S

Forest Service
U.S. DEPARTMENT OF AGRICULTURE

San Bernardino National Forest | November 2024

Line Fire Burned Area Summary

Burned Area Report

Fire Background

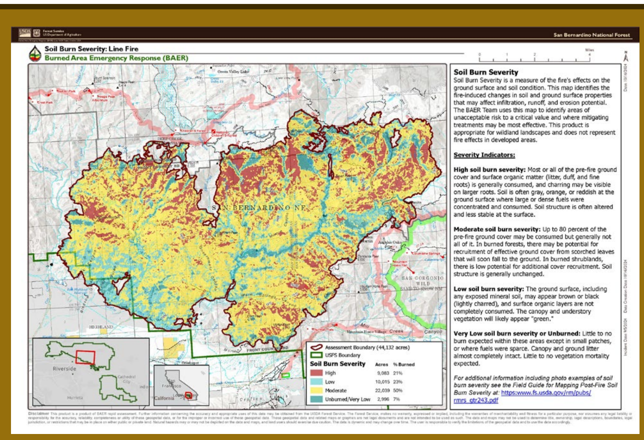
Forest Service firefighters along with firefighters from other agencies including the City of Highland and San Bernardino County responded to a reported wildland fire on Baseline Road on September 5, 2024. Arriving fire engines reported several acres on fire, and immediately requested more resources, including multiple additional fixed wing aircraft and helicopters.

The Line Fire prompted evacuation orders, road closures, and threatened structures, homes, critical infrastructure, endangered species, watersheds, and cultural and heritage resources. Continued high temperatures throughout the day and night, dry conditions, and strong winds increased the intensity and spread of the fire, causing imminent threat to life, with an excessive heat warning to be issued by the National Weather Service. On September 7, the State of California declared the fire to be a State of Emergency.

On September 11, the fire was mapped at just under 37,000 acres. Fire activity decreased, with modest growth of a few hundred acres per day until September 29, when a second period of increased fire behavior and significant fire growth began, burning an additional 4,900 acres on the north and east sides of the Line Fire.

While many wildfires cause minimal damage to the land and pose few threats to the land or people downstream, some fires result in damage that requires special efforts to reduce impacts afterwards. The Burned Area Emergency Response (BAER) program is designed to identify and manage potential risks to resources on National Forest System lands and reduce these threats through appropriate emergency measures to protect human life and safety, property, and critical natural or cultural resources. BAER is an emergency program for stabilization work that involves time critical activities to be completed before damaging events to meet program objectives.

The Forest Service assembled a BAER team on September 21 for the Line Fire. This team of experts in various resource disciplines began assessing the post-fire effects to critical values on Forest Service lands. Impacts to the soil are the primary indicator of potential post-fire changes in watershed response, as well as watershed recovery. The team developed soil burn severity (SBS) maps to document the degree to which the fires had changed soil properties. Using the SBS map, physical scientists can predict erosion potential, changes to runoff and flood flows, and increased geologic hazards. Field evaluations and modeling results are used to determine relative increases in post-fire risk to different critical values and inform recommendations to address these increased risks.



Line Post-Fire Soil Burn Severity Map

Soils

Soil burn severity is not an assessment of vegetation consumption, but rather an integration of vegetation loss, changes in soil structure and infiltration capacity, remaining vegetation, duff, or ash, and soil color, all of which may indicate relative degrees of soil heating.

The final soil burn severity maps were developed with ESRI ArcGIS software using satellite-imagery-derived Burned Area Reflectance Classification (BARC) and field survey data. Field work included assessment of ash characteristics, ground cover, root condition, soil structure, soil water-repellency, and vegetation burn severity as described in the Field Guide for Mapping Post-fire Soil Burn Severity (Parsons et al. 2010). High burn severity is characterized by a complete consumption of organic material with the surface layers of the soil resulting in a change to single-grain structure. Fine roots are commonly charred or consumed 3-5 cm deep. The highest-severity areas often have a loose, dusty appearance, and no longer have any cohesion or soil strength. Generally, there will be less destruction of soil organic matter, roots, and structure in an area mapped as moderate compared to high. In areas mapped as moderate SBS, soil structure, roots, and litter layer may remain intact beneath a thin ash layer. Low soil burn severity results in very little alteration of soil organic matter and little or no change in soil structural stability.

Mapped and validated SBS for the burned area is High (21%), Moderate (50%), Low (23%), and Very Low/Unburned (7%) (see map on pages 1 and 7). The more severe a fire's effects are on the soil, the more likely those soils will erode in subsequent rainstorms – especially in locations with steep slopes. Erosion after fires can cause tremendous damage to homes and other structures in the years after a fire.

Geology

The team identified the geologic conditions and processes that have shaped and altered the watersheds and landscapes and assessed the impacts from the fire on those conditions and processes that could affect downstream critical values. Using the understanding of rock types and characteristics, geomorphic processes, and distribution of geologic hazards helps predict how the watersheds will respond to and be impacted by upcoming storms.

