Appendix D. Wildfire Hazard and Mitigation Assessment

10/14/2025 | PREPARED FOR

The Calaveras River Watershed Resiliency Pilot Study

STOCKTON EAST WATER DISTRICT

CALAVERAS COUNTY WATER DISTRICT

Woodard & Curran

2025 Wildfire Hazard Assessment + Mitigation Strategy

vibrant planet

TABLE OF CONTENTS

Executive Summary

This report represents wildfire hazard and uses open-source data layers collated and calibrated by Vibrant Planet. The wildfire data layers, produced and modeled by Pyrologix, are intended to provide a quantitative foundation for wildfire risk mitigation planning efforts associated with the Calaveras River Watershed Pilot Study.

This data presents a picture of current conditions as it relates to wildfire hazard and provides an initial strategy to mitigate risk to communities and water resources by describing a potential set of projects designed to mitigate risk to communities and water resources in the region. Unless otherwise noted, all data and maps within this report reflect hazard conditions that have incorporated disturbance data through 2024.

Resilient Landscapes

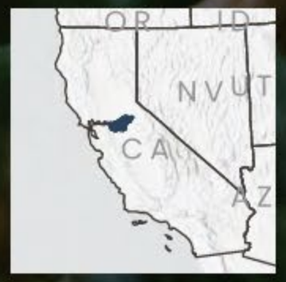
Resilient Landscapes

AREA OF INTEREST

AREA OF INTEREST

676,577

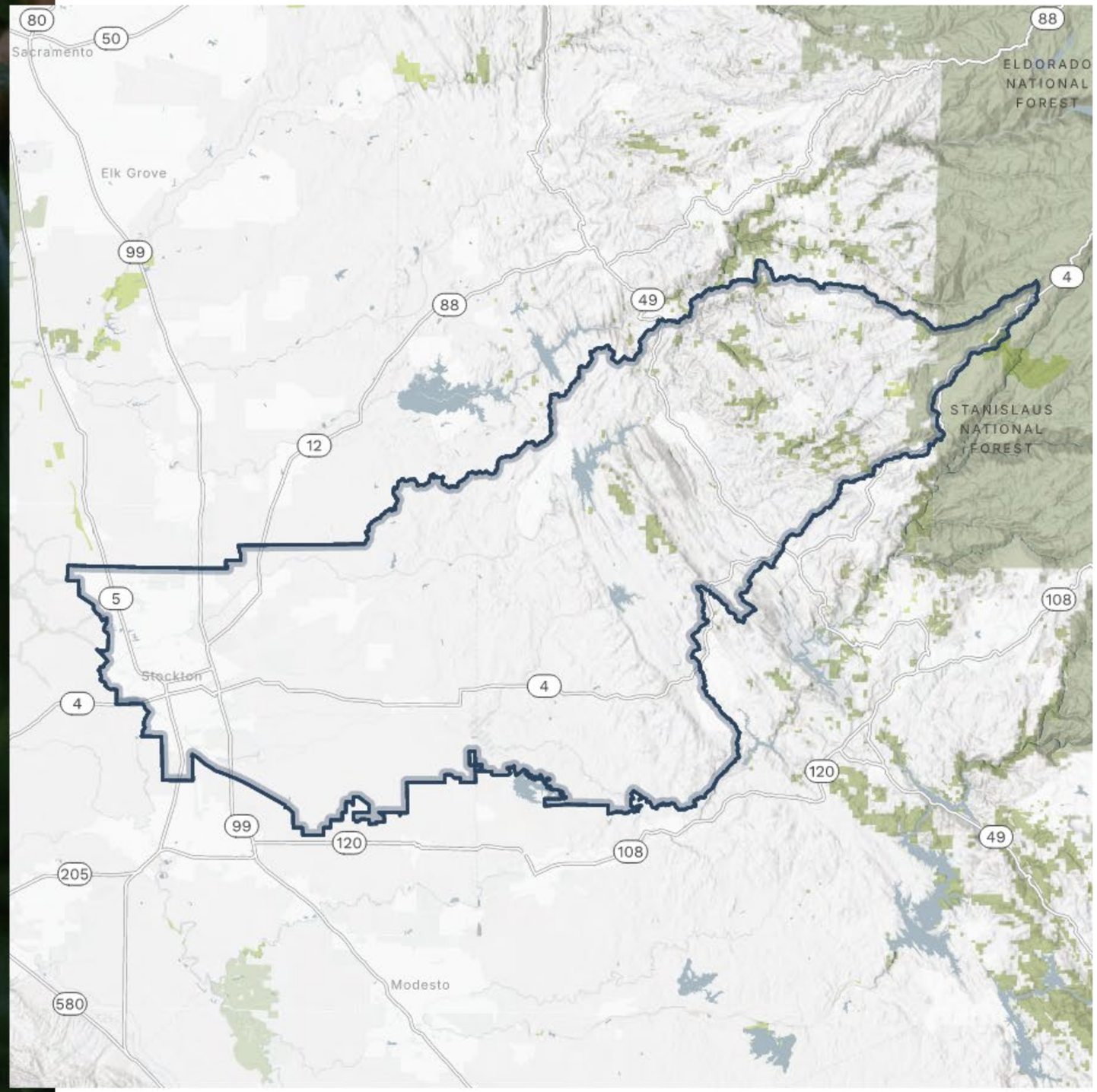
acres

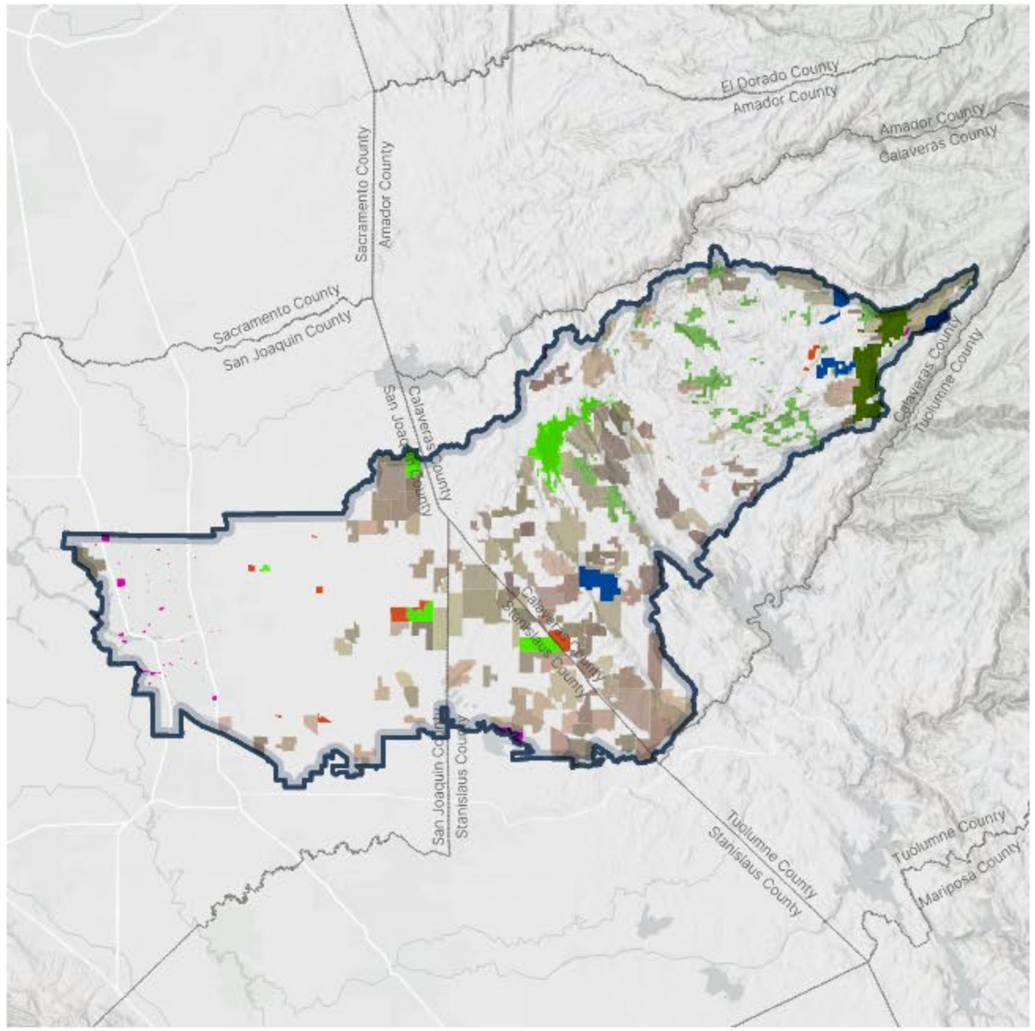


This analysis and the associated data layers cover the area of interest (AOI) shown in this map and subsequent map pages, depicted by a navy blue outline. Summary tables and statistics represent the full data layer extent, which typically align with the AOI, or with features that intersect the AOI.

