Risk (VARs). Areas where there were concentrations of residential homes, campgrounds, and public infrastructure received the greatest attention. Field observations were conducted from October 11 to 16, 2016. Road-related features, such as culverts and bridges, were surveyed at major drainage crossings.

The VARs assessed by the WERT include possible loss of life and property due to an elevated potential for increased streamflows, hyperconcentrated flows, debris torrents, debris flows, rock fall, and associated slope movement. VARs were assessed using the USGS post-fire debris flow modeling data for the 24 mm/hr 15-minute rainfall intensity (probability hazard), FEMA 100-year floodplain mapping, soil burn severity data, topography, aerial imagery, hillshade, slope, watershed boundaries (HUC-12[5]), DWR awareness floodplains, and roads. Team members confirmed hazards based on site-specific observations and interpretation of active geomorphic processes and landforms (Figure 8). When appropriate, team members noted preliminary or possible emergency protection measures.

It should be noted that the observations included in this report are not intended to be fully comprehensive and/or conclusive, but rather to serve as a preliminary tool to assist emergency responding agencies (e.g., CAL FIRE, County of Santa Clara, Caltrans, Office of Emergency Services, 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 emergency responding 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.**

[5] A HUC-12 watershed is typically 15,000 to 40,000 acres in size.

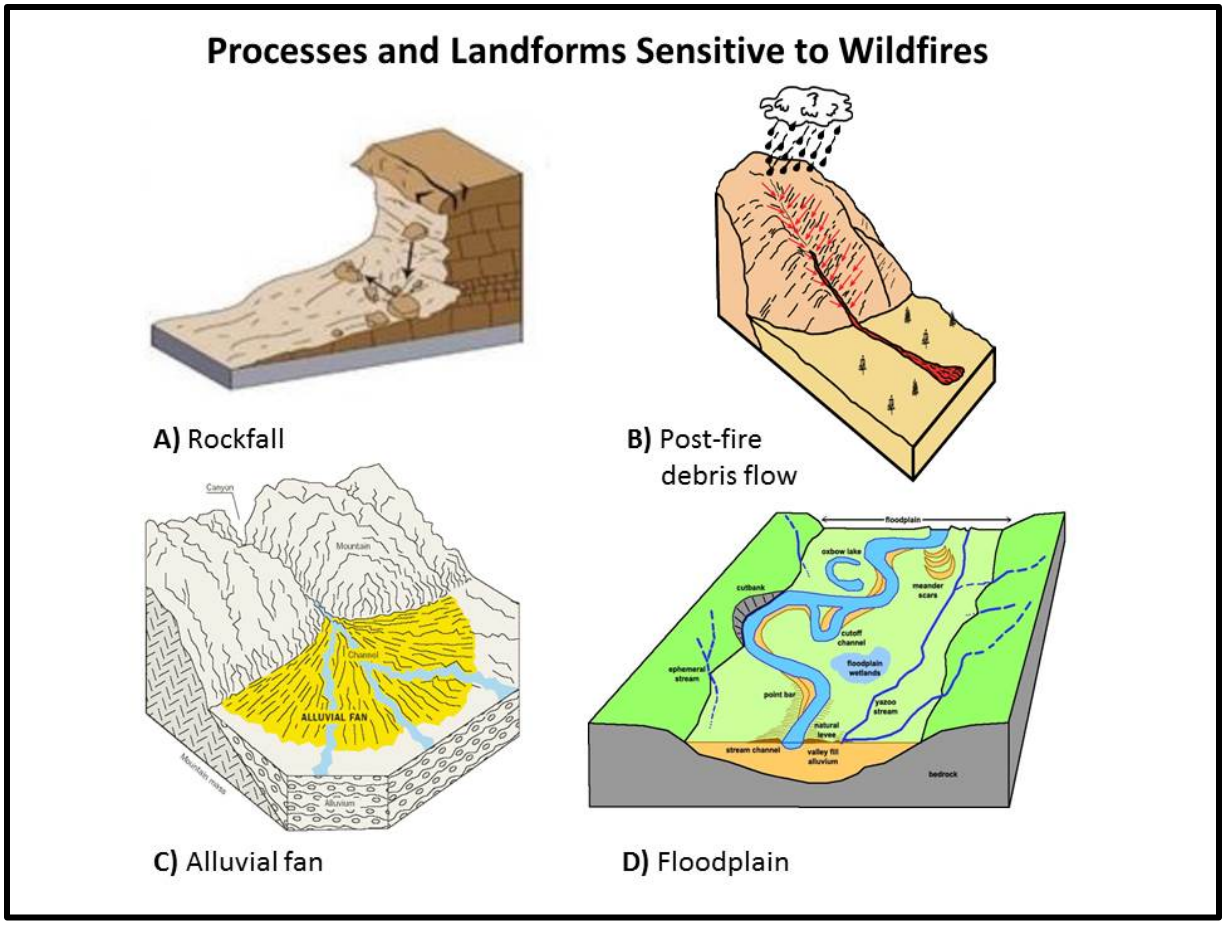


Figure 8. Geomorphic processes and landforms considered by WERT personnel to verify and assess hazards for VARs on the Loma Fire. VARs potentially subject to these geomorphic processes or located within or adjacent to these landforms were generally assigned a higher risk.

4.0 Results and Observations

4.1 Soil Burn Severity

In general, the WERT found the Loma Fire BARC map to be relatively accurate and chose not to make revisions. As a result, the BARC map was denoted as the soil burn severity map (Figure 9). Typically the higher the burn severity, the more susceptible the area is to rapid runoff and erosion. The Loma Fire soil burn severity map was used by the WERT as a guide to help identify areas of likely erosion and debris flow that may occur during storm events and threaten impacts to downslope structures and infrastructure. There were approximately 1,980 acres (44%) of unburned/low soil burn severity, 1,742 acres (39%) of moderate soil burn severity, and 740 acres (17%) of high soil burn severity.

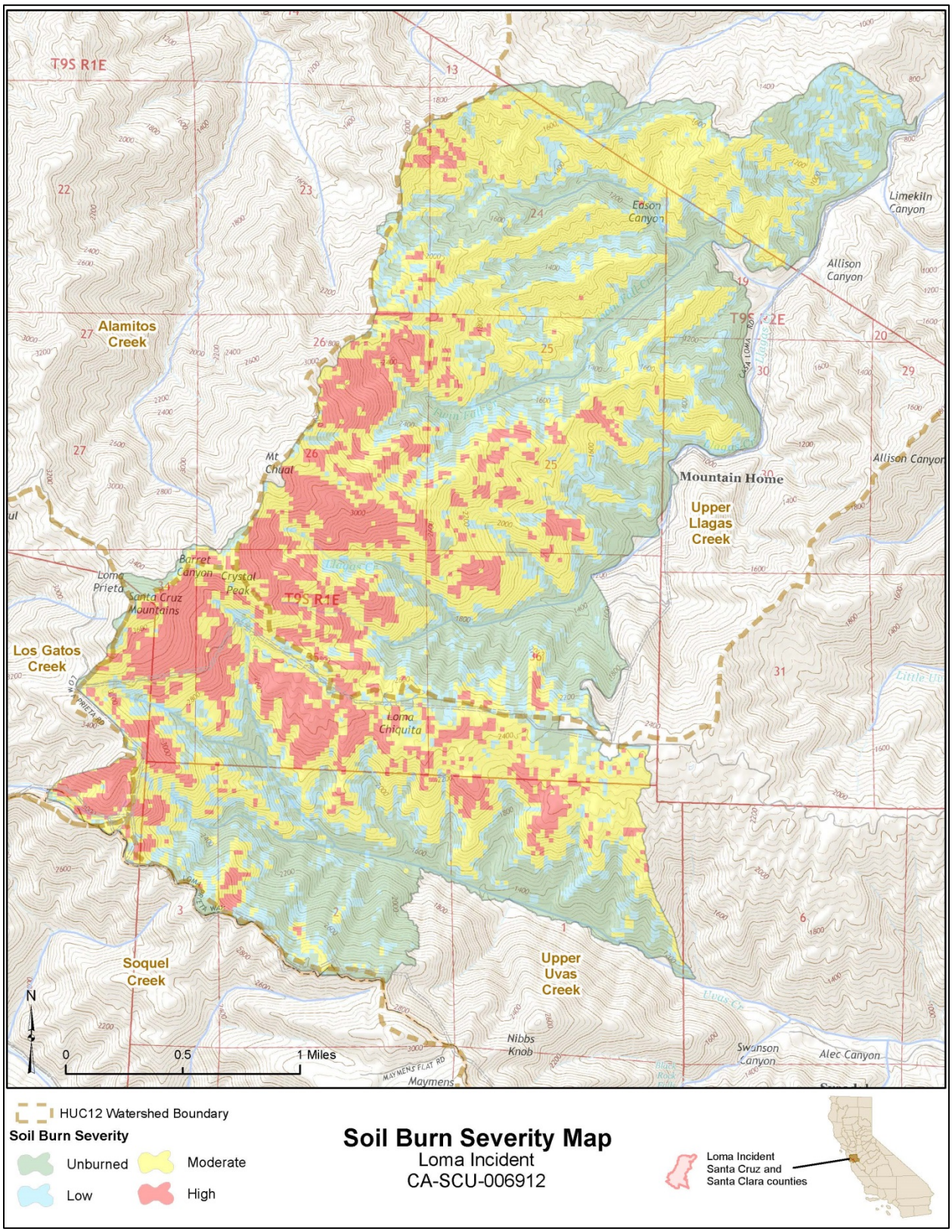


Figure 9. Soil burn severity map.

4.2 Flood Flow Model Results

Estimates for pre- and post-fire flood flows for the 9 pour point locations are provided in Table 5 (locations are shown in Figure 7). The flood flow model estimates the 2- and 10-year return interval flood flows in the Llagas and Uvas creek watersheds. No bulking factor was included in the analysis; however, bulking by sediment can be extremely important during the first post-fire winter. Previous studies have shown that post-fire sediment can bulk flows by 0.5 to 3 times clear water flow. For example, estimates of projected flood flow volumes are commonly doubled in southern California watersheds (LACDPW, 2006) due to bulking, or entrainment of sediment from mass wasting processes. Lower bulking factors are more likely for northern California watersheds, such as Uvas and Llagas creeks, but this is currently unknown. Also, watershed area affects the size of estimated post-fire flood flows. In general, Neary et al. (2005) and Foltz et al. (2009) state that post-fire changes in peak flows are greatest in smaller-sized watersheds less than 250 acres (1 km^2).

Pour point L-5 models the Llagas Creek watershed upstream of Chesbro Reservoir. Flow for L-5 is projected to increase 1.35 times for a 2-year return interval storm and 1.16 times for a 10-year return interval event. Pour point L-4 is located at the USGS stream gage site on Llagas Creek upstream of Chesbro Reservoir. L-4 is projected to increase 1.53 and 1.25 times for the 2- and 10-year return intervals, respectively. Pour point L-3 is a key low water crossing on Casa Loma Road (VAR 101), and is projected to increase 1.74 times and 1.34 times for the 2- and 10-year return intervals, respectively. Pour point L-2 is located on the Twin Falls Creek tributary of Llagas Creek. L-2 is projected to increase 2.11 and 1.56 times for the 2- and 10-year return intervals, respectively. The location of pour point L-1 was selected due to the high concern of a drainage area flowing under a residential structure (VAR 118). Pour point L-1 is projected to increase 2.32 and 1.68 times for the 2- and 10-year return intervals, respectively.

Table 5. Loma Fire pre and post-fire non-bulked flow modeling results.

Watershed	Pre Fire Discharge		Post Fire Discharge		Times Increase (2yr)	Times Increase (10yr)
	Q2 (CFS)	Q10 (CFS)	Q2 (CFS)	Q10 (CFS)	X Increase of Normal Flow	X Increase of Normal Flow
L-1	9	29	21	48	2.32	1.68
L-2	115	353	243	552	2.11	1.56
L-3	308	933	537	1254	1.74	1.34
L-4	415	1254	636	1563	1.53	1.25
L-5	589	1772	797	2063	1.35	1.16
U-1	298	662	716	1031	2.40	1.56
U-2	495	1092	1025	1588	2.07	1.45
U-3	2623	5672	3024	6040	1.15	1.06
U-4	2685	5805	3085	6172	1.15	1.06

Pour point U-4 models the flood flows upstream of Uvas Reservoir. The projected increase of U-4 is 1.15 and 1.06 for the 2- and 10-year return intervals, respectively. Pour point U-3 is located at the USGS stream gage site on Uvas Creek upstream of Uvas Reservoir. U-3 is projected to increase 1.15 and 1.06 times for the 2- and 10-year return intervals, respectively. Pour point U-2 is located on the downstream boundary of the fire perimeter on Uvas Creek. U-2 is projected to increase 2.07 and 1.45 times for the 2- and 10-year return intervals, respectively. Pour point U-1 was placed in the upper Uvas watershed near the Sveadal community. U-1 is projected to increase 2.40 and 1.56 times for a 2- and 10 year return intervals, respectively.

Even without bulking, 10-year return interval flows for pour points L-1 and L-2 are estimated to change to 100-year events the first winter. A 10-year recurrence interval flow for the low water crossing on Casa Loma Road (L-3) is projected to change to a 50-100-year event, and the 10-year flow for U-1 in the upper Uvas Creek basin is expected to change to a 50-year return interval event.