The Line Fire occurred in the San Bernardino Mountain Range, which is dominated by extremely steep and rugged terrain dissected by many, sometimes deep drainages such as the Santa Ana River and Hemlock Creek. The San Bernardino Mountains are some of the most tectonically active and rapidly uplifting mountains in the United States. The forces lifting the mountains are being countered by opposing forces tearing them down. The rock-types present are generally old and deeply weathered, making the mobility of material at the surface very high. The fluvial geomorphic processes shaping these ever-changing mountains include landsliding of various types, rock-fall, dry ravel, sheet, rill, and wind erosion, flooding and debris flows. Bedrock within the Line Fire is dominated by plutonic igneous rocks of various types (Granodiorite, Monzogranite), with smaller inclusions of metamorphosed (gneiss) and sedimentary rock (sandstone). Finally, the bedrock is commonly overlayed by landslide deposits and alluvial fans, some of which are very old (Pleistocene).

The team provided soil burn severity field data to the US Geological Survey Landslide Hazard Program to assist in forecasting the probability, potential volumes, and hazards of debris flows through their developed empirical models using geospatial data related to basin morphometry, soil burn severity, soil properties, and rainfall characteristics to estimate the probability and volume of debris flows that may occur in response to a specific design storm,

The USGS Post-fire Debris Flow Hazard Model uses estimates of probability, volume, and combined hazard are based on a design storm with a peak 15-minute rainfall intensity of 12–40 millimeters per hour (mm/hr). After receiving the Line Fire SBS map, the USGS assessed the fire area that presented debris flow probability of occurrence, predicted volumes, and combined hazard for multiple precipitation events. A design storm with a peak 15-minute rainfall intensity of 28 mm/hr was selected to evaluate debris flow potential and volumes. (See maps on pages 8-11).

Hydrology

Primary watershed response is expected to include an initial flush of ash and burned materials, erosion in drainages and on steep slopes in the burned area, increased peak flows and sediment transport and deposition, and debris flows. Watershed response is dependent on the occurrence of rainstorms and rain-on-snow events and will likely be greatest with initial storm events. Increased watershed response is most likely in areas with high to moderate soil burn severity. Disturbances will become less evident as vegetation is reestablished, providing ground cover that reduces erosion and increases surface roughness which slows flow accumulation and increases infiltration. This will likely lead to increased water quality concerns for municipal and domestic drinking water providers within and downstream of the fire.

A rapid hydrologic assessment that includes the fire's soil burn severity was 50% moderate and 20% high, which leads to an increased hydrologic response including reduced interception and infiltration of precipitation, increased runoff and erosion, higher stream flow volumes for a given precipitation input, and a more rapid rise of stream and river levels compared with those of unburned conditions. The loss of canopy cover, reduction in ground cover, and decreased infiltration rates within areas of moderate and high soil burn severity are expected to result in increased runoff especially during high intensity storm events. This increase can result in short-term water quality degradation as ash and sediment move through the stream system. Modeling indicated that peak flows within analyzed drainages may increase 38% to 597% from pre-fire conditions for the 2-year peak flow.

Peak flow analysis was conducted at 15 pour points using a modified regression equation. Pre-fire peak flow modeling was completed using the USGS StreamStats program which provides peak flow statistics with recurrence intervals of 2-, 5-, 10-, 25-, 50-, 100-, and 200-years. For each of the delineated drainages post-fire peak flow analysis was completed by first calculating the pre-fire discharge rate/surface area unit of measure (cfs/mi^2) for each recurrence interval peak flow. It is assumed that areas with unburned/very low will have similar watershed response to pre-fire conditions. The areas with low, moderate and high soil burn severity are assumed to have a cfs/mi^2 value equivalent to the next return interval peak flow. For example, when modeling response for the 2-year return interval peak flow areas with low SBS are assumed to have a cfs/mi^2 response for a 5-year peak flow, moderate SBS is assumed to have a cfs/mi^2 response for a 10-year peak flow, and high SBS areas are assumed to have the cfs/mi^2 value of a 25-year peak flow.

The table below shows the estimated percent increase for the 2-year peak flow event for each modeled drainage. Overall, smaller basins where a greater amount of the drainage burned as moderate or high severity showed the greatest predicted increase in flows.

Table 6: Modeled flood discharge within the analyzed drainages

Analyzed Drainage	Total Acres	% High and Moderate SBS	Post-fire 2-year peak flow % increase
Alder/Hemlock Confluence	4,543	65%	567%
Bear Creek	56,174	3%	38%
City Creek	12,024	9%	89%
Confluence of Fredalba & Plunge Creeks	4,617	62%	514%
Oak Creek	1,464	58%	336%
Plunge Creek	10,590	63%	551%
Santa Ana River at Crystal Creek	118,476	8%	105%
Schenk Creek	785	73%	422%
Warm Springs Canyon at Santa Ana River	2,280	84%	513%
1N09a	49	86%	291%
1N09b	113	97%	426%
Alder Rd	46	73%	253%
2W04 Trail	3,553	68%	505%
Deer Creek	2,743	74%	597%
Mile Creek	786	61%	537%

Critical Values

The first critical value BAER teams assess is always human life and safety on National Forest System (NFS) lands. During and after heavy rainstorms, Forest Service employees and visitors to NFS lands could be threatened by floodwaters and debris flows. In addition, users of roads within and downstream of the burned areas may be affected by road washouts during and after heavy rainstorms. The National Weather Service can establish an early warning alert plan for areas that are potentially at risk from these events.