The Calaveras River watershed was selected by the California Department of Water Resources (DWR) as one of five watersheds to participate in the Watershed Resilience Program designed to pilot the planning of climate resilience at a watershed scale. The Watershed Resilience Program will advance the vision and framework described in the California Water Plan 2023 by providing financial and technical support to improve regional resilience. This important work will lay the foundation for future efforts within the Calaveras watershed and throughout the state of California.

The Calaveras River watershed includes portions of the counties of San Joaquin, Stanislaus, and Calaveras counties. The Calaveras River Watershed Resiliency Plan will help build regional resilience through multi-benefit projects, integrated resource management, and nature-based solutions with a focus on equity. This will be accomplished through a robust outreach and engagement process to foster collaboration, analyze and assess climate vulnerabilities and risks, develop adaptation and implementation strategies, and track performance against set metrics. The Watershed Resiliency Plan will incorporate feedback from a wide-ranging group of stakeholders known as the Watershed Network, ensuring a Plan that is inclusive of interests and perspectives from across our diverse watershed.





File Name: land_resume-2.gpkg

LANDOWNER or MANAGER

- US Forest Service
- Bureau of Land Management
- US Fish and Wildlife Service
- National Park Service
- Other Federal Land
- Native American Lands
- Local Government
- Non-Governmental Organization
- State Fish and Wildlife
- State Parks and Recreation
- Other State Land
- Other Landowners

Large landowners displayed in browns, for the full list of 400+ landowners see the dataset.

Resilient Landscapes

LAND RESUME

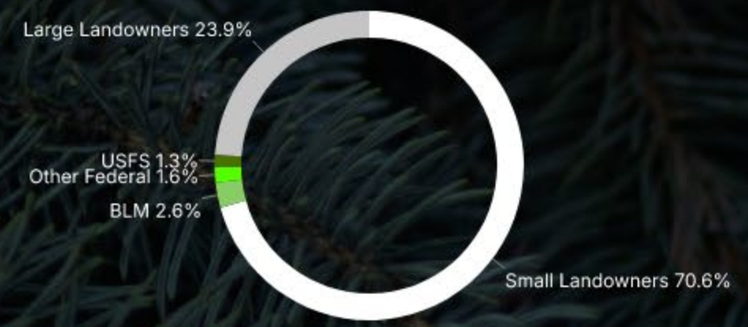
The Land Resume categorizes and partitions the landscape by land ownership (federal, state, local, or other) and land use.

Identifying land ownership and management in an area is important for hazard planning and awareness when wildfires occur. Wildfire is an ecological process that does not recognize jurisdictional boundaries and understanding land ownership helps ensure that all relevant stakeholders are brought to the table while making decisions.

The Land Resume represents a partitioning of the landscape based on unique combinations of ownership and land use designation. Land ownership is broken into classifications of federal, state or local government managed lands, and all else represented as other landowners. Ownership data for the Land Resume is sourced from the Protected Areas Database of the United States, or PAD-US (U.S. Geological Survey Gap Analysis Project (GAP), 2022) and Regrid parcel data (The Regrid Data Store, 2022).

OWNER/MANAGER	ACRES
Other Landowners	466,103
US Forest Service	8,341
Other Federal Land	6,347
Other Landowners	5,900
Sierra Pacific Land and Timber Company	4,521
Wooster Kelly C Trustee	4,145
Cook Land and Cattle Co Inc	4,094
Rodden Ranches LLC	3,687
Trailhead Properties LLC	3,599
Rancheria Del Rio Estanislaus LLC	3,392
Somers Kiana Tr et al	3,234
Duane Martin Ranches LP	3,072

For landowners with less than 3,000 acres, see the dataset.