SCVWD modeling results with the HEC-HMS methodology estimated that at L-4, the Llagas Creek gaging station, the 2-year and 10-year return interval flows will increase 12% and 10%, respectively. For pour point U-3, the Uvas Creek gaging station, SCVWD modeling estimates a 2% increase for both 2-year and 10-year flood flows.

4.3 Debris Flow Model Results

The USGS post-fire debris flow hazard model was employed for the Loma Fire to assist in the WERT's assessment of locations where hazards to life and property may exist. The debris flow likelihood maps based on the 24 mm/hr (0.94 in/hr) design rainfall are presented in Figure 10 and Appendix D, and illustrate the likelihood of debris flows occurring in response to a more frequent precipitation event. The WERT used the USGS model results based on the 40 mm/hr (1.6 in/hr) event to aid in our field assessment of values at risk. This less frequent precipitation event emphasizes areas for field teams to focus their observations. By varying the precipitation input parameters, the basin probability analyses indicate that with:

- A 24 mm/hr (0.94 in/hr) precipitation event, 25 of 41 basins have likelihood of 50% or greater to produce debris flows.
- A 40 mm/hr (1.6 in/hr) event, 37 of 41 basins have likelihood of 50% or greater to produce debris flows.

USGS Stream Watch Segments were used to indicate the presence of drainages within and below the burn area that can be impacted by the combined effects of debris flows and floods generated from one or more tributary basin. These are areas where a combination of runoff hazards may be present, and where flood hazard analyses should consider bulking factors for modeling the increase in runoff volume due to the contribution of sediment and debris.

For watersheds burned in the Loma Fire, these results give an indication of potential post-fire watershed response. It is important to note that the USGS probability and volume models provide debris flow hazards results for a single precipitation event. However, an additional hazard to be considered is the coupled result from several small debris flow or sediment-laden runoff events that load channel networks, followed by one large intense precipitation event that mobilizes this sediment as a large debris flow.

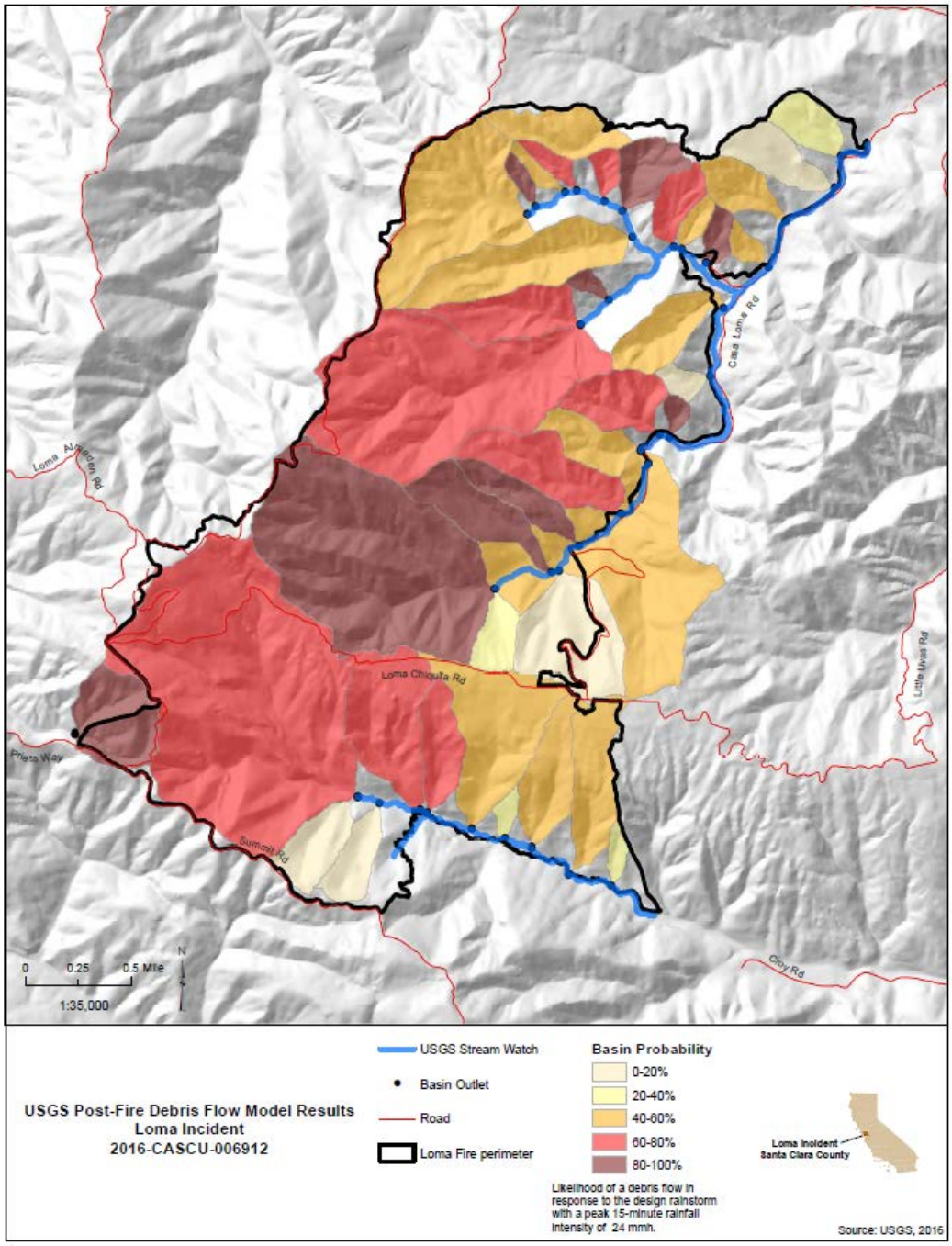


Figure 10. USGS debris flow model results for the Loma Fire (also see Appendix D, and the USGS webpage: http://landslides.usgs.gov/hazards/postfire_debrisflow/2016/20160926loma/).

The USGS model results do not constitute a site-specific analysis of debris flow hazards. Additional on-the-ground evaluation should be conducted by qualified and licensed professionals where necessary. The model results are also limited in that they do not show hazards for basins that are less than 0.2 km² (~50 acres) in area, and do not specifically identify hazards in areas where one or more tributaries may contribute flood and debris flows (watch segments), as discussed above. The hazards in burn areas that do not show a modeled result are therefore undefined by the model, but may be present. Similarly, for areas not shown as having a segment debris flow hazard associated with a drainage network, a hazard may still be present, yet undefined because the segment model results are limited based on the resolution of the input digital elevation model (DEM). Additionally, other hillslope processes such as rock falls and debris slides are not included in the model results.

4.4 Pre- and Post-Fire Erosion and Sedimentation Results

The pre-fire erosion hazard rating (EHR) results indicate that areas of high and extreme EHR generally correlate with the areas of steep slopes, such as the northeastern portion of the fire area and the north-facing slopes of the upper Uvas Creek watershed (southwest portion of the fire area). Overall, 38 percent of the fire area was included in the extreme category, 37 percent in the high category, 25 percent in moderate, and 0.24 percent in low (Figure 11).

Pre-fire sedimentation rates were obtained from two USGS gaging stations: (1) L-4 (USGS 11153470 Llagas Creek above Chesbro Reservoir near Morgan Hill, CA), and (2) U-3 (USGS 11153900 Uvas Creek above Uvas Reservoir near Morgan Hill, CA). Total sediment yield data were collected for the Llagas Creek station from 1972 to 1978. Values ranged from 33.3 tons/day in 1978 to 0.004 tons/day in 1976 (Table 6). The mean sediment rate for this period was 306 t/mi^2/yr or **0.5 t/ac/yr.**

Table 6. Total sediment discharge for Llagas Creek (USGS webpage).

Water Year	80156, Total sediment discharge, short tons per day
1972	0.092
1973	12.3
1974	8.51
1975	2.24
1976	0.004
1977	0.007
1978	33.3
** No Incomplete data have been used for statistical calculation	

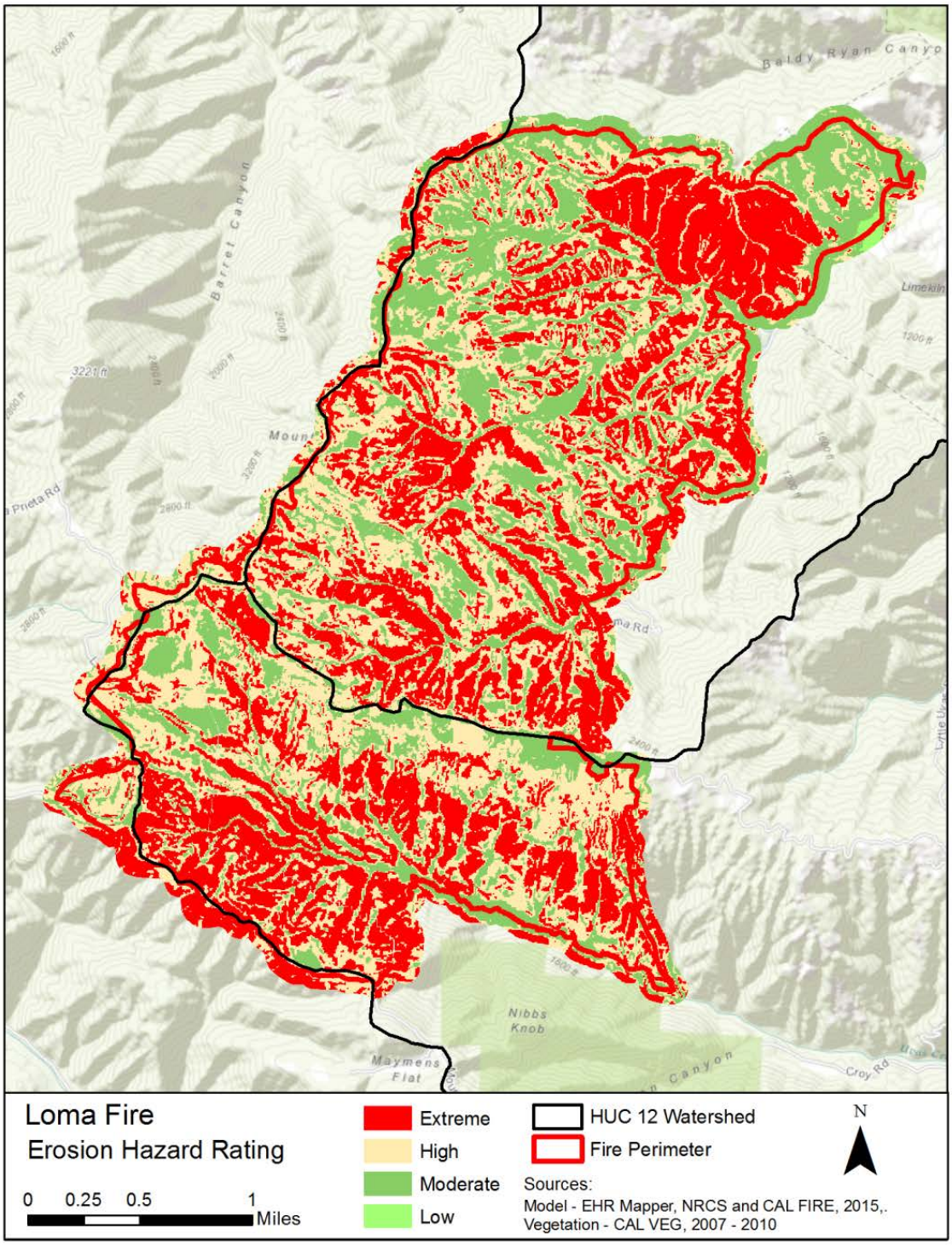


Figure 11. Loma Fire EHR map, prior to burning.

For the Uvas Creek station, suspended sediment data were collected from 1966 to 1976. Mean suspended sediment discharge ranged from 131.9 tons/day in 1967 to 0.023 tons/day in 1976 (Table 7). The mean suspended sediment rate during these years was 533 t/mi^2/yr or 0.8 t/ac/yr. If bedload is assumed to be 33 percent of total sediment (Cafferata and Reid 2013), then total sediment yield during this period was 800 t/mi^2/yr or **1.25 t/ac/yr.**[6]

Table 7. Suspended sediment discharge for Uvas Creek (USGS webpage).

Water Year	80155, Suspended sediment discharge, short tons per day
1966	1.56
1967	131.9
1968	12.0
1969	65.4
1970	33.4
1971	10.2
1972	1.80
1973	48.5
1974	22.0
1975	10.8
1976	0.023
** No Incomplete data have been used for statistical calculation	

Bathmetric data provided by the SCVWD for Uvas Reservoir revealed that approximately 745 acre-feet of sediment accumulated over 25 years between surveys. Assuming a conversion factor of 0.81 short tons per cubic yard (Minear and Kondolf 2009), this equates to 2,290 yd^3/mi^2/yr or 1,854 t/mi^2/yr (**2.9 t/ac/yr**). This value is more than two times higher than the value using 11 year USGS suspended sediment record, assuming the bedload percentage is reasonably accurate. USGS bathymetric data for Chesbro Reservoir from 1955 to 1976 show an average sedimentation rate of 620.5 t/mi^2/yr or approximately **1.0 t/ac/yr**.[7]

Post-fire Batch ERMiT model predictions for the 10-year recurrence interval runoff event show that surface erosion rates are estimated to be from 5 to 10 tons per acre for 62 percent of the fire area (Figure 12). These rates have a 10 percent probability of exceedance. Hillslope erosion in these watersheds may affect downstream infrastructure, roads and drainage structures, fill stream channels with high levels of sediment, increase downstream turbidity, and bulk flood flows with higher than typical sediment loads. These areas would roughly be expected to have a 10-fold increase in sedimentation the first post-fire winter compared to pre-fire conditions with this level of probability, based on the sediment rates measured for the Llagas Creek watershed by the USGS, and less in the Uvas Creek basin, where pre-fire erosion rates are higher.