For human life and safety mitigations, the BAER team recommends continued fire area closure that includes certain road and trail closures, general warning signs and communications to travelers on any NFS roads and trails within or directly adjacent to the Line Fire.

Roads and Bridges

Roads in and downstream of burned areas are at risk of damage due to post-fire conditions. The most likely threat due to the fires is clogging of culverts, bridges, and other in-channel infrastructure from the higher levels of floatable debris (especially burned trees) in burned watersheds. Once blocked by debris, road drainage structures no longer function and the stream flows over the road, often causing considerable damage and limiting access. Various measures can reduce this risk, including protecting culvert inlets with debris racks, removing large floatable debris from channels upstream of structures before floods, and making heavy equipment available and readily mobilized during storm events to keep structures clear of debris.

Debris flows are less likely than debris-laden flood flows, but they pose a greater threat to roads when they do occur and are difficult to mitigate.

Critical values addressed in the BAER report include National Forest System (NFS) roads and related drainage features. Treatments for the protection of these roads include storm-proofing, storm response, culvert removal, and new road drainage features (rolling dips, critical dips, and super dips).

Recreation

National Forest System recreation infrastructure includes campgrounds, trails, and day use areas. Like roads, recreation infrastructure could be damaged in post-fire storm events.

Most of the recreation assets within the Line Fire burned area relate to trails. There are about 28 miles of Forest Service System trails – all non-motorized within the fire perimeter. Some of these important trails are the Siberia Creek Trail (National Recreation, special designation) and the Santa Ana River Trail (Silver Medal International Mountain Bicycling Association (IMBA) Awarded).

The team proposes trail drainage stabilization (storm-proofing) treatments, which include armoring and/or cleaning existing water control features and adding additional drainage features to provide additional capacity for elevated sediment laden post-fire runoff.

Additional recreational sites of concern include Clarks Ranch yellow post sites (with minimal infrastructure – just fire rings and flattened areas), which is a popular dispersed recreation area for camping, hiking, day trips, hunting, etc. The BAER team recommended an area and road closure of fire area until the hillslopes have stabilized and watershed response has diminished.

Botany

Invasive plants adversely affect native plant communities through allelopathy (suppression of growth of a native plant by release of a toxin from a nearby invasive plant) and direct competition for water and resources. Over time, native plant diversity decreases as invasive plants expand, reducing habitat for native plant species and wildlife. Shifts from diverse native plant communities to non-native invasive plant dominance could alter future fire behavior, intensity, extent, and season of burning.

Current infestations are primarily located along roads, old dozer lines, campgrounds, and trails throughout the burned area, with interior areas being largely un-infested. However, the burned area creates conditions for invasive species to outcompete native plants. The team recommends a treatment of Early Detection, Rapid Response (EDRR) to monitor for noxious weed infestation and expansion in areas disturbed due to mechanical suppression activity and burned areas prone to new noxious weed infestations.

Cultural Resources

The most typical post-fire threats to cultural sites are physical threats such as erosion or damage from (now dead) falling trees. In some cases, newly exposed artifacts are threatened by human damaging activities such as looting or vandalism. Cultural resources were evaluated by the team and treatments proposed as necessary to protect these values from post-fire threats.

Hazardous Materials

Two Forest Service facilities were identified in the Line Fire footprint that potentially could expose the recreating public and FS employees to hazardous materials (hazmat) include the Keller Peak Lookout, and the Morton Peak Lookout restroom. The BAER team recommends area closures and install or repair gates to restrict access.

Federally Listed Species Habitat - Wildlife and Fisheries

The Line Fire is within the current range of the Mountain Yellow-Legged Frog. Threats include long-term habitat degradation and loss due to debris flows, flooding, sediment, scouring of streams, human disturbance, non-native species introduction, and the cumulative effects of these potential threats.

Potential threats to Southwestern Willow Flycatcher, Least Bell's Vireo, Coastal California Gnatcatcher, and San Bernardino Kangaroo Rat habitat include long-term habitat loss and type conversion due to debris flows, flooding, sediment, scouring of streams, impacts to seedbank and natural recovery, human disturbance, OHV incursions, and non-native species introduction.