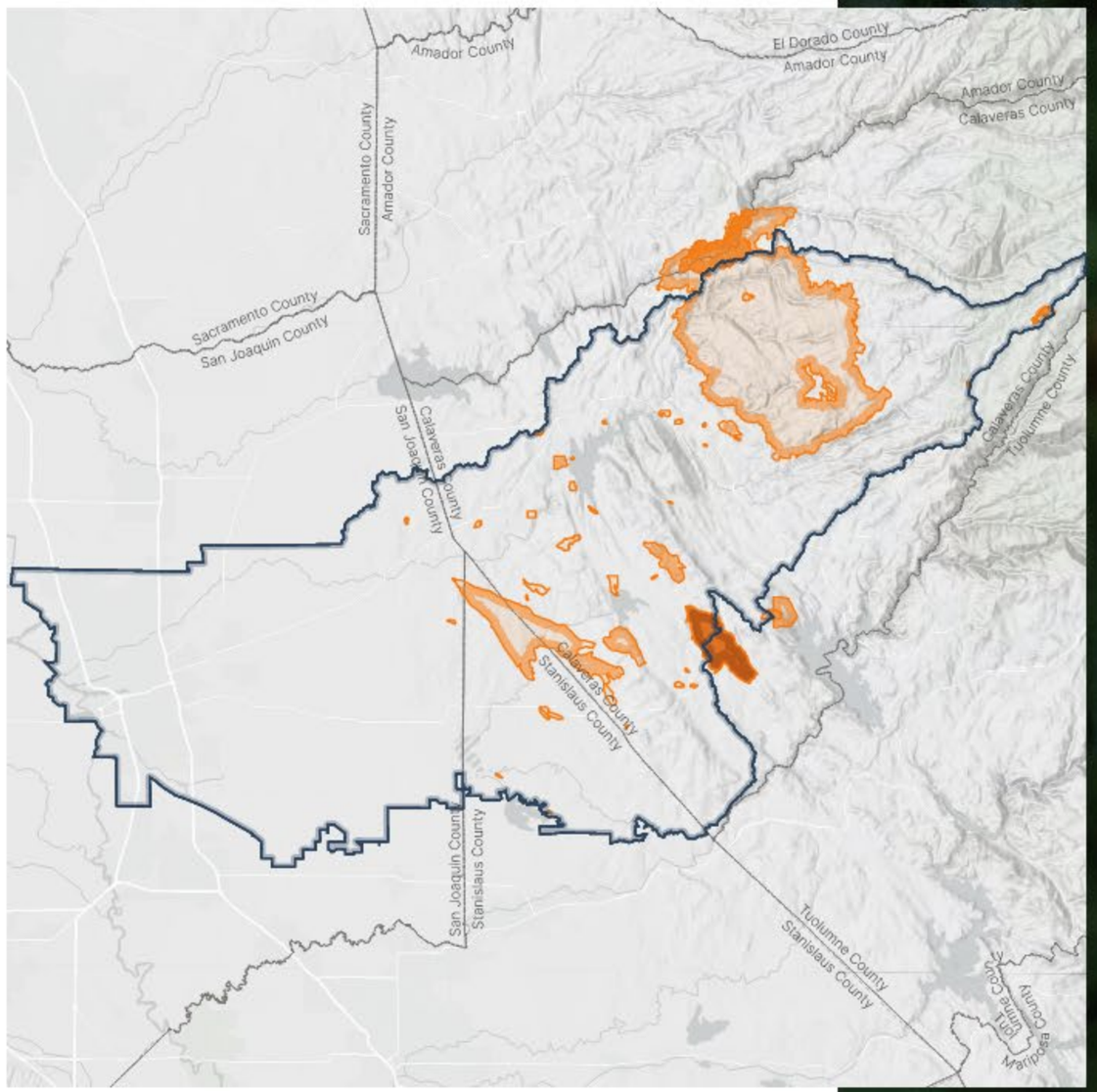
Resilient Landscapes

FIRE HISTORY

Fire history is a record of fire at a given location, including both wildfires and prescribed burns.

This dataset represents a record of fire at a given location on the landscape and includes both wildfire and prescribed burns. Recent data, representing fire footprints after 2020, is compiled from National Fire Perimeter data (National Interagency Fire Center (NIFC), n.d.) and includes footprints up to 2024. Fire history prior to 2020 is sourced from the combined wildland fire datasets for the United States and certain territories, (Welty & Jeffries, 2021).