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[6] McKee et al. (2013) reported that small tributaries in the Bay Area, including Uvas and Llagas creeks, have a mean sediment yield of 605 t/mi^2/yr (212 metric tonnes/km^2/yr).

7 http://water.usgs.gov/osw/ressed/interactive_map/map_ca.html

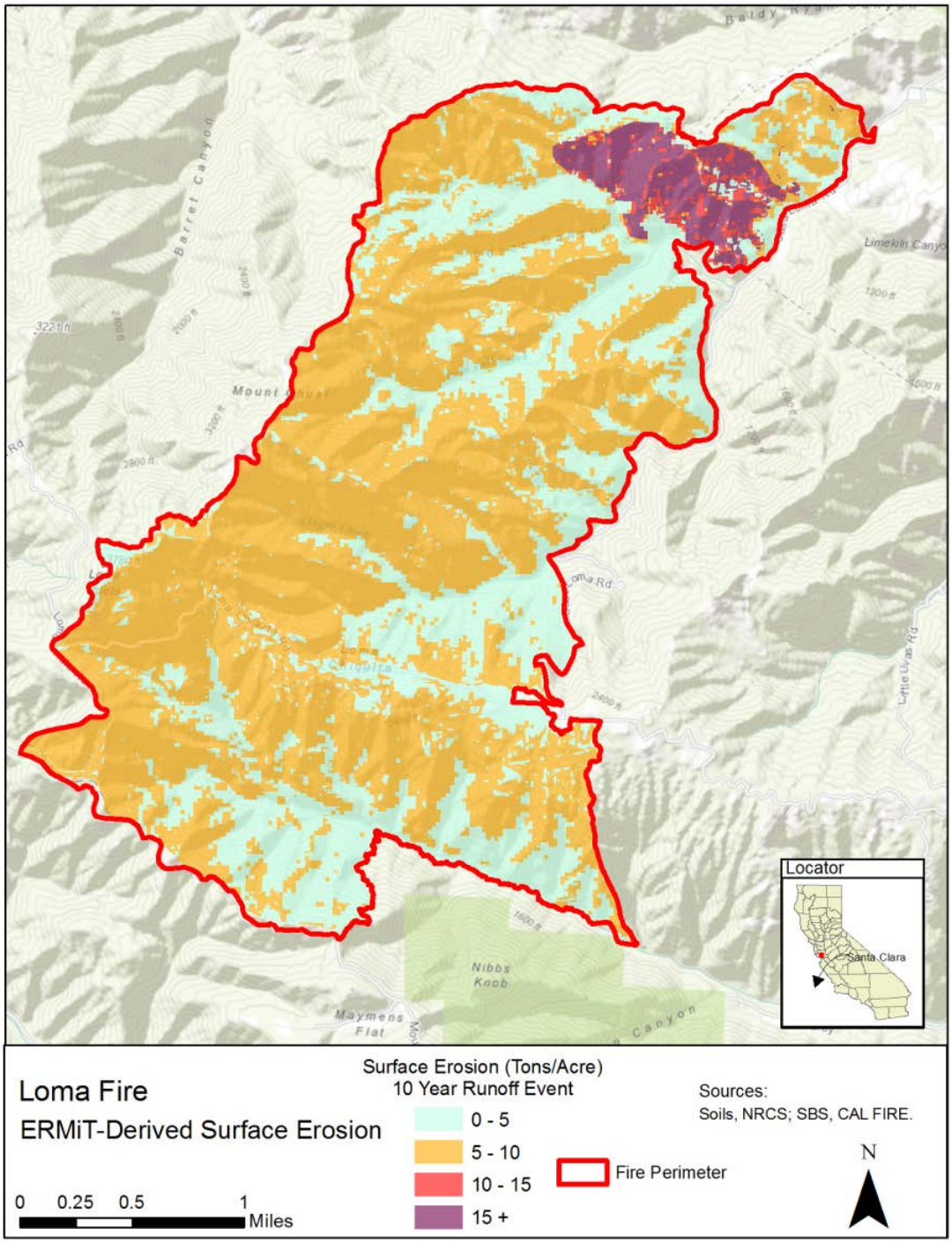


Figure 12. Batch ERMiT erosion rates for the Loma Fire area.

Both the pre-fire EHR model and the post-fire ERMiT model highlight the same area of extreme erosion potential in the lower portion of the Llagas watershed (i.e., northeast corner of the fire, Figures 11 and 12). This part of the fire differs from other regions of the burned area due to the presence of Jurrasic volcanic rocks and Franciscan Melange. It lies in the Sanikara Rock Outcrop soil complex and is notable for shallow

loam soils, high rock exposure, a chaparral-dominated vegetation community, and very steep slopes of 75 percent or greater. Most of this area was in the moderate soil burn severity zone. This combination of factors makes this small area stand out from the remainder of the burned area as an extreme concern for increased sediment yield and possible debris flows. Based on a 10-year recurrence interval, the Batch ERMiT model prediction varies from 15 to over 20 tons per acre.

Past post-fire studies in the California Coast Ranges support this level of increased sedimentation. Ritter and Brown (1972) reported that sediment yields increased significantly in Williams Reservoir following a 1961 wildfire that burned in the nearby 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 the Pajaro River watershed. Additionally, a post-fire sediment study conducted on Boggs Mountain Demonstration State Forest following the 2015 Valley Fire, located in Lake County, has revealed sediment rates the first winter of 5-10 t/ac for intensely burned forest areas (D. Coe, CAL FIRE, unpublished data).

4.5 Emergency Determination – Exigencies

The emergency from geologic and hydrologic hazards (i.e., debris landslides, debris flows, rockfall, and flooding) to values at risk caused by the fire include adverse effects for the health and safety of people, residences, roads, and bridges within the wildfire area. Of particular concern is the potential risk for loss of life and property in moderate to high soil severity burn areas within the wildland/urban interface. Based on the WERT field observations, particular concern for the potential risk for loss of life and infrastructure downslope of high and moderate soil severity burn areas exist at the Mountain Home community (Casa Loma Road, Twin Falls Road, and Chual Spur Road), the Sveadel/Croy Road area, lower Llagas Creek above Chesbro Reservoir, and lower Uvas Creek above Uvas Reservoir. Some of these areas are located in previously mapped flood hazard zones as identified by FEMA and DWR, and are at an elevated flood risk regardless of the Loma Fire effects.

4.6 Development and Key Infrastructure

Development in the assessment area is concentrated in two principal valleys draining Uvas and Llagas creeks, and along steep upland areas and ridge tops forming the drainage divide between them. The community of Sveadal is located within the upper Uvas Creek watershed, and the community of Mountain Home is situated within the upper portion of the Llagas Creek watershed. Residences are also located along the crest and slopes of Summit Ridge, Loma Chiquita Ridge, and along several unnamed ridges that bound the central and northwest portion of the Llagas Creek watershed. The Chesbro and Uvas reservoir dams provide limited flood control for downstream communities.

4.7 Observations and Recommendations

4.7.1 Mountain Home Area

The Mountain Home area includes small communities along Casa Loma Road, Chual Spur Road, and Twin Falls Road. Small clusters of homes are situated along Casa Loma Road in the upper Llagas Creek watershed and near Twin Falls Creek above its confluence with Llagas Creek. Chual Spur Road connects the upper portion of Llagas Creek with the Mt. Chual area, with homes distributed along the steep native surfaced road.

Observations

- Along several reaches of Llagas Creek, numerous debris fans issue from side canyon swales and drainages that were constructed from past debris flow events. Shallow and deep-seated landslides are also mapped throughout the steep sloping terrain. Increased flood flows can also be expected.
- Hillslopes within the Santa Clara Valley Open Space Authority ownership underlain by the Sanikara-Rock Outcrop complex are prone to high erosion rates. This is supported by the presence of mapped shallow debris slides and the results of both surface erosion and debris flow hazard models.
- VARs 112-126 and 203-207: This group of homes and drainage structures are located within the headwaters of Llagas Creek along Casa Loma Road, which experienced low to high burn severity (Photos 1, 4, and 5; Appendix B). Dry ravel was observed on the very steep slopes (greater than 100%) that form the upper headwater slopes. It is anticipated that the effects of the low to high burn severity in the watershed that drains to the residential area will increase and magnify the size and intensity of rainfall runoff that could lead to flooding, debris flows, and mud flows, depending on the intensity of fall, winter, and spring storm events. Debris flows and flooding may impact homes and existing infrastructure, including access bridges and low water crossings that provide access to residences. As noted above, some of these VARs are located in previously identified flood hazard zones as identified by FEMA and DWR, and are at an elevated flood risk regardless of the Loma Fire effects.
- VAR 111: This culvert on Chual Spur Road is situated within an area that experienced moderate to high burn severity and has a high likelihood of debris flow hazards. In addition, Chual Spur Road lacks adequate road drainage, and dry ravel and sloughing of road cuts were observed along several segments of the roadway (Photo 2, Appendix B). Debris flow and debris laden runoff may impact drainage structures, causing road failure and enhanced sediment delivery to Llagas Creek.
- VARs 104-110 and 201-202: This group of homes and drainage structures are located in the headwaters of Llagas Creek in the Twin Falls Creek tributary along Casa Loma Road, which experienced low to high burn severity. It is anticipated that this level of burn severity in the watershed that drains to the residential area will increase and magnify the size and intensity of rainfall runoff that could lead to

flooding, debris flows, and mud flows, depending on the intensity of storm events the first winters following the fire. Debris flows and flooding may impact homes and existing infrastructure, including access bridges and low water crossings that provide access to residences. In addition, the upper reaches of this tributary are situated in an area where potentially asbestos bearing host rocks have been mapped.

Recommendations

- Consider specific recommendation for VARs provided in Appendix C.
- Utilize early warning systems available to homeowners.
- Perform storm patrols and monitor road drainage infrastructure.
- Because “watch stream” flood hazards are present, any flood analyses should consider bulking factors to model the increase in runoff volume due to the contribution of sediment and debris. Previous studies have shown that post-fire sediment can bulk flows by 0.5 to 3 times clear water flow.
- Improve drainage to Chual Spur Road.

4.7.2 Lower Llagas Creek

The area downstream of Mountain Home in the Llagas Creek watershed is a vegetation transition zone. As the stream descends the canyon, the vegetation changes from mixed conifer-oak woodland to chaparral and coastal scrub, and then finally to herbaceous rangeland and oak savanna. In this area Llagas Creek transitions from a steep canyon setting with fairly dispersed home locations at the wildland urban interface to a denser residential pattern as it approaches the outskirts of Morgan Hill. Rancho Cañada del Oro occupies the northern portion of the burned area and is owned by the Santa Clara Valley Open Space Authority. This section considers the areas downstream of pour point L-3 to the Chesbro Reservoir inlet at pour point L-5.

Observations

- VARs 101-103, 143-150, and 212-217: This group of homes and drainage structures are located in the lower portion of Llagas Creek, which experienced low to high burn severity. It is anticipated that the effects of the low to high burn severity in the watershed that drains to the residential area will increase and magnify the size and intensity of rainfall runoff that could lead to flooding, depending on the severity of fall, winter, and spring rains. Flooding may impact homes and existing infrastructure, including access bridges and low water crossings (Photo 6, Appendix B) that provide access to residences. As noted above, some of these VARs are located in previously identified flood hazard zones as identified by FEMA and DWR, and are at an elevated flood risk regardless of the Loma Fire effects.

- Hillslopes within the Santa Clara Valley Open Space Authority ownership underlain by the Sanikara-Rock Outcrop complex are prone to high erosion rates. This is supported by the presence of mapped shallow debris slides and the results of both surface erosion and debris flow hazard models.
- It is estimated that post-fire flood flows with a 10-year return interval will increase approximately 50%, while a 2-year event will approximately double. Applying a post-fire sediment bulking factor would result in 0.5 to 3 times the flow values noted above.

Recommendations

- Consider specific recommendation for VARs provided in Appendix C.
- Utilize early warning systems available to homeowners.
- Perform storm patrols and monitor road drainage infrastructure.
- Because "watch stream" flood hazards are present, any flood analyses should consider bulking factors to model the increase in runoff volume due to the contribution of sediment and debris. Previous studies have shown that post-fire sediment can bulk flows by 0.5 to 3 times clear water flow.
- Vegetation removal within channels at bridge crossings.

4.7.3 Sveadal Area

The Croy Road area includes the Sveadal community and Uvas Canyon Regional Park in the upper Uvas Creek watershed area. Croy Road ends at Uvas Canyon Regional Park at a year-round campground. The campground is situated on a high alluvial terrace above Uvas Creek, but there is a recreational foot trail that leads down to Uvas Creek. The Sveadal community is located just downstream of Uvas Canyon Regional Park. This community consists of several homes and foot bridges, as well as recreational areas situated along Uvas Creek. Additionally, sporadic homes and vehicle bridges are situated downstream of the Sveadal community along Croy Road near Uvas Creek. This section considers the areas downstream immediately below pour points U-1 and U-2.