Anticipated Vegetation Recovery

Post-fire recovery varies greatly based on climate, vegetation types and burn severity. It is typical for recovery to take between 3-5 years for reestablishment of ground cover. The persistence of drought in the years following wildfires also delays the recovery time frame. Even with only a short period of time since fire containment, resprouting of trees and shrubs as well as emergence of forbs have been noted within the burned area.

Non-Forest Service Values

Since fire effects know no administrative boundaries, additional threats exist for assets not owned or managed by the Forest Service. Post-fire emergency response is a shared responsibility. There are several Federal, State, and local agencies that have emergency response responsibilities or authorities in the post-fire environment. The BAER team and local unit BAER Coordinator has engaged with interagency partners to facilitate consideration of off-Forest values covered through other programs with the relevant responsible entities.

Partner Agency Contacts:

John Woessner, CalFire-WERT

Drew Coe, CalFire-WERT
Don Lindsay, CA Geological Survey-WERT
Kevin Callahan, CA Geological Survey-WERT
Michael Fam, San Bernardino County Public Works
Marc Rodabaugh, San Bernardino Co Public Works
Crisanta Gonzalez, San Bernardino County OES
Phuong Woolery, NRCS-District Conservationist
Eduardo Gamez, NRCS-Area Engineer
Ilima Segoviano, NRCS-Area Engineer
Alex Tardy, NOAA NWS-San Diego
Jayme Laber, NOAA NWS-LA Oxnard

Conclusion

There are multiple phases of post-fire actions after a wildfire covering suppression repair through long-term recovery. BAER is the rapid assessment of burned watersheds by a BAER team to identify imminent post-wildfire threats to human life and safety, property, and critical natural or cultural resources on National Forest System lands and take immediate actions to implement emergency stabilization measures before the first major storms. The BAER team has identified imminent threats to critical values based on a rapid assessment of the area burned by the Line Fire. The assessment was conducted using the best available methods to analyze the potential for damage from post-fire threats, including flooding and debris flows. The findings provide the information needed to prepare and protect National Forest System critical values against post-fire threats. The recommended BAER treatments in this report have been approved or funded. Implementation of the treatments is currently underway.

BAER treatments cannot prevent all the potential flooding or soil erosion impacts. It is important for the public to stay informed and be prepared for potentially dangerous run-off events. Many burned-area watersheds were already hydrologically responsive to rainfall and prone to erosion and sediment transport prior to the fire and will likely be even more responsive due to post-fire conditions. However, vegetation recovery is anticipated to be rapid with ground cover approaching pre-fire conditions within 1-3 years, which will attenuate post-fire effects on watershed processes. The Forest Service will continue to provide information and participate in interagency efforts to address threats to public and private values resulting from the Line Fire. Information can be found on-line at Cabdf Southern California Postfire Baer 2024 Information | InciWeb.

The Forest Service will continue to work towards long-term recovery of the burned area in coordination with efforts to rebuild and restore the communities affected. A vegetation burn severity map, or mortality map, has been produced as a part of the recovery efforts to help other scientists, such as wildlife biologists, botanists, and silviculturists understand what to expect from this changed landscape.

Local Forest Service Leadership

Danelle Harrison, Forest Supervisor,
danelle.harrison@usda.gov
Nicolas (Jamahl) Butler, Deputy Forest Supervisor,
nicholas.j.butler@usda.gov
Mike Nobles Acting District Ranger,
michael.nobles@usda.gov
Mike Ho, Acting District Ranger,
michael.ho@usda.gov
AnnaMarie Santana, San Jacinto District Ranger,
annamarie.santana@usda.gov