Fire history information is used as an input to FSim, the large fire simulator, which focuses on the relatively small fraction of wildfires that escape initial attack and become "large" (>247 acres). Note that the map displays only fires from 2015-2024, including those smaller than 247 acres, however the hazard and weighted risk assessment include fires that occurred during this time frame and prior.

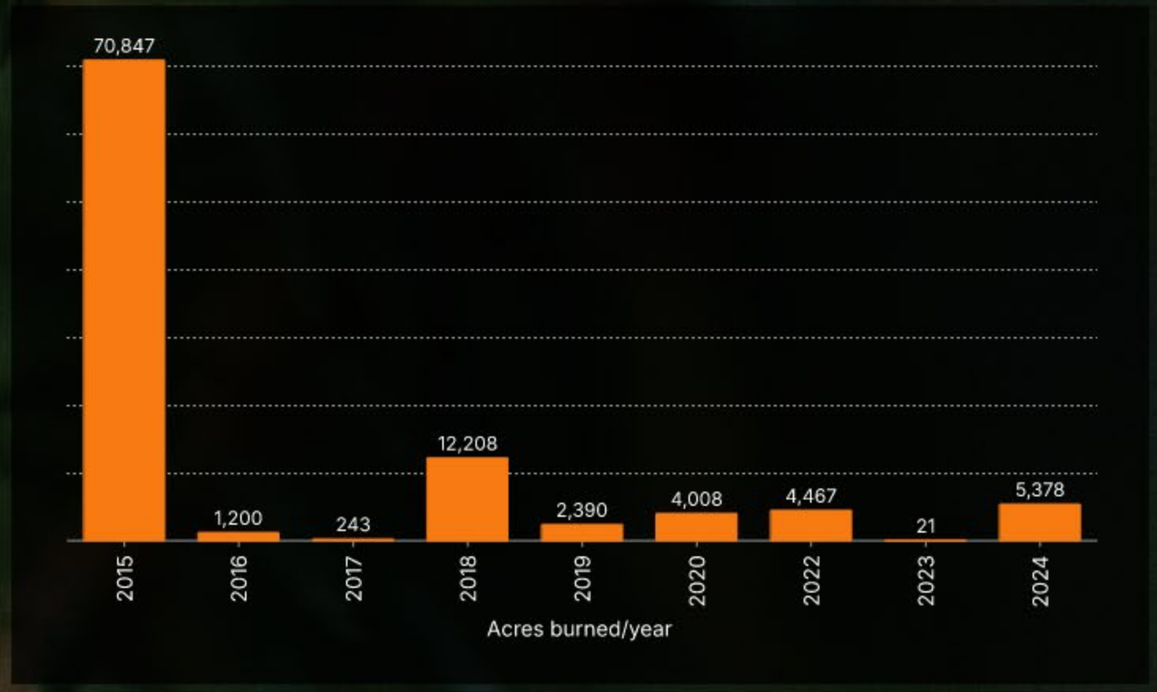