Observations

- In general, the County Park and Sveadal community area lie east of the burn area. Post-fire debris flow hazards from steep tributary canyons do not appear to be focused on these areas, but may contribute abundant debris to the headwaters of Uvas Creek. Increased flood flows can also be expected.
- Several shallow and deep-seated landslides are mapped within the Uvas Creek watershed. If these landslides are reactivated, they may contribute additional sediment to the main channel, bulking flood flows.
- Dry ravel and sloughing of road cuts, including small rockfalls, were observed along several segments of Croy Road.

- The upper reaches of this watershed are situated in an area where potentially asbestos-bearing host rocks have been mapped.
- VAR 127: A trail with access at the campground leads to Uvas Creek in Uvas Canyon Reginal Park. The upstream watershed experienced low to high burn severity. It is anticipated that the effects of the low to high burn severity will increase and magnify the size and intensity of rainfall runoff that could lead to flooding, debris flows, and mud flows, depending on the severity of fall, winter, and spring storm events. The trail access could be flooded and pose a danger to hikers.
- VARs 128-132: These groups of homes and road drainage structures are located in the upper Uvas Creek basin in the Sveadal community; they are situated along Croy Road, which experienced low to high burn severity. It is anticipated that the effects of the low to high burn severity in the watershed that drains to the residential area will increase and magnify the size and intensity of rainfall runoff that could lead to flooding, debris flows, and mud flows, depending on the severity of fall, winter, and spring rains. Debris flows and flooding may likely impact homes and existing infrastructure, including access bridges to many residences. It is estimated that a post-fire 10-year return interval flood in this area could produce a pre-fire 100-year flow event.
- VARs 134-140: These groups of homes are located along Croy Road south of the Sveadal community (Photo 7, Appendix B). It is anticipated that the effects of the low to high burn severity in the watershed that drains to the residential area will increase and magnify the size and intensity of rainfall runoff that could lead to flooding, debris flows, and mud flows, depending on the severity of fall, winter, and spring rains. Debris flows and flooding may impact homes and existing infrastructure, including access bridges that provide entrance to residences. It is estimated that a post fire 10-year return interval event in this area could produce a pre-fire 50-100-year event (approximately a 60% increase). As noted above, some of these VARs are located in previously identified flood hazard zones as identified by FEMA and DWR, and are at an elevated flood risk regardless of the Loma Fire effects.

Recommendations

- Consider specific recommendation for VARs provided in Appendix C.
- Utilize early warning systems available to homeowners.
- Perform storm patrols and monitor road drainage infrastructure.
- Because “watch stream” flood hazards are present, any flood analyses should consider bulking factors to model the increase in runoff volume due to the contribution of sediment and debris. Previous studies have shown that post-fire sediment can bulk flows by 0.5 to 3 times clear water flow.
- Close trail access (VAR 127) to Uvas Creek during storm events, as described in Appendix C.

4.7.4 Lower Uvas Creek

Downstream from Sveadal, widely spaced sporadic homes and vehicle bridges occur along the creek with redwood and mixed conifer on steep slopes in a confined channel. Continuing down the drainage, the channel grade gradually flattens out and the confined channel moves into a narrow valley. The vegetation transitions from redwood and mixed conifer to mixed chaparral and oak woodland. Homes are widely spaced in the lower portions of the Uvas Creek drainage, with some homes built very close to streambanks. The predominant threat to lives and property in this reach is flooding. As noted above, some of these VARs are located in previously identified flood hazard zones as identified by FEMA and DWR, and are at an elevated flood risk regardless of the Loma Fire effects.

Observations

- VARs 137-142 and 209-211: This group of values at risk includes several homes, outbuildings, and associated utilities, a trailer near the channel margin, and a bridge. This area ranges from the mid reaches of the Uvas Creek watershed to the lower end of the drainage immediately upstream of the inlet to Uvas Reservoir. This area is well outside and downstream of the burn area. Local residents have memories of past flooding events, including rare overbank flooding. Increased size and intensity of flows from the high to moderately burned areas above this area may result in increased flooding along this portion of the channel. Homes near streambanks may experience stream incision and destabilization of streambanks. This area may also experience flooding, which could impede access to bridges providing entrance to residences, overflow culverts, and undercut the road prism.
- It is estimated that post-fire flood flows with a 10-year return interval will increase 6%, while a 2-year event will increase 15%. Applying a post-fire sediment bulking factor would result in 0.5 to 3 times the flow values noted above.

Recommendations

- Consider specific recommendation for VARs provided in Appendix C.
- Utilize early warning systems available to homeowners.
- Perform storm patrols and monitor road drainage infrastructure.
- Because “watch stream” flood hazards are present, any flood analyses should consider bulking factors to model the increase in runoff volume due to the contribution of sediment and debris. Previous studies have shown that post-fire sediment can bulk flows by 0.5 to 3 times clear water flow.

4.7.5 Loma Prieta Peak Area and Loma Chiquita Ridge

The most elevated portions of the burn area include the southeast and south sides of the peak of Loma Prieta (el. 3,786 feet), and the Loma Chiquita ridgeline spur southeast of Crystal Peak that divides the Llagas Creek drainage on the northeast from the Uvas Creek drainage to the southwest. Loma Prieta is the site of numerous communications facilities, and scattered dwellings form a residential community along the broad crest of Loma Chiquita ridge. Access to the Loma Chiquita ridgeline is available via roads from the Llagas Creek drainage via Casa Loma Road, and from Loma Prieta Way (Summit Road) to the southwest through Loma Prieta Road to Loma Chiquita Road. Loma Prieta is accessible via Loma Prieta Road from the southwest and via the steep Chual Spur Road to the east. These roads are largely unsurfaced and single lane with minimal drainage structures. Due to enhanced runoff from the adjacent burned slopes, these roads may be expected to experience more than typical levels of erosion.

Observations

No specific VAR points or polygons were documented within this area due to the lack of significant drainage areas up gradient of these elevated areas. However, general observations were made during the BARC validation phase and during the helicopter reconnaissance flight.

The burn area on the southeast side of Loma Prieta drains to pour point U-1, located in the upper Uvas Creek drainage. The slope gradient in this area ranges from moderate to steep and burn severity was moderate to high on many of the slopes (Photo 8, Appendix B). Highly disturbed/fractured bedrock is locally exposed on slopes and in road cuts. Two large dormant landslides have been mapped in this area (see geologic map, Figure 4). Reactivation of these two slides could affect a home and/or disrupt Loma Chiquita Road, as well as reduce access to residences on Loma Chiquita Ridge to Casa Loma Road and to facilities on top of Loma Prieta.

- Raveling was observed at several locations along the segment of Loma Chiquita Road below Loma Prieta (Photo 9, Appendix B) and there is a potential for rock fall or shallow debris slides/flows to affect this road or other roads on this slope.
- A large portion of Chual Ridge experienced moderate to high burn severity and access to Loma Prieta via Chual Spur Road could be adversely impacted by burn-enhanced debris slides/flows or surface erosion.

The burn area on Loma Chiquita Ridge is within pour points U-1 and U-2 in the Uvas Creek drainage to the southwest, and in pour point L-3 within the Llagas Creek drainage to the northeast. The burn severity was dominantly moderate to high on the broad southwest-facing portion of this ridge and below Crystal Peak, but becomes progressively more restricted to ridgelines downslope to the southwest into Uvas Canyon (Photo 10, Appendix B).

- The residential community is underlain by low- to moderate-gradient slopes.
- Steeper southwest-facing slopes below are mostly within Santa Clara Valley Open Space Authority property.

- The residential area is located mostly above the modeled debris flow line segments owing to their elevated topographic position.

A small, high severity burn area occurred northwest of the intersection of Loma Prieta Road (Summit Road) and Loma Prieta Way at the head of the Los Gatos Creek drainage. This area is within the Midpeninsula Regional (Sierra Azul) Open Space Preserve and no structures are present or down gradient to the northwest before Lake Elsman Reservoir is encountered.

In addition, potentially asbestos-bearing host rocks have been mapped in the upper reaches of the Uvas Creek drainage below Loma Prieta.

Recommendations

- Perform storm patrols and monitor road drainage infrastructure.
- Implement drainage improvements for Chual Spur Road and Loma Prieta Road (Summit Road).

4.7.6 Rainfall During WERT Deployment

From October 14 to 17, 2016, 11.97 inches (304 mm) of rain was recorded with a tipping bucket rain gage from two Pacific frontal storms at the Uvas Canyon County Park station (Figure 13). Rainfall intensity ranged from 0.04 inches per hour to 0.79 inches per hour, with a mean intensity over the entire two storm period of 0.16 inches per hour. The maximum hourly intensity of 0.79 in/hr equates to less than a one year return interval (1-yr RI = 0.85 in/hr).

Field observations and reports identified small rockfalls, surface soil erosion (e.g, rilling and gullying), and a general increase in riverine runoff, including ash and woody debris movement. Based on our limited review, post-fire debris flows did not occur. These observations generally support the debris flow modeling threshold used in this report (0.94 in/hr).

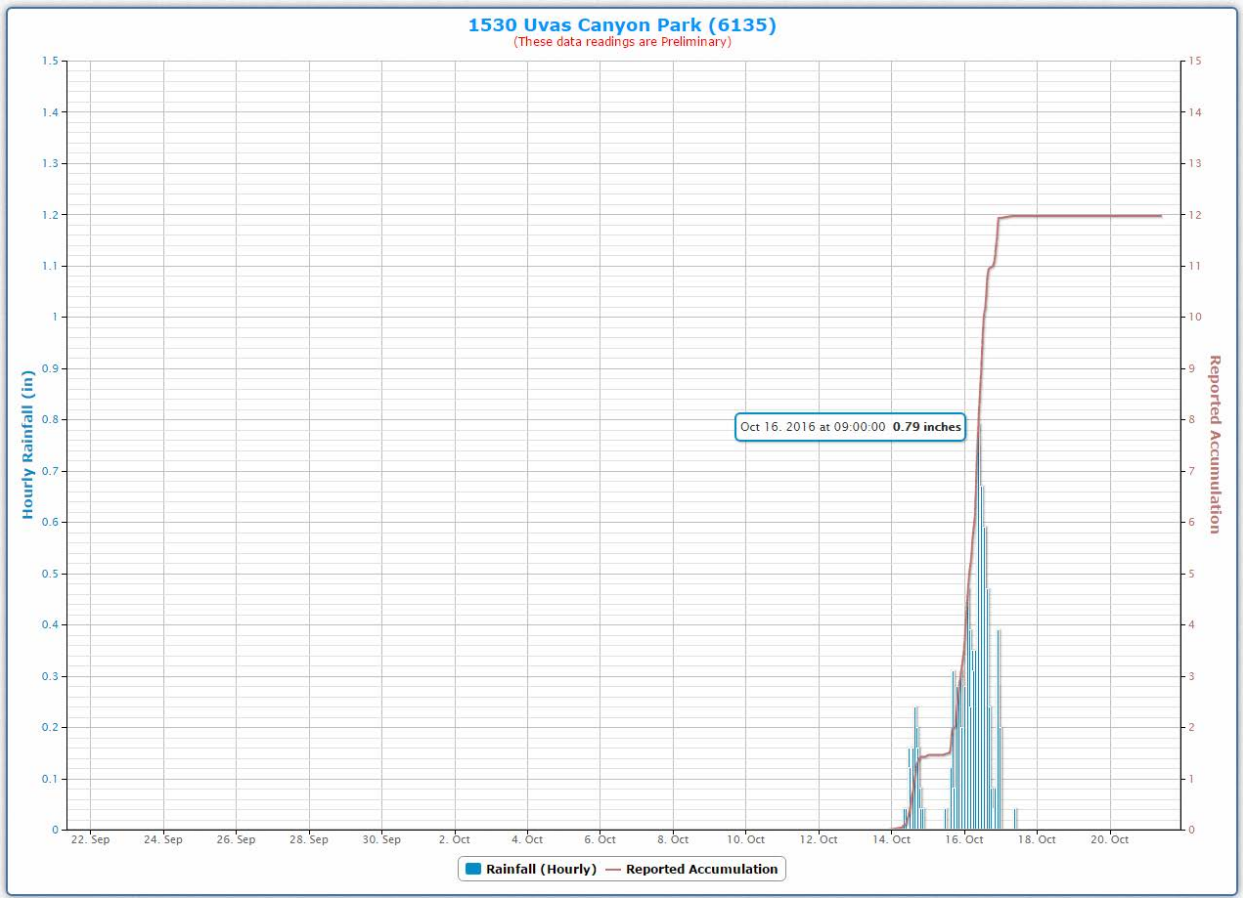


Figure 13. Rainfall during WERT deployment (October 13-17, 2016).
http://alert.valleywater.org/pgi.php