Local Forest Service BAER Coordinator

Noel Ludwig, noel.ludwig@usda.gov

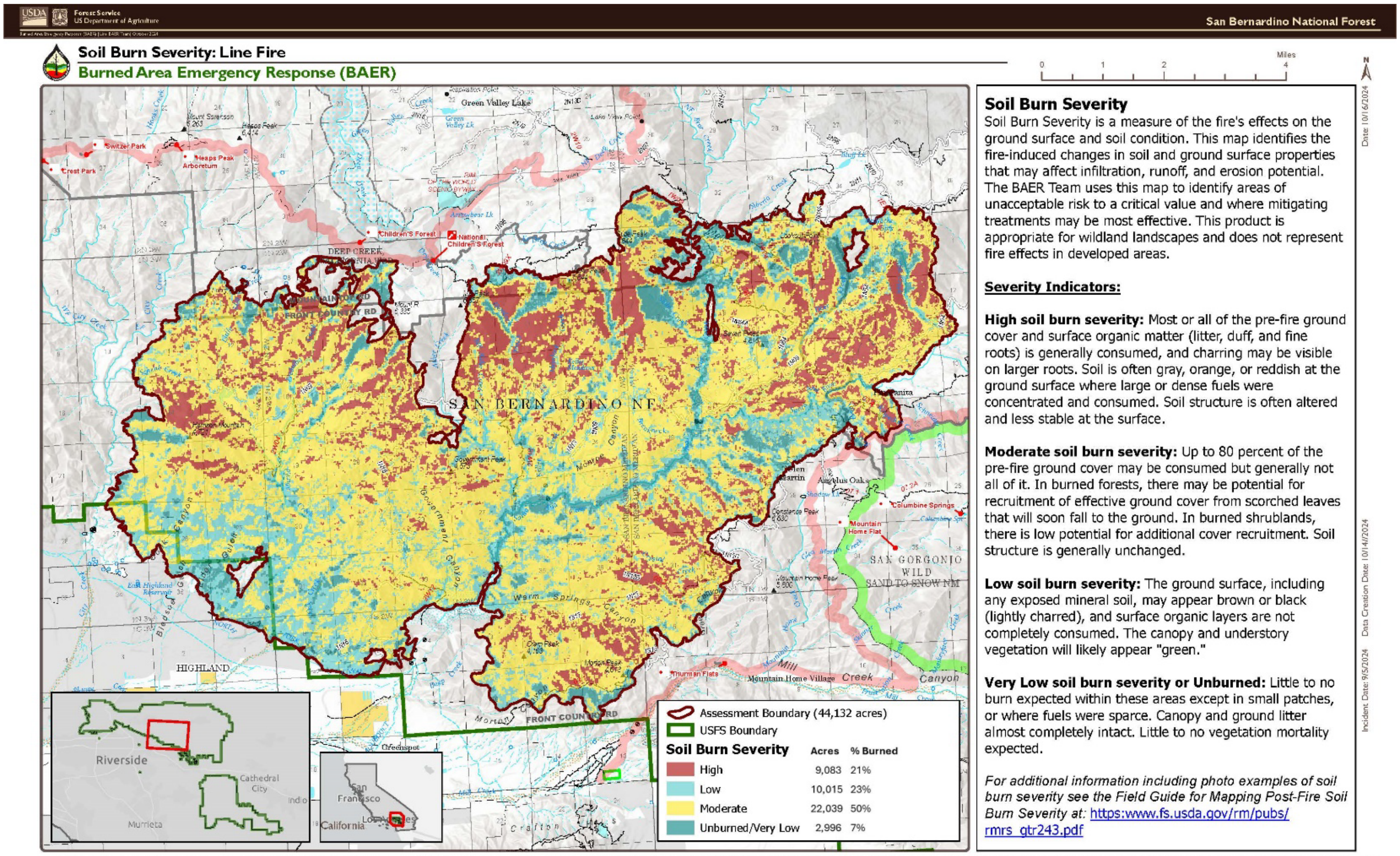
Local Forest Service BAER Interagency Liaison

Todd Ellsworth, todd.ellsworth@usda.gov

References:

Parson, Annette; Robichaud, Peter R.; Lewis, Sarah A.; Napper, Carolyn; Clark, Jess T. 2010. Field guide for mapping post-fire soil burn severity. Gen. Tech. Rep. RMRS-GTR-243. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 49 p. (https://www.fs.usda.gov/rm/pubs/rmrs_gtr243.pdf).

LINE POST-FIRE SOIL BURN SEVERITY MAP:



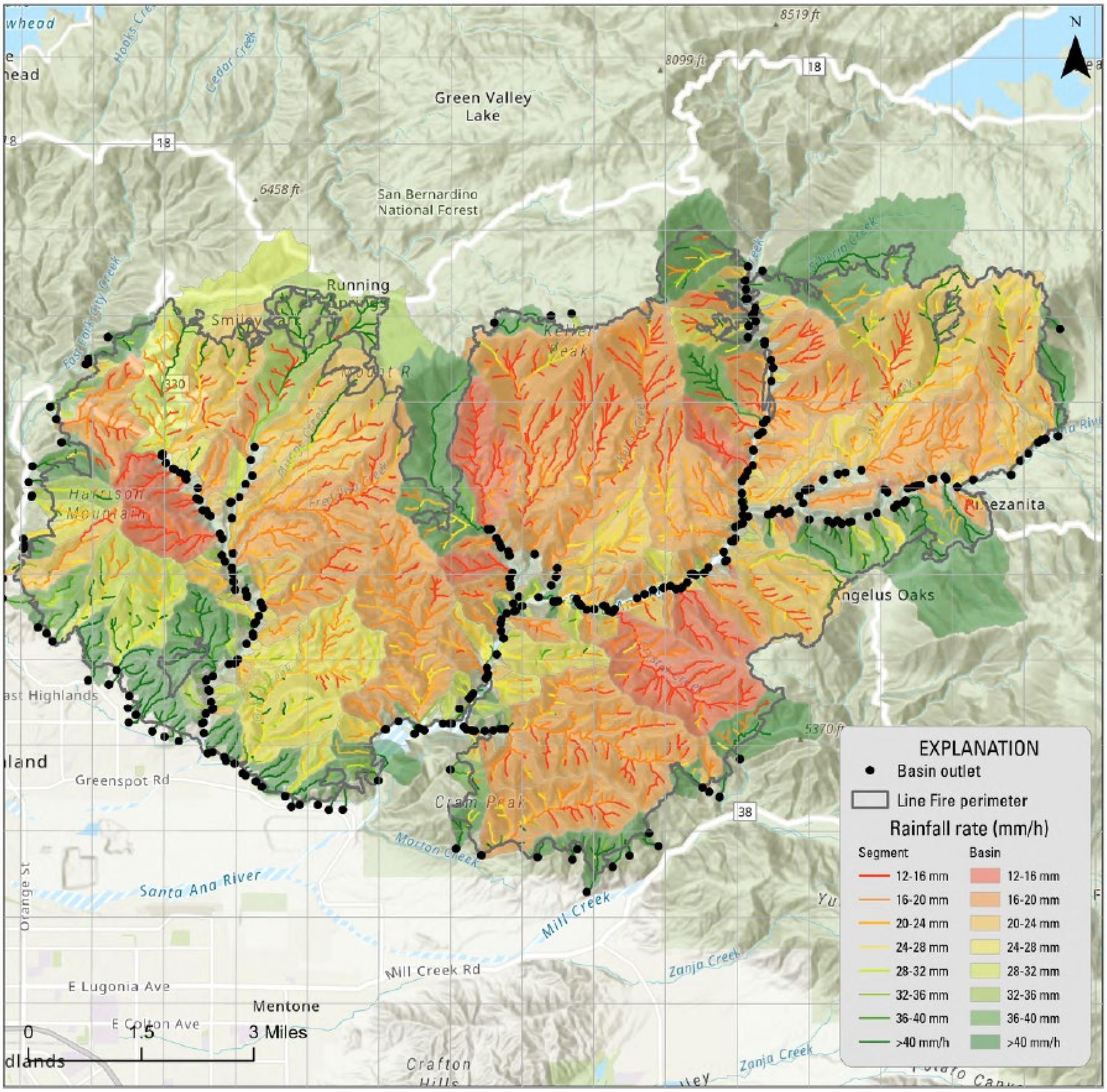


Figure 5. Thresholds for 1-year rainfall rates with a 50% likelihood of producing debris flows. Model and map produced by the U.S. Geological Survey, Geological Hazards Science Center, Golden, CO.