File Name: fire_history.gpkg

TOTAL FIRE FOOTPRINT

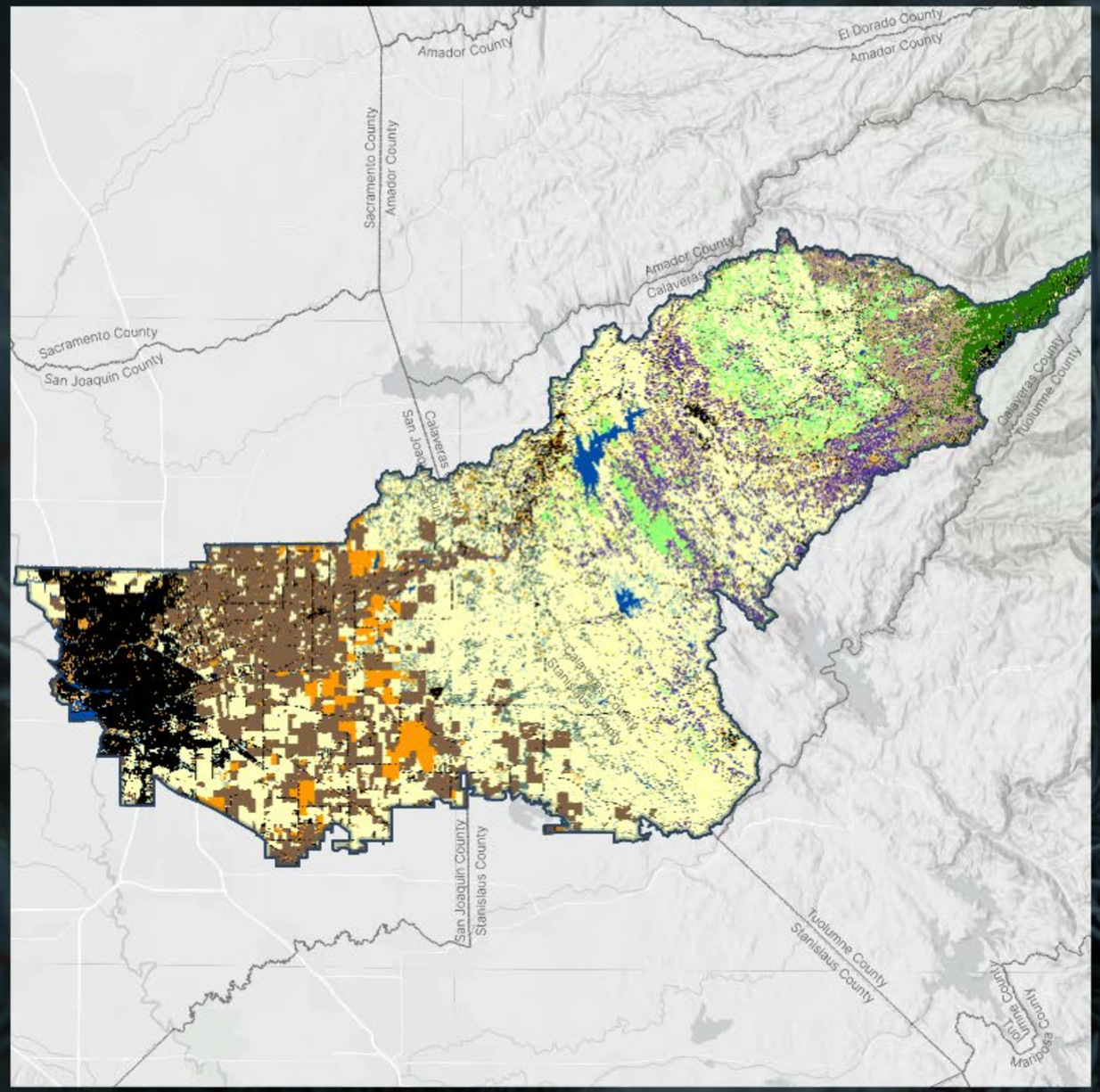
100,762 acres

burned since 2015 (includes overlaps)



Resilient Landscapes

VEGETATION TYPE



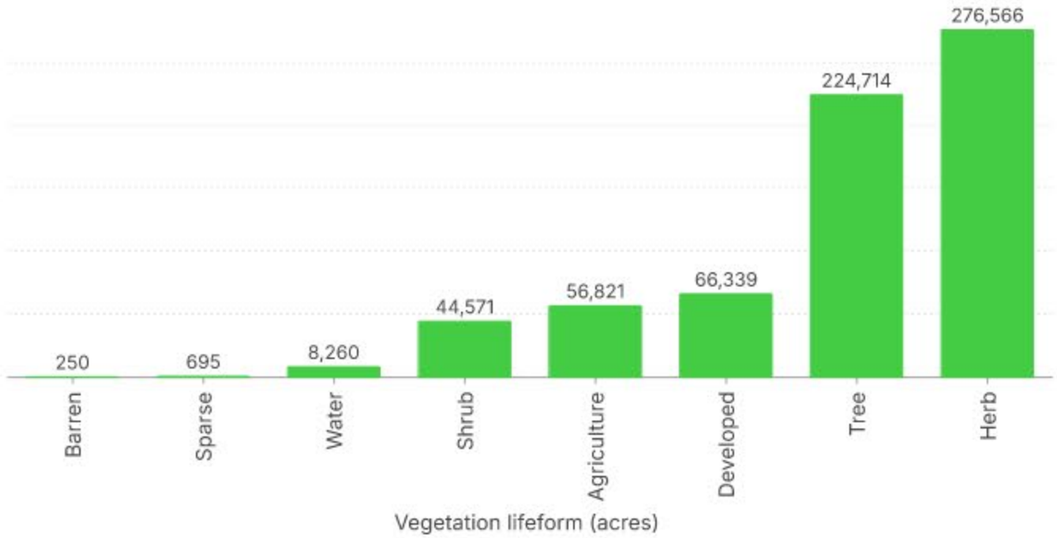
File Name: fuel_vegetation_type.tif

Fuel Vegetation Type (FVT) describes current vegetation conditions, informs surface fuel types, fuelscapes, and ultimately informs wildfire intensity across the landscape.