4.8 General Recommendations

Early Warning Systems

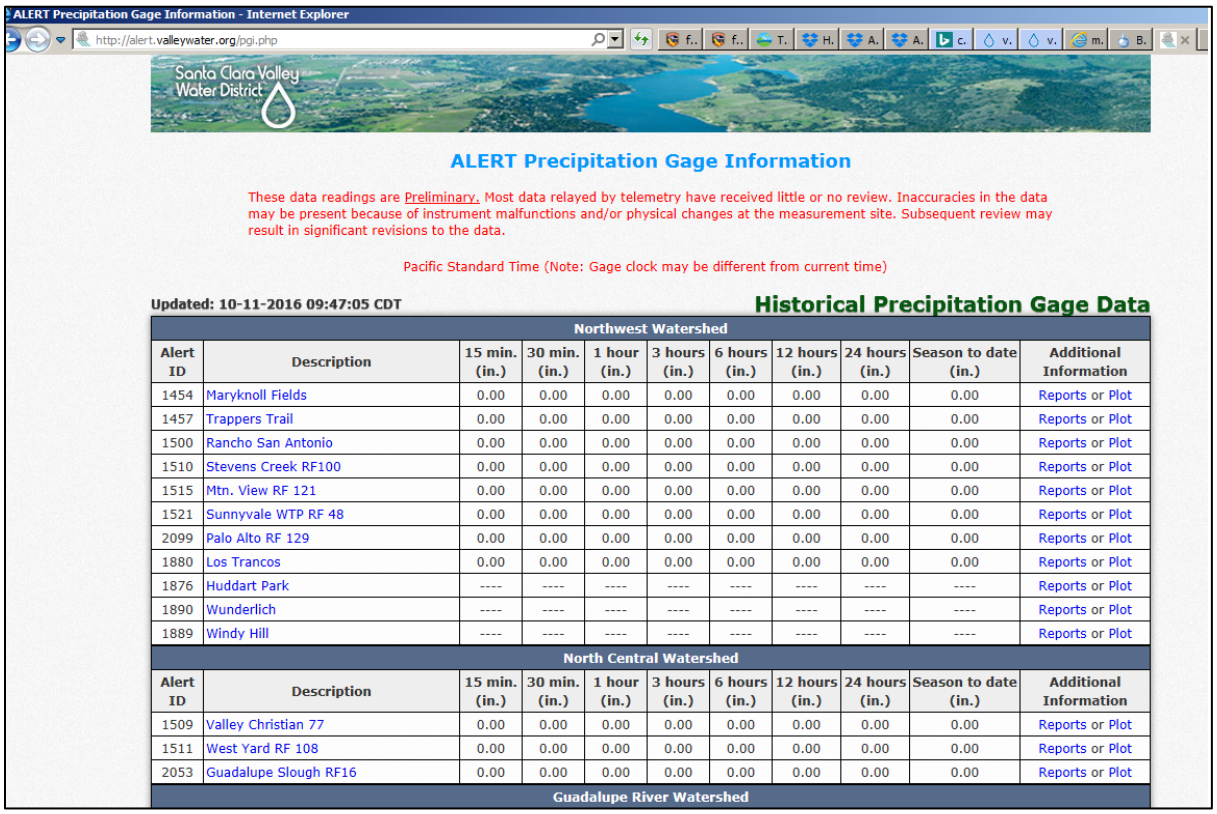
Existing early warning systems should be used and improved such that residents can be alerted to incoming storms, allowing enough time to safely vacate hazard areas. In areas where cell reception is poor or non-existent, methods should be developed to effectively contact residents.

Emergency-response and public-safety agencies are often faced with making decisions and deploying resources both well in advance of strong winter storm events and during the storms themselves. Information and methodology critical to this process is provided for by the USGS open file report OF10-1039 that can be accessed at: http://pubs.usgs.gov/of/2010/1039/pdf/OF10-1039.pdf.

Santa Clara County has an ALERT system (Santa Clara County Emergency ALERT System) that uses phone or email to notify anyone who lives and works in Santa Clara County of an impending emergency, including flooding and wildfires (Figure 14).

Information and signup for the system can be found here:
https://www.sccgov.org/sites/alertscc/Pages/home.aspx

http://alert.valleywater.org/pgi.php



Northwest Watershed										
Alert ID	Description	15 min. (in.)	30 min. (in.)	1 hour (in.)	3 hours (in.)	6 hours (in.)	12 hours (in.)	24 hours (in.)	Season to date (in.)	Additional Information
1454	Maryknoll Fields	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Reports or Plot
1457	Trappers Trail	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Reports or Plot
1500	Rancho San Antonio	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Reports or Plot
1510	Stevens Creek RF100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Reports or Plot
1515	Mtn. View RF 121	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Reports or Plot
1521	Sunnyvale WTP RF 48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Reports or Plot
2099	Palo Alto RF 129	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Reports or Plot
1880	Los Trancos	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Reports or Plot
1876	Huddart Park	----	----	----	----	----	----	----	----	Reports or Plot
1890	Wunderlich	----	----	----	----	----	----	----	----	Reports or Plot
1889	Windy Hill	----	----	----	----	----	----	----	----	Reports or Plot
North Central Watershed										
Alert ID	Description	15 min. (in.)	30 min. (in.)	1 hour (in.)	3 hours (in.)	6 hours (in.)	12 hours (in.)	24 hours (in.)	Season to date (in.)	Additional Information
1509	Valley Christian 77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Reports or Plot
1511	West Yard RF 108	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Reports or Plot
2053	Guadalupe Slough RF16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Reports or Plot
Guadalupe River Watershed										

Figure 14. Santa Clara County ALERT precipitation gage information.

For post-fire debris flow hazards, warnings with practical lead times of several hours must come from a combination of weather forecasts, rainfall measurements of approaching storms, and debris-flow triggering thresholds. The USGS has worked together with the National Weather Service (NWS) to provide guidance for post-fire debris flow thresholds that may be used by the NWS for “watch” and “warning” notifications: http://landslides.usgs.gov/hazards/warningsys.php

Road Drainage Systems and Storm Patrols

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. Where and when necessary, required road improvement work should follow the guidelines suggested by Weaver et al. (2015). Also, constricting vegetation and loose woody debris may need to be removed around crossing structures.

Structure Protection

Possible structure protection measures should be coordinated through Santa Clara County OES and the NRCS. Debris flow mitigation measures could potentially consist of K-rails, H-beams with wood lagging, plywood, sand bagging, and Muscle Wall installations.

Temporary Housing

When there is need for temporary housing or new building construction for residents displaced by the fire, site-specific evaluation of hazards for temporary housing should be conducted by a qualified professional and in accordance with the local lead agency. The following factors should be considered as part of the evaluation.

On hillslopes above potential temporary housing and building sites:

- Could runoff from the hillslope concentrate in swales and small drainages and flow onto the site, and flood or otherwise damage the proposed structure, or present a life-safety hazard?
- Is the hillslope behind the structure steep and erodible, where rilling, gullying, or shallow failures could deliver a sufficient volume of sediment and debris to damage the proposed structure or pose a life-safety hazard?
- Are large rocks, boulders, or other material present on the slope that pose a rock or debris fall hazard that could impact the proposed structure, or present a life-safety hazard?
- Is there evidence of recent or impending erosion or mass wasting that could damage the proposed structure or pose a life/safety hazard (e.g., debris torrents/flows, deep-seated slides or slumps)?

On hillslopes below potential temporary housing and building sites:

- Is there evidence of recent or impending fill slope landslide-type failures that indicate an elevated risk of building pad failure?
- Is the building pad located above a watercourse where normal or flood flows could potentially erode the toe of the slope and trigger failure?

If any of these conditions are present, then mitigations need to be implemented, or alternative sites need to be identified and evaluated. Technical experts such as licensed engineers or geologists may be needed to support the evaluation.

General Recommendations to Protect Fish and Wildlife Special Status Species

- Any operations within the stream channel may require obtaining a DFW Lake and Streambed Alteration Agreement.[8] It is strongly recommended that landowners contact the local DFW office to determine if an Agreement is needed. In the event of emergency stream work, notification after the emergency should be submitted to DFW.

[8] https://www.wildlife.ca.gov/conservation/lsa

- To avoid potential impacts to downstream aquatic resources, work shall not be conducted if flowing water is present, unless in the event of an emergency to life or property.
- Heavy equipment or vehicles shall not operate within the stream channel, unless the work is conducted under an approved DFW Lake and Streambed Alteration Agreement.
- Work that results in disturbance to any streambank shall be minimized.
- No equipment maintenance shall be done within or near the stream channel where petroleum products or other pollutants from equipment may enter these areas under any flow.
- Operators shall take all necessary steps to contain sediment and reduce stream turbidity.
- All removed debris shall be placed in an area such that it will not re-enter the stream channel.
- Woody debris shall be disposed of by lopping and scattering and/or chipping and scattering it outside of the flood zone of the stream channel.
- There shall be no piling/burning of woody debris within the flood zone of the stream channel.
- If frog and/or salamanders or their egg masses, tadpoles, or eft[9] are observed during any stream work, operations shall cease and DFW and/or USFWS shall be contacted to conduct a species consultation.

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[9] Eft is the juvenile stage of a newt or salamander.

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Appendix A
List of Contacts

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Appendix B
WERT Evaluation Photos

Photo 1. View down debris fan deposited by tributary of Llagas Creek behind residence at VAR no. 121.

Photo 2. Raveling and incipient shallow soil failures below Chual Spur Road, above VAR no. 111.

Appendix B
WERT Evaluation Photos

Photo 3. BARC map assessment on Chual Ridge at survey point 54.

Photo 4. Structure along Llagas Creek at VAR no. 117.

Appendix B
WERT Evaluation Photos

Photo 5. Tributary channel (blue arrow) of Llagas Creek that drains underneath structure at VAR no. 118.

Photo 6. At-grade water crossing with concrete apron at VAR no. 101 during storm flow on the morning of October 16, 2016. “Turn around, don’t drown,” National Weather Service: http://tadd.weather.gov/

Appendix B
WERT Evaluation Photos

Photo 7. Structure below Sveadal at VAR no. 134 along Uvas Creek during the storm event that occurred on October 16, 2016.

Photo 8. Aerial view of burn area on southeast flank of Loma Prieta in upper Uvas Creek drainage.

Appendix B
WERT Evaluation Photos

Photo 9. Fractured rock and raveling along cut for Loma Chiquita Road.

Photo 10. Aerial view northeast showing severity of burn area on Loma Chiquita Ridge.

Appendix C. Values at Risk

Community	Site Number	Address	Field Observation	Feature	Feature Category	Potential hazard to life	Potential hazard to property	In FEMA/DWR 100-yr Floodplain	USGS Debris Flow Basin ID No.	Preliminary Emergency Protective Measures	Pour Point	Latitude	Longitude
Mountain Home	101	Casa Loma Road	Low water crossing with concrete apron	Road	other	high	low	Yes		Storm patrol; remove posts and fence	L3	-121.78014	37.14449
Mountain Home	114	Casa Loma Road	Flooding and debris affecting house on creek	Home	home	high	high	Yes	261	Early warning	L3	-121.80343	37.11569
Mountain Home	116	Casa Loma Road	Flooding and debris affecting log cabin	Home	home	high	high	Yes	261	Early warning	L3	-121.80339	37.11591
Mountain Home	117	Casa Loma Road	Flood and debris affecting home	Home	home	high	high	Yes	261	Early warning	L3	-121.80260	37.11720
Mountain Home	118	Casa Loma Road	Debris flow, house built over swale next to creek	Home	home	high	high	Yes	194	Early warning	L1	-121.80110	37.12105
Mountain Home	121	Casa Loma Road	Debris flow	Home and outbuildings at base of dedris fan	home	high	high			K-rail at fan apex, diversion of flow on to tractor road, early warning. Spoke with home owner about k-rail placement and early warning.	L3	-121.79619	37.12119
Mountain Home	123	Casa Loma Road	Flood affecting home on outside channel bend.	Home	home	high	high	Yes		Storm patrol	L3	-121.79650	37.12637
Mountain Home	124	Casa Loma Road	Flooding affecting two structures on margin of creek, upstream dwelling has higher hazard to life and property due to its elevation and proximity to creek.	Home	home	high	high	Yes		Early warning	L3	-121.79672	37.12698
Mountain Home	203	Casa Loma road	Flooding, 3 homes located next to creek	Homes on margin of Llagas creek	home	high	high		261	Early warning	L3		
Mountain Home	102	Casa Loma Road	Flooding, home on margin of Llagas Creek	Home	home	low	high	Yes		Drain pond impoundment, deploy muscle wall along stream bed, early warning	L3	-121.79316	37.13207
Mountain Home	103	Tin Falls Road	Flooding and debris jam, bridge overtopping	Bridge	drainage structure	low	low	Yes		Storm patrol	L3	-121.79447	37.13120
Casa Loma	144	Casa Loma Road	Flooding affecting home near creek, spoke with homeowner who indicated he's not witnessed flooding overbank	Home	home	low	low	Yes		Early warning	L4	-121.77161	37.14819
Casa Loma	145	Casa Loma	Flooding affecting bridge, homeowner stated flood waters came within 6 inches of bridge deck, next to gage 80, SC water district.	Bridge	drainage structure	low	low	Yes		Storm patrol	L4	-121.76758	37.14841
Casa Loma	146b	Casa Loma Road	Flooding affecting home on margin of creek	Home	home	low	low	Yes		Early warning	L4	-121.75461	37.14891
Casa Loma	148	Casa Loma Road	Flooding affecting home near creek	Home	home	low	low	Yes		Early warning	L5	-121.75417	37.14910
Casa Loma	149	Casa Loma Road	Flooding affecting home	Home	home	low	low	Yes		Early warning	L5	-121.74915	37.14849
Casa Loma	213	Casa Loma Road	Flooding affecting home and trailer on either side of creek	Home and trailer	home	low	low	Yes		Early warning	L5		
Casa Loma	214	Casa Loma Road	Flooding affecting horse arena, and homes. Spoke with property owner and he indicated that 1997 flood caused damage to his stables	Home and stables	home	low	low	Yes		Early warning	L5		
Casa Loma	215	Casa Loma Road	Flooding affecting barn and outbuilding	Barn and out building	other	low	low	Yes		Early warning	L5		

Note: These results were based upon a rapid review so that as much time as possible was allowed for emergency measures to be put into place before storm events.
This table is part of a broader document and should be used in conjunction with that document to ensure proper implementation of recommendations provided.