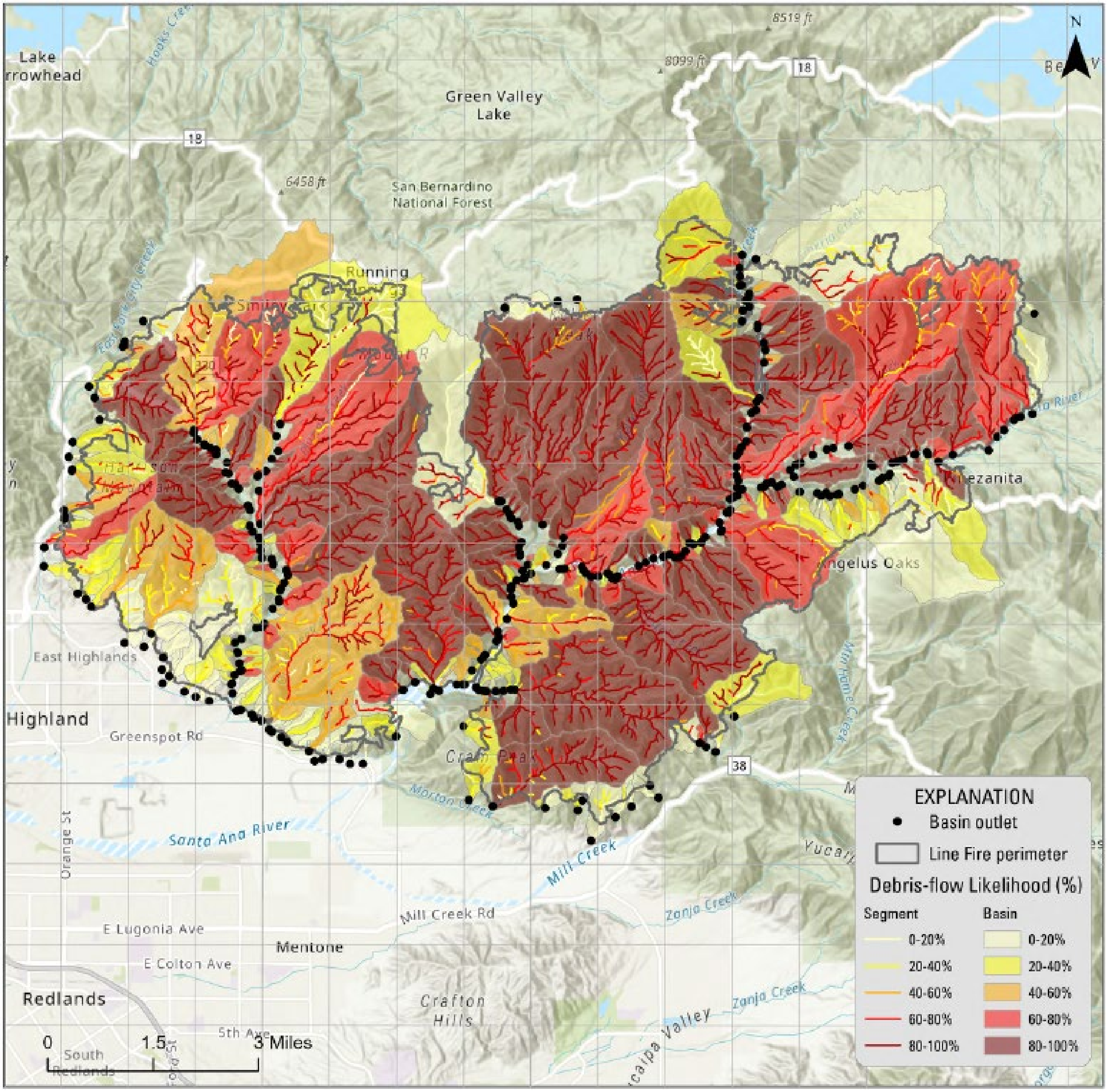


Figure 6. Debris flow likelihood based on a storm with a peak 15-minute rainfall intensity of 28 mm/hr. Model and map produced by the U.S. Geological Survey, Geological Hazards Science Center, Golden, CO.

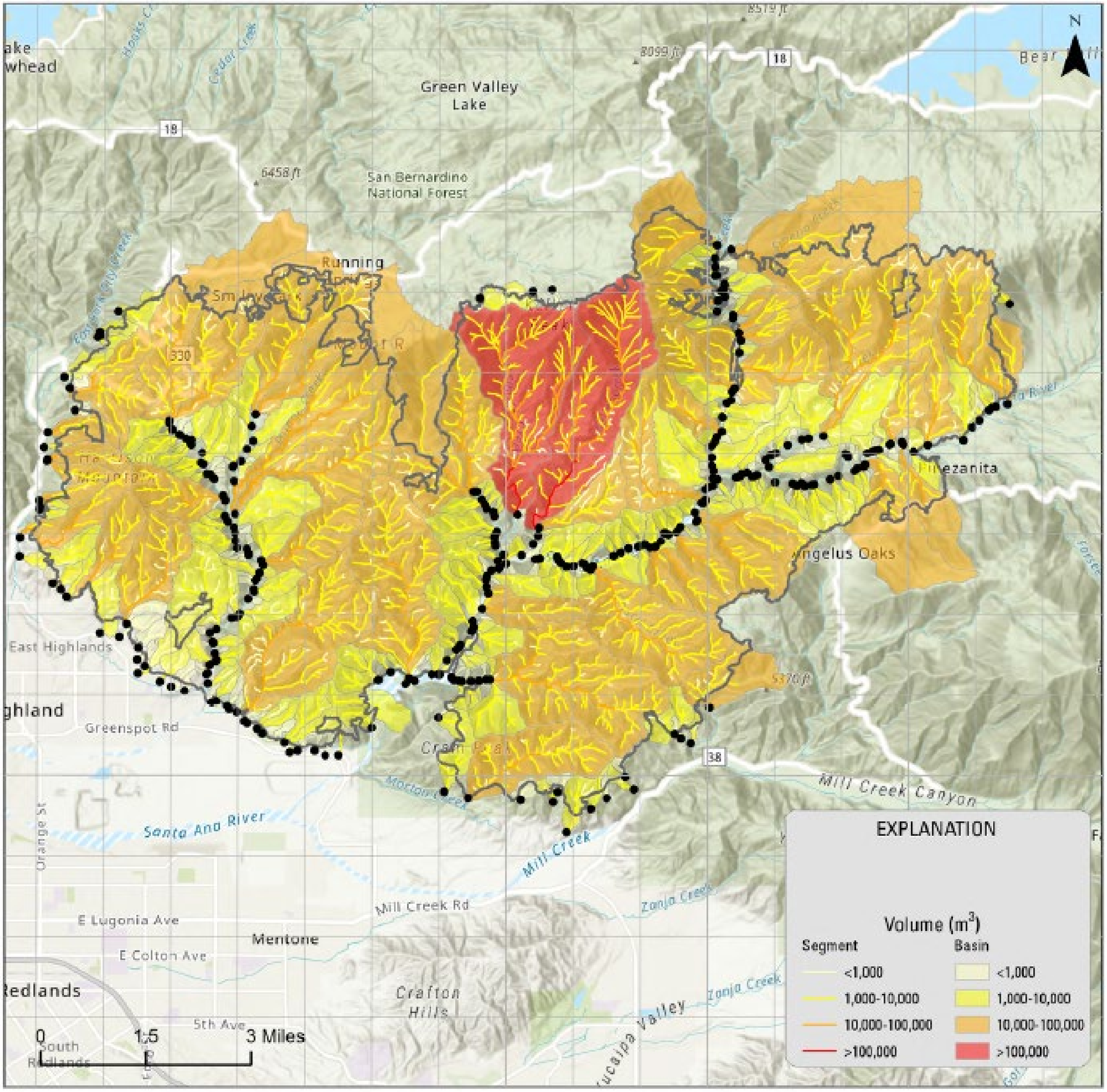


Figure 7. Debris flow estimated volumes based on a storm with peak 15-minute rainfall intensity of 28 mm/hr. Model and map produced by the U.S. Geological Survey, Geological Hazards Science Center, Golden, CO. Results are based on best available data; actual hazard is also dependent on volume of available debris in each basin.