Vegetation lifeform (grass, shrub, tree) from LANDFIRE v2.2.0 fuel vegetation type (U.S. Geological Survey, 2022) is used as a covariate to represent different potential for loss based on fire residence time and resistance to control. These layers are updated to current conditions using recent fuel treatment, fire, and insect and disease disturbance data. Each individual FVT code is then assigned a crosswalk to a surface fuel type (FM40).

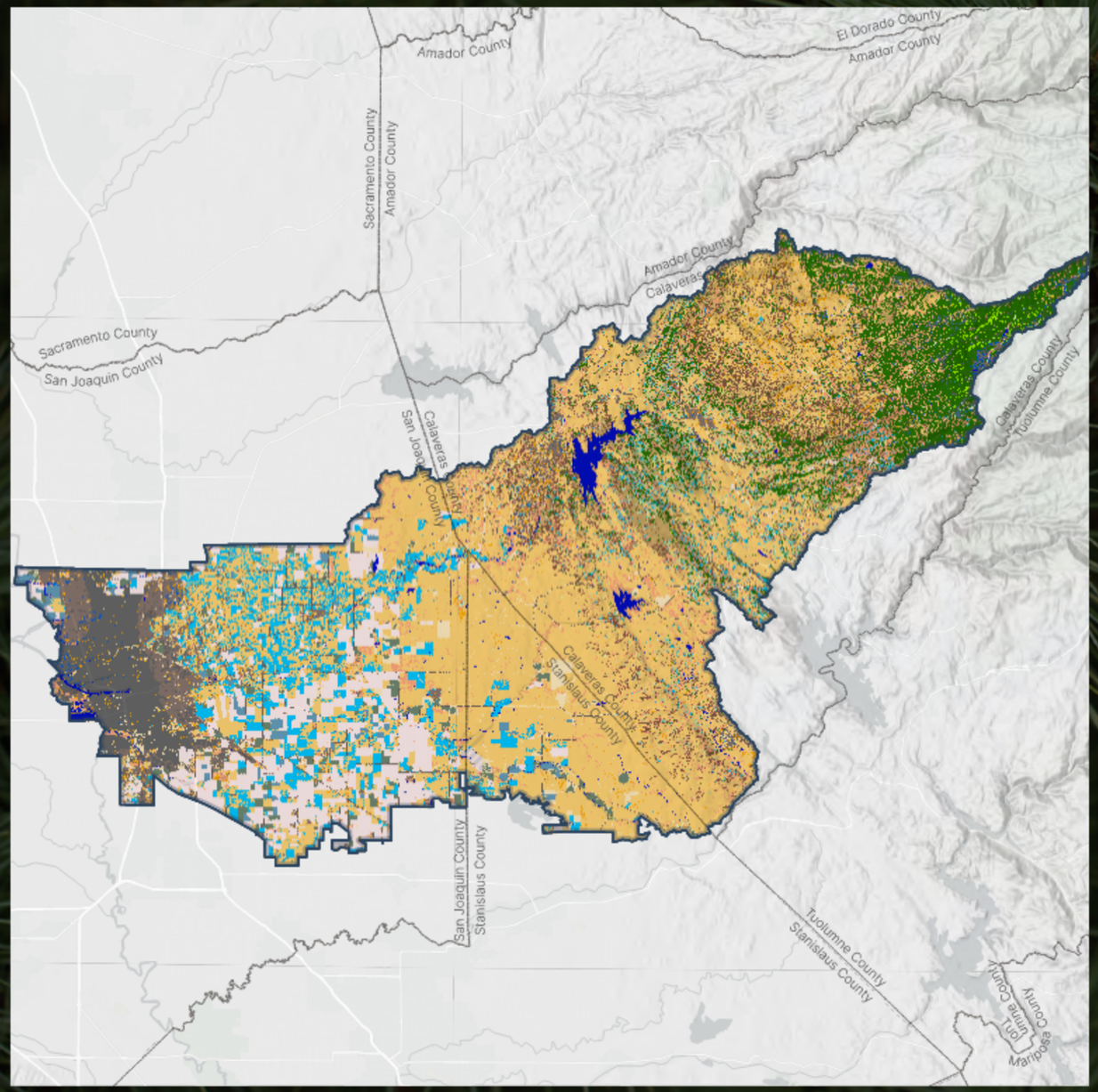
LANDFIRE FVT

This map uses LANDFIRE standard symbology (SBCLS), for more information on Fuel Vegetation Type codes see https://landfire.gov/fuel/fvt



Resilient Landscapes

SURFACE FUEL TYPE



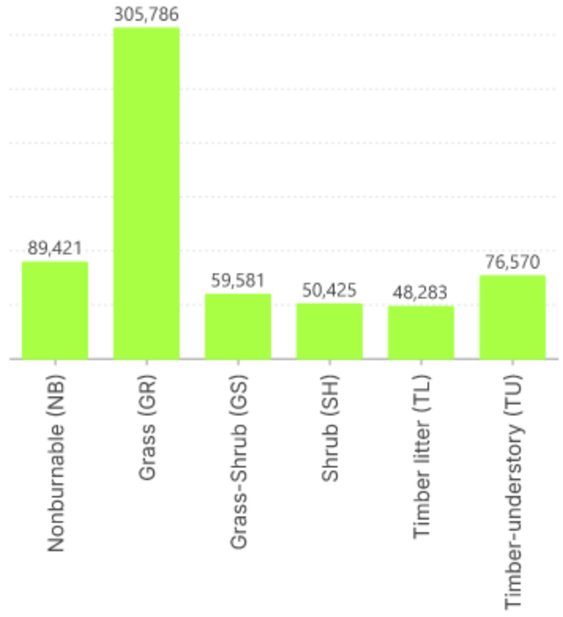
File Name: surface_fuel_model_class.tif

Surface fuels are the live and dead vegetation lying on or immediately adjacent to the ground, such as woody debris, grasses, and shrubs. Even when shrubs or grasses are the tallest fuels, they are still considered surface fuels.

To assign a surface fuel model, pre-disturbance fuel vegetation datasets representing fuel vegetation type (FVT), fuel vegetation cover (FVC), and fuel vegetation height (FVH) are combined with planned and unplanned disturbance information to determine post-disturbance fuels for the prior ten-year period. For example, a 2024 fuelscape would include disturbances from 2014-2023. It is assumed that disturbances prior to 2014 would be mostly recovered to a pre-disturbance state and are not included when determining surface or canopy fuels.