Appendix C. Values at Risk

Mountain Home	113	Chual Spur Road at intersection with Casa Loma	Flooding and debris over low water crossing with three 36-inch culverts	Traveling public on low crossing	drainage structure	moderate	low	Yes	261	Storm patrol	L3	-121.80515	37.11477
Mountain Home	115	Casa Loma Road	Flooding and debris affecting home	Home	home	moderate	moderate	Yes	261	Early warning	L3	-121.80337	37.11577
Mountain Home	119	Casa Loma Road	Flood affecting home	Home	home	moderate	moderate	Yes		Early warning	L3	-121.79749	37.12064
Mountain Home	122	Casa Loma	Flooding, affecting home on margin of creek; also steep slope above road may issue debris on to home	Home and access bridge	home	moderate	moderate	Yes		Early warning	L3	-121.79566	37.12308
Mountain Home	125	Casa Loma Road	Flooding affecting home on margin of creek, several out building also on property; homeowner indicated high flows about 7 years prior	Home	home	moderate	moderate	Yes		Early warning	L3	-121.79655	37.12794
Mountain Home	126	Casa Loma Road	Flooding affecting home on margin of creek, access bridge, and propane tank	Home	home	moderate	moderate	Yes		Early warning	L2	-121.79526	37.13100
Mountain Home	143	Casa Loma Road	Flooding affecting home on side of creek	Home	home	moderate	moderate	Yes		Early warning, sand bags between house and creek	L2	-121.77381	37.14779
Casa Loma	146	Casa Loma Road	Flooding affecting home on margin of creek	Home	home	moderate	moderate	Yes		Early warning, sandbagging along creek side, muscle wall	L5	-121.76983	37.14818
Mountain Home	204	Casa Loma Road	Flooding on Casa Loma Road	Road, traveling public	other	moderate	low	Yes		Storm patrol, early warning	L3		
Mountain Home	205	Casa Loma Road	Flooding	Road, traveling public	other	moderate	low	Yes		Storm patrol	L3		
Mountain Home	206	Casa Loma Road	Flooding affecting road	Road and traveling public	other	moderate	moderate	Yes		Storm patrol	L3		
Mountain Home	207	Casa Loma Road	Flood affecting roadway and traveling public	Traveling public	other	moderate	low	Yes	143	Storm patrol	L3		
Mountain Home	112	Casa Loma Road	Flooding and debris impacting bridge	Wood bridge access road to trailer	drainage structure	low	moderate	Yes	261	Storm Patrol	L3	-121.80533	37.11461
Casa Loma	147	Casa Loma Road	Flooding affecting bridge and access to home	Bridge	drainage structure	low	low	Yes		Storm patrol	L5	-121.75511	37.14908
Mountain Home	120	Casa Loma Road	Bridge crossing entering home	Bridge	drainage structure	moderate	moderate	Yes		Early warning, Storm patrol	L3	-121.79727	37.12053
Casa Loma	216	Uvas Road	Flooding affecting home and out buildings, homeowner stated that flooding has gone overbank	Home	home	moderate	moderate	Yes		Early waning, channel veg clearance near bridge	L5		
Chual	111	Chual spur Road	Debris flow at culvert crossing, two 24-inch culverts	Road	drainage structure	low	moderate		259	Storm patrol	L3	-121.80729	37.11715
Cutting Edge Ranch	150	Uvas Road	Flooding affecting bridge to ranch, bridge has center support, with 1.5 feet of scour around base	Bridge	drainage structure	moderate	moderate	Yes		Storm patrol, brush clearance up and down stream	L5	-121.74306	37.14847
Lower Uvas	210	Croy Road	Flooding affecting lower home and water tank with pump system, spokewith the homeowner about the hazard, she stated that flooding has occurred before around the lower building.	Home and water	home	high	high	Yes		Early warning and sandbags to protect lower home and water tank	U3		
Lower uvas	211	Uvas Road	Flooding affecting warehouse and shed	Warehouse and shop	other	low	moderate	Yes		Early warning	U3		
Lower Uvas	142	Croy Road	Flooding affecting home	Home	home	low	low			Early warning		-121.73522	37.10205

Note: These results were based upon a rapid review so that as much time as possible was allowed for emergency measures to be put into place before storm events.
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Appendix C. Values at Risk

Rancho Canada Del Oro Open Space District	212	Casa Loma Road	Flooding affecting parking area and trail	Parking lot and trail	recreational	low	low	Yes		Close parking and trail access, Storm patrol	L4		
Silver Oaks Ranch	141	Croy Road	Flooding affecting home, spoke with homeowner, past floods have reached to near building foundation.	Home	home	low	low	Yes		Early warning	U3	-121.74096	37.09708
Silver Oaks Ranch	209	Croy Road	Flooding affecting Ostritch range building and other out buildings in polygon area	Home, ranch building and out building	home	low	low	Yes		Early warning	U3		
South of sveadal	134	Cherlin house	Flooding affecting home on outside channel bend. Rock barrier was previously built to protect home	Home	home	high	high	Yes		Early warning	U3	-121.78343	37.08420
South of Sveadal	136	Intersection of Lady Bug and Croy Road	Flooding affecting small building structure	Home	home	low	low	Yes		Early warning, sand bags to protect	U3	-121.77858	37.08450
South of Sveadal	137	Croy Road	Flooding affecting bridge	Bridge	drainage structure	low	low	Yes		Storm patrol	U3	-121.75970	37.08655
South of Sveadal	138	Croy Road Unknown address	Flooding affecting camper	Camper	other	low	low	Yes		Early warning	U3	-121.75267	37.09017
South of Sveadal	139	Croy Road	Flooding affecting home	Home	home	low	low	Yes		Early warning, sand bags along margin of home	U3	-121.75111	37.09000
South of Sveadal	140	Croy Road	Flooding affecting trailer near channel margin, flood in 1986 went over bank	Trailer	home	moderate	moderate	Yes		Early warning, relocate trailer	U3	-121.74681	37.09144
South of Sveadal	135	Lady Bug Road	Flooding affecting bridge. Intense scour and. Undercutting. Observed on upstream right bank abutment	Bridge	drainage structure	moderate	moderate	Yes		Storm patrol	U3	-121.77934	37.08441
Sveadal	128	Krueger cabin	Flooding affecting home and foot bridge access to home	Home and Foot Bridge	home	moderate	moderate	Yes		Early warning	U3	-121.78847	37.08496
Sveadal	133	Near cabin C34	Flooding affecting bridge	Bridge	drainage structure	moderate	moderate	Yes		Early warning, Storm patrol	U3	-121.78544	37.08497
Sveadal	208		Flooding affecting picnic area	Picnic areas	recreational	moderate	low	Yes		Early warning and closure during storms	U3		
Sveadal	129	Footbridge to gazebo	Flooding affecting footbridge access to residence	Footbridge	other	moderate	moderate	Yes		Early warning	U3	-121.78802	37.08463
Sveadal	130	Valhalla House	Flooding affecting footbridge	Footbridge and trail network	other	moderate	moderate	Yes		Early warning	U3	-121.78727	37.08417
Sveadal	131	Vestbo cabin	Flooding affecting home	Home	home	moderate	moderate	Yes		Sand bags along margin of home near creek, early warning	U3	-121.78641	37.08474
Sveadal	132	Bridge near Vespa house	Flooding and debris at constriction on upstream side of bridge	Bridge	drainage structure	moderate	moderate	Yes		Storm patrol, early warning	U3	-121.78637	37.08477
Twin falls	202	Twin falls Road	Fallen logs left in creek							Remove logs	L2		
Twin Falls	104	Twin Falls Road	Debris flow, barn and other out buildings, parking area with cars	Barn, outbuildings, cars	home	high	high	Yes		Early warning	L2	-121.79782	37.13281
Twin Falls	105	Twin Falls Road	Road crossing swale with plugged 12 -inch CMP	Access road to home, embankment	drainage structure	low	low	Yes	94	Storm patrol, clean out CMP, t-posts	L2	-121.79975	37.13412
Twin Falls	108	Twin Falls Road	Flooding and debris, 48-inch CMP, potential crossing failure,	Culvert crossing	drainage structure	low	moderate		136	Storm patrol	L2	-121.80838	37.12845
Twin Falls	109	Twin Falls Road	Debris flow at culvert crossing	Culvert crossing	drainage structure	low	moderate		140	Storm patrol, tposts	L2	-121.81544	37.12516
Twin Falls	110	Twin Falls Road	Debris flow at road crossing	Road	drainage structure	low	moderate		140	Storm patrol	L2	-121.81008	37.12716
Twin Falls	107	Twin Falls Road	Flooding, debris blocking 36-inch CMP	Road crossing drainage	drainage structure	moderate	moderate	Yes		Storm patrol	L2	-121.80188	37.13287

Note: These results were based upon a rapid review so that as much time as possible was allowed for emergency measures to be put into place before storm events.
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Appendix C. Values at Risk

Twin falls	201	Twin Falls Road	Debris flow an flooding at confluence	Road, traveling public	other	moderate	low	Yes		Storm patrol	L2		
Twin Falls Road	106	Twin Falls Road	Debris flow and flooding, wood bridge	Bridge	drainage structure	moderate	high	Yes		Storm patrol	L2	-121.80194	37.13331
Uvas County Park	127	Croy Road	Flooding on Uvas Creek trail network, spoke with park maintenance about closing trail during rain storms	Public during recreational use of trail	recreational	high	no	Yes		Closure of trail during storms	U3	-121.79520	37.08621
	217	Uvas Road	Flooding affecting several homes and out buildings, spoke with homeowner about hazard	Homes and out buildings	home	low	low	Yes		Early warning	L5		

General Recommendations

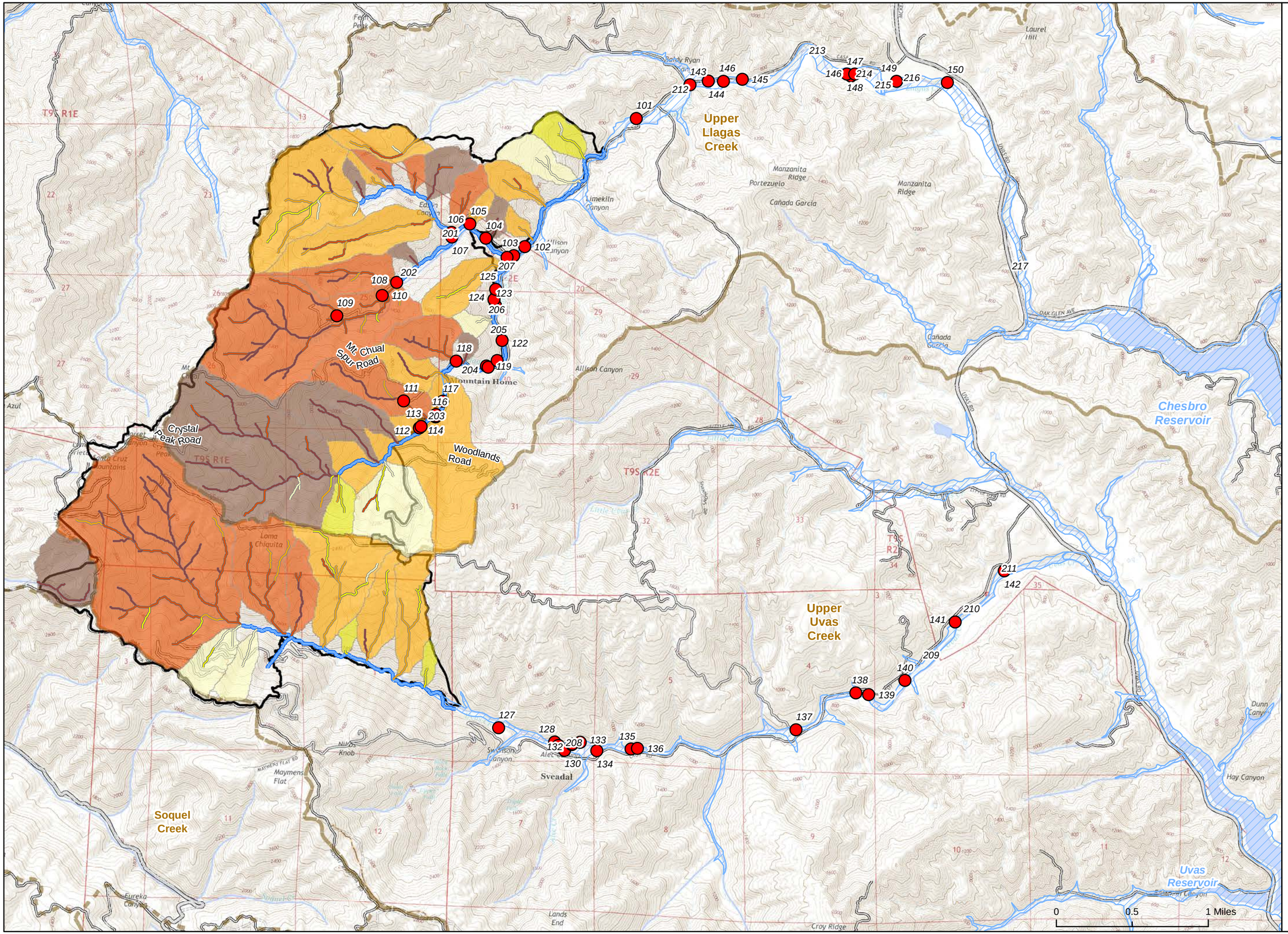
1	Utilize early warning systems available to homeowners.
2	Perform storm patrols and monitor road drainage infrastructure.
3	Close recreational trail access during storm events.
4	Improve drainage to unimproved roads.
5	Remove vegetation and loose woody debris around drainage structures and bridges.
6	Utilize structure protection such as sand bags, K-rails, and Muscle Wall where appropriate.
7	Refer to temporary housing guidence in General Recommendations section of report

* Shaded areas refer to polygons

Note: These results were based upon a rapid review so that as much time as possible was allowed for emergency measures to be put into place before storm events.
This table is part of a broader document and should be used in conjunction with that document to ensure proper implementation of recommendations provided.