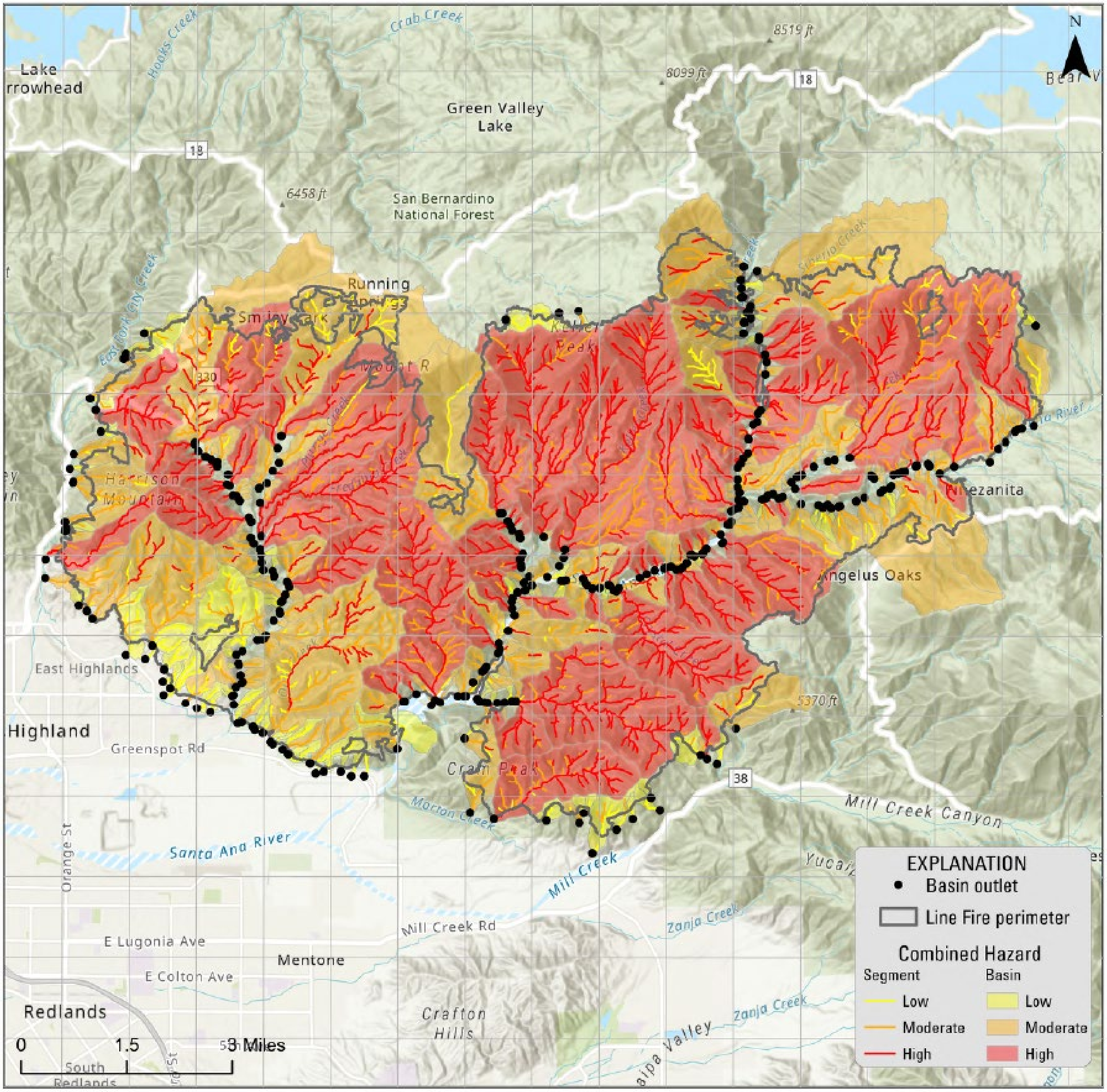


Figure 8. Debris flow combined hazard based on a storm with peak 15-minute rainfall intensity of 28 mm/hr. Model and map produced by the U.S. Geological Survey, Geological Hazards Science Center, Golden, CO. Results are based on best available data; actual hazard is also dependent on volume of available debris in each basin.