Appendix D
Values at Risk Map

Loma Incident
CA-SCU-006912



Legend

- Loma Fire Perimeter
- Roads
- HUC 12 Watershed Boundary
- Values at Risk-Points
- Values at Risk Polygons
- USGS Watch Stream
- FEMA Flood Zone & DWR Awareness Floodplain

Basin Debris Flow Prediction 15 min 24 mmh

- 0-20%
- 20-40%
- 40-60%
- 60-80%
- 80-100%

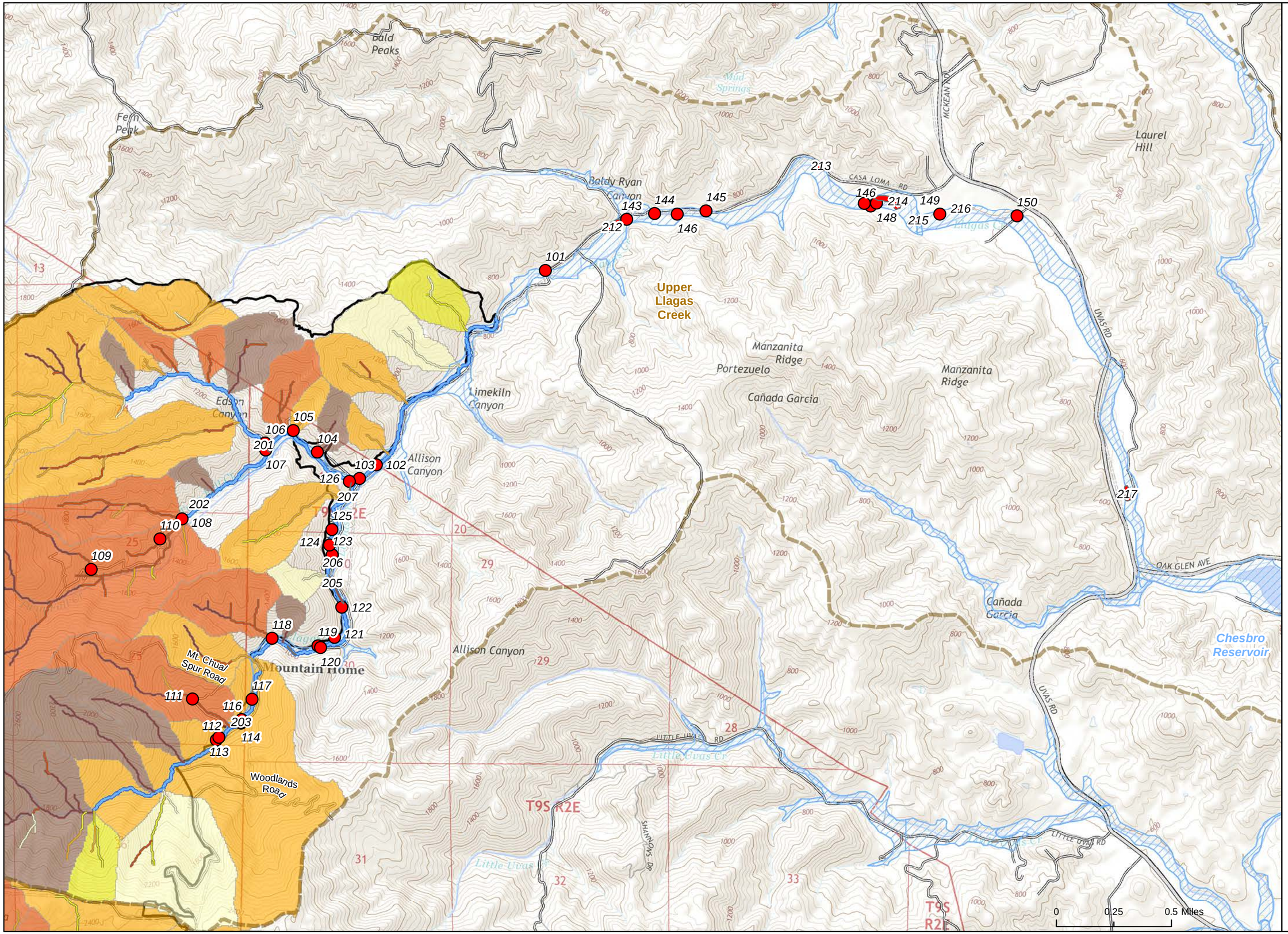
Segment Debris Flow Prediction 15 min 24 mmh

- 0-20%
- 20-40%
- 40-60%
- 60-80%
- 80-100%

Appendix D

Values at Risk Map Upper Llagas Watershed

Loma Incident
CA-SCU-006912



Legend

- Loma Fire Perimeter
- Roads
- HUC 12 Watershed Boundary
- Values at Risk-Points
- Values at Risk Polygons
- USGS Watch Stream
- FEMA Flood Zone & DWR Awareness Floodplain

Basin Debris Flow Prediction 15 min 24 mmh

- 0-20%
- 20-40%
- 40-60%
- 60-80%
- 80-100%

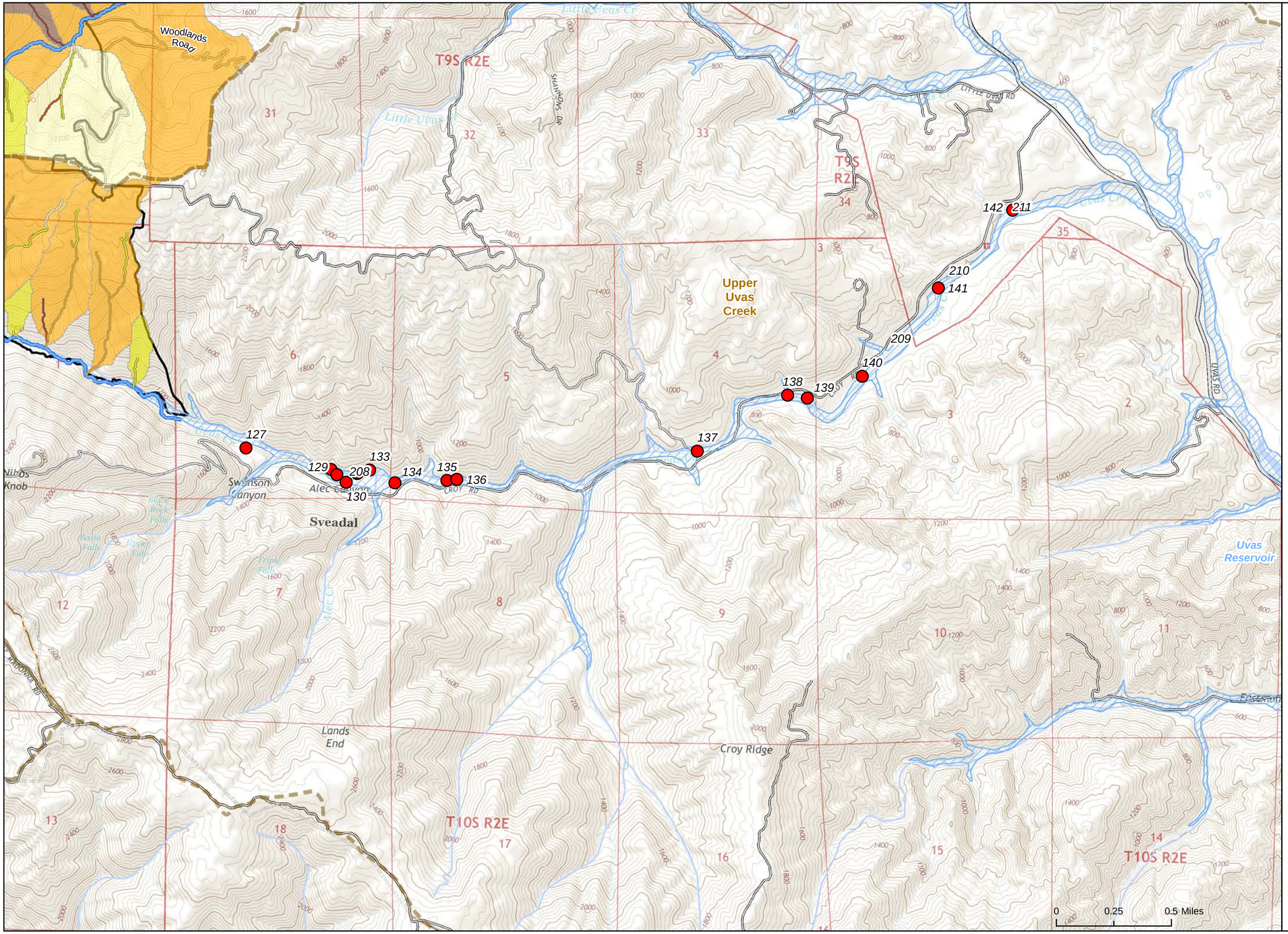
Segment Debris Flow Prediction 15 min 24 mmh

- 0-20%
- 20-40%
- 40-60%
- 60-80%
- 80-100%

Appendix D

Values at Risk Map Upper Uvas Watershed

Loma Incident
CA-SCU-006912



Legend

- Loma Fire Perimeter
- Roads
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Basin Debris Flow Prediction 15 min 24 mmh

- 0-20%
- 20-40%
- 40-60%
- 60-80%
- 80-100%

Segment Debris Flow Prediction 15 min 24 mmh

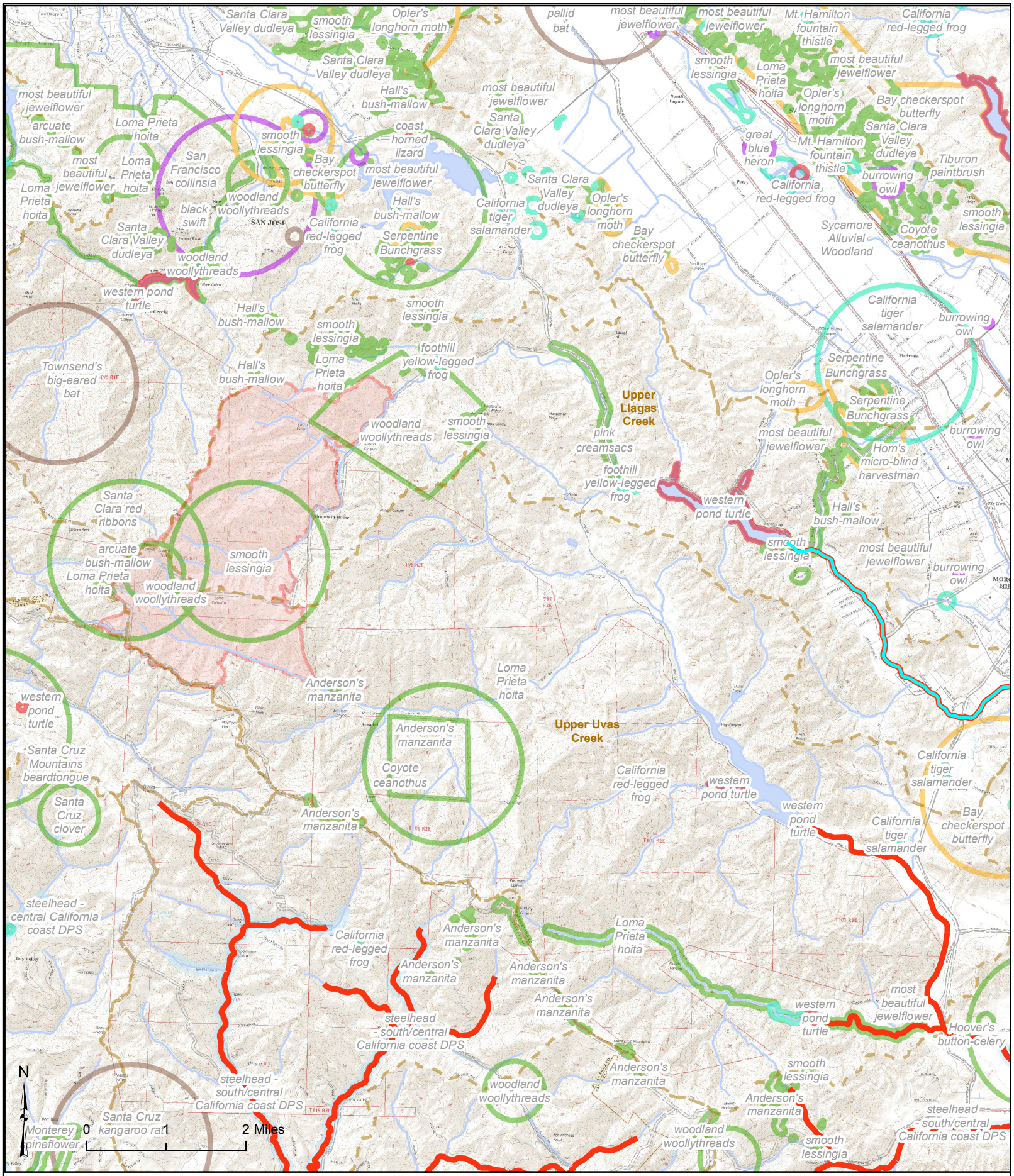
- 0-20%
- 20-40%
- 40-60%
- 60-80%
- 80-100%

Appendix E
Loma Fire Special Status Species List

SCIENTIFIC NAME	COMMON NAME	COUNTY	FEDERAL STATUS	STATE STATUS	CDFW Status	RARE PLANT RANK
Mammals						
Taxidea taxus	American badger	SCR	None	None	SSC	
Lasiurus cinereus	hoary bat	SCL	None	None		
Antrozous pallidus	pallid bat	SCR	None	None	SSC	
Neotoma fuscipes annectens	San Francisco dusky-footed woodrat	SCL	None	None	SSC	
Dipodomys venustus venustus	Santa Cruz kangaroo rat	SCR	None	None		
Corynorhinus townsendii	Townsend's big-eared bat	SCL	None	Candidate Threatened	SSC	
Myotis yumanensis	Yuma myotis	SCL	None	None		
Vulpes macrotis mutica	San Joaquin kit fox	SCL	Endangered	Threatened		
Fish						
Oncorhynchus mykiss irideus	steelhead - central California coast DPS	SCR	Threatened	None		
Oncorhynchus mykiss irideus	steelhead - south-central California coast DPS	SCL	Threatened	None		
North Central Coast Drainage Sacramento Sucker/Roach River	North Central Coast Drainage Sacramento Sucker/Roach River	SCR	None	None		
Birds						
Riparia riparia	bank swallow	SCR	None	Threatened		
Cypseloides niger	black swift	SCL	None	None	SSC	
Athene cunicularia	burrowing owl	SCL	None	None	SSC	
Accipiter cooperii	Cooper's hawk	SCR	None	None	WL	
Aquila chrysaetos	golden eagle	SCL	None	None	FP; WL	
Ardea herodias	great blue heron	SCL	None	None		
Pandion haliaetus	osprey	SCL	None	None	WL	
Charadrius alexandrinus nivosus	western snowy plover	SCR	Threatened	None	SSC	
Progne subis	purple martin	SCL	None	None	SSC	
Buteo swainsoni	Swainson's hawk	SCL	None	Threatened		
Amphibians						
Aneides niger	Santa Cruz black salamander	SCL	None	None	SSC	
Ambystoma macrodactylum croceum	Santa Cruz long-toed salamander	SCR	Endangered	Endangered	FP	
Rana boylii	foothill yellow-legged frog	SCR	None	None	SSC	
Ambystoma californiense	California tiger salamander	SCL	Threatened	Threatened	WL	
Rana draytonii	California red-legged frog	SCL	Threatened	None	SSC	
Dicamptodon ensatus	California giant salamander	SCR	None	None	SSC	
Crustacean						
Linderiella occidentalis	California linderiella	SCR	None	None		
Reptiles						
Anniella pulchra nigra	black legless lizard	SCR	None	None	SSC	
Phrynosoma blainvillii	coast horned lizard	SCL	None	None	SSC	
Emys marmorata	western pond turtle	SCR	None	None	SSC	
Insects						
Cicindela ohlone	Ohlone tiger beetle	SCR	Endangered	None		
Bombus caliginosus	obscure bumble bee	SCL	None	None		
Bombus occidentalis	western bumble bee	SCR	None	None		
Adela oplerella	Opler's longhorn moth	SCL	None	None		
Euphydryas editha bayensis	Bay checkerspot butterfly	SCL	Threatened	None		
Danaus plexippus pop. 1	monarch - California overwintering population	SCR	None	None		
Trimerotropis infantilis	Zayante band-winged grasshopper	SCL	Endangered	None		
Microcina homi	Hom's micro-blind harvestman	SCL	None	None		

Appendix E
Loma Fire Special Status Species List

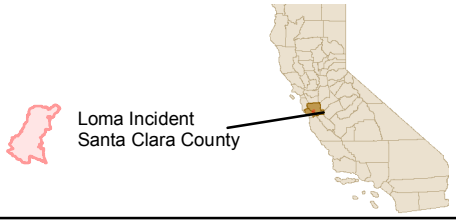
Botanical Species						
Serpentine Bunchgrass	Serpentine Bunchgrass	SCL	None	None		
Plagiobothrys glaber	hairless popcornflower	SCL	None	None		1A
Chorizanthe pungens var. hartwegiana	Ben Lomond spineflower	SCR	Endangered	None		1B.1
Centromadia parryi ssp. congdonii	Congdon's tarplant	SCR	None	None		1B.1
Ceanothus ferrisiae	Coyote ceanothus	SCL	Endangered	None		1B.1
Eryngium aristulatum var. hooveri	Hoover's button-celery	SCL	None	None		1B.1
Horkelia cuneata var. sericea	Kellogg's horkelia	SCR	None	None		1B.1
Hoita strobilina	Loma Prieta hoita	SCL	None	None		1B.1
Streptanthus albidus ssp. albidus	Metcalf Canyon jewelflower	SCL	Endangered	None		1B.1
Arctostaphylos pajaroensis	Pajaro manzanita	SCR	None	None		1B.1
Chorizanthe robusta var. robusta	robust spineflower	SCL	Endangered	None		1B.1
Plagiobothrys diffusus	San Francisco popcornflower	SCR	None	Endangered		1B.1
Dudleya abramsii ssp. setchellii	Santa Clara Valley dudleya	SCL	Endangered	None		1B.1
Trifolium buckwestiorum	Santa Cruz clover	SCR	None	None		1B.1
Calyptridium parryi var. hesseae	Santa Cruz Mountains pussypaws	SCL	None	None		1B.1
Holocarpha macradenia	Santa Cruz tarplant	SCR	Threatened	Endangered		1B.1
Erysimum teretifolium	Santa Cruz wallflower	SCR	Endangered	Endangered		1B.1
Polygonum hickmanii	Scotts Valley polygonum	SCR	Endangered	Endangered		1B.1
Chorizanthe robusta var. hartwegii	Scotts Valley spineflower	SCR	Endangered	None		1B.1
Pentachaeta bellidiflora	white-rayed pentachaeta	SCR	Endangered	Endangered		1B.1
Arctostaphylos andersonii	Anderson's manzanita	SCR	None	None		1B.2
Malacothamnus arcuatus	arcuate bush-mallow	SCL	None	None		1B.2
Amsinckia lunaris	bent-flowered fiddleneck	SCR	None	None		1B.2
Arctostaphylos silvicola	Bonny Doon manzanita	SCR	None	None		1B.2
Plagiobothrys chorisianus var. chorisianus	Choris' popcornflower	SCR	None	None		1B.2
Plagiobothrys chorisianus var. chorisianus	Choris' popcornflower	SCR	None	None		1B.2
Pedicularis dudleyi	Dudley's lousewort	SCR	None	Rare		1B.2
Fritillaria liliacea	fragrant fritillary	SBT	None	None		1B.2
Malacothamnus hallii	Hall's bush-mallow	SCL	None	None		1B.2
Arctostaphylos hookeri ssp. hookeri	Hooker's manzanita	SCR	None	None		1B.2
Fissidens pauperculus	minute pocket moss	SCR	None	None		1B.2
Chorizanthe pungens var. pungens	Monterey spineflower	SCR	Threatened	None		1B.2
Streptanthus albidus ssp. peramoenus	most beautiful jewelflower	SCL	None	None		1B.2
Cirsium fontinale var. campylon	Mt. Hamilton fountain thistle	SCL	None	None		1B.2
Monardella sinuata ssp. nigrescens	northern curly-leaved monardella	SCR	None	None		1B.2
Lasthenia californica ssp. macrantha	perennial goldfields	SCR	None	None		1B.2
Castilleja rubicundula var. rubicundula	pink creamsacs	SCL	None	None		1B.2
Collinsia multicolor	San Francisco collinsia	SCL	None	None		1B.2
Erysimum ammophilum	sand-loving wallflower	SCR	None	None		1B.2
Penstemon rattanii var. kleei	Santa Cruz Mountains beardtongue	SCR	None	None		1B.2
Lessingia micradenia var. glabrata	smooth lessingia	SCL	None	None		1B.2
Castilleja affinis var. neglecta	Tiburon paintbrush	SCL	Endangered	Threatened		1B.2
Monolopia gracilens	woodland woollythreads	SCL	None	None		1B.2
Carex comosa	bristly sedge	SCR	None	None		2B.1
FP = Fully Protected						
WL = Watch List						

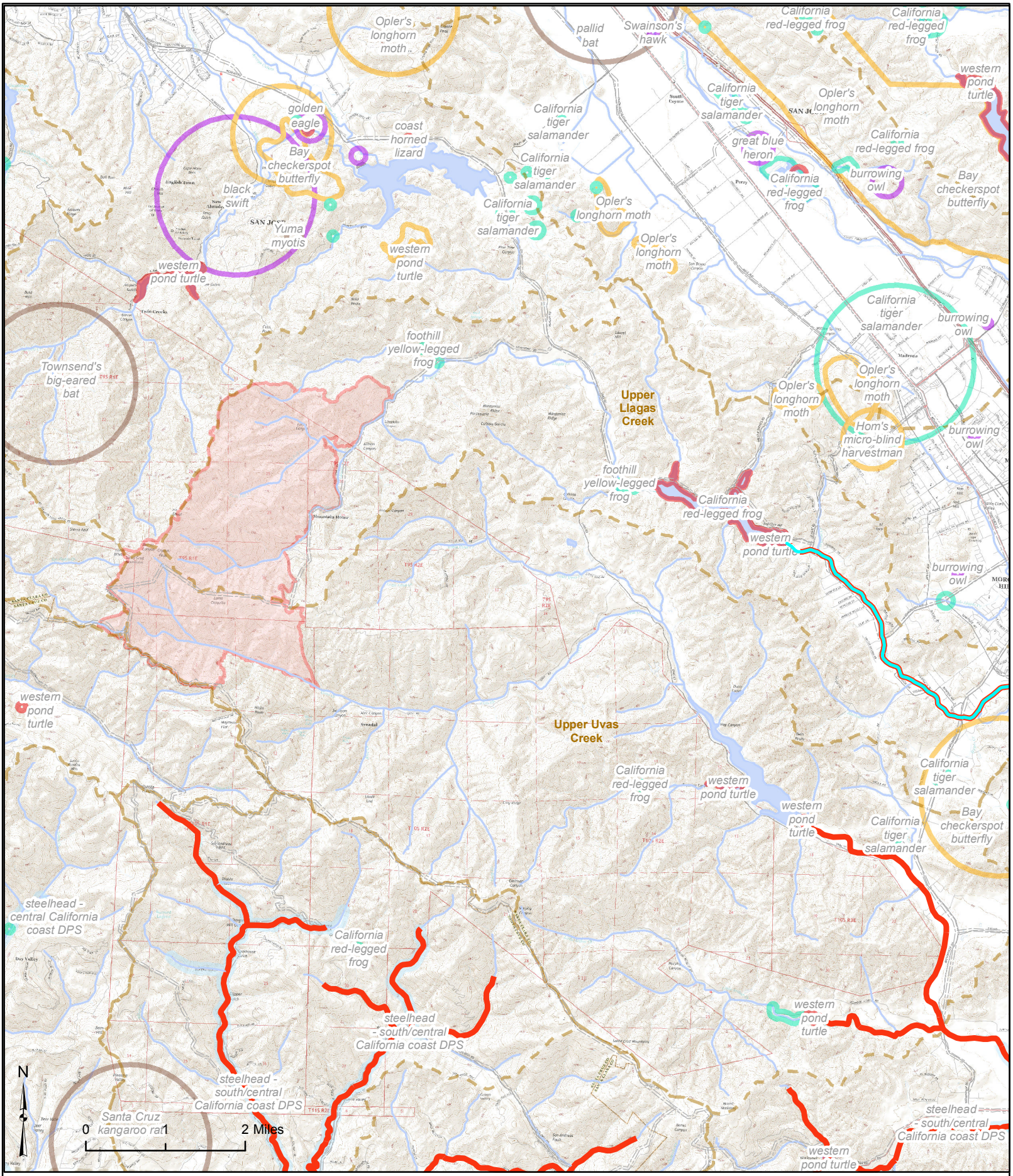


Loma Fire Perimeter
Mammal
Bird
Fish
Plant
HUC 12 Watershed Level
Amphibian
Reptile
Insect

Appendix E
Biologic Map

Loma Incident
CA-SCU-006912





Loma Fire Perimeter
Mammal
Bird
Fish
HUC 12 Watershed Level
Amphibian
Reptile
Insect

Appendix E
Biologic Map
(Without Botany)
Loma Incident
CA-SCU-006912

Loma Incident
Santa Clara County