Pre-disturbance fuel vegetation datasets for the current conditions fuelscape are derived from the existing vegetation dataset from the 2016 LANDFIRE Remap effort (U.S. Geological Survey, 2022), where LANDFIRE refreshed all imagery contributing to their modeling. The existing vegetation inputs include EVT, existing EVC, and EVH. A series of crosswalk rules is used to convert existing vegetation datasets to fuel vegetation datasets (FVT, FVC, FVH).

These adjusted, pre-disturbance fuel vegetation datasets are used in conjunction with biophysical settings and disturbances to generate the current condition surface fuel model (FM40) using a series of established rulesets.



LANDFIRE FM40

This map uses LANDFIRE standard symbology, for more information on Surface Fuel codes see https://landfire.gov/fuel/fbfm40 .

Resilient Landscapes

IGNITION FREQUENCY DENSITY GRID

Fire ignition frequency density is the number of fire ignitions per unit time per unit area (ignitions per year per sq km). Wildfire ignition probability data provides spatially explicit estimates of the likelihood that a wildfire will start in a given location, and can include either human or natural ignitions or both. This layer indicates if an area has a history of human caused ignitions.

The Ignition Frequency Density grid indicates where fires are likely to originate as the annual relative frequency per sq km (number of fires per sq km per year) with emphasis placed on fires with significant growth potential. It is derived from historical data, and can be a useful metric to identify areas where fires are likely to start, such as along roads due to human-caused ignitions, or ridgetops for lightning-caused ignitions. This layer represents only human-caused ignitions, which typically display a pattern showing decreasing ignitions moving away from roads and population centers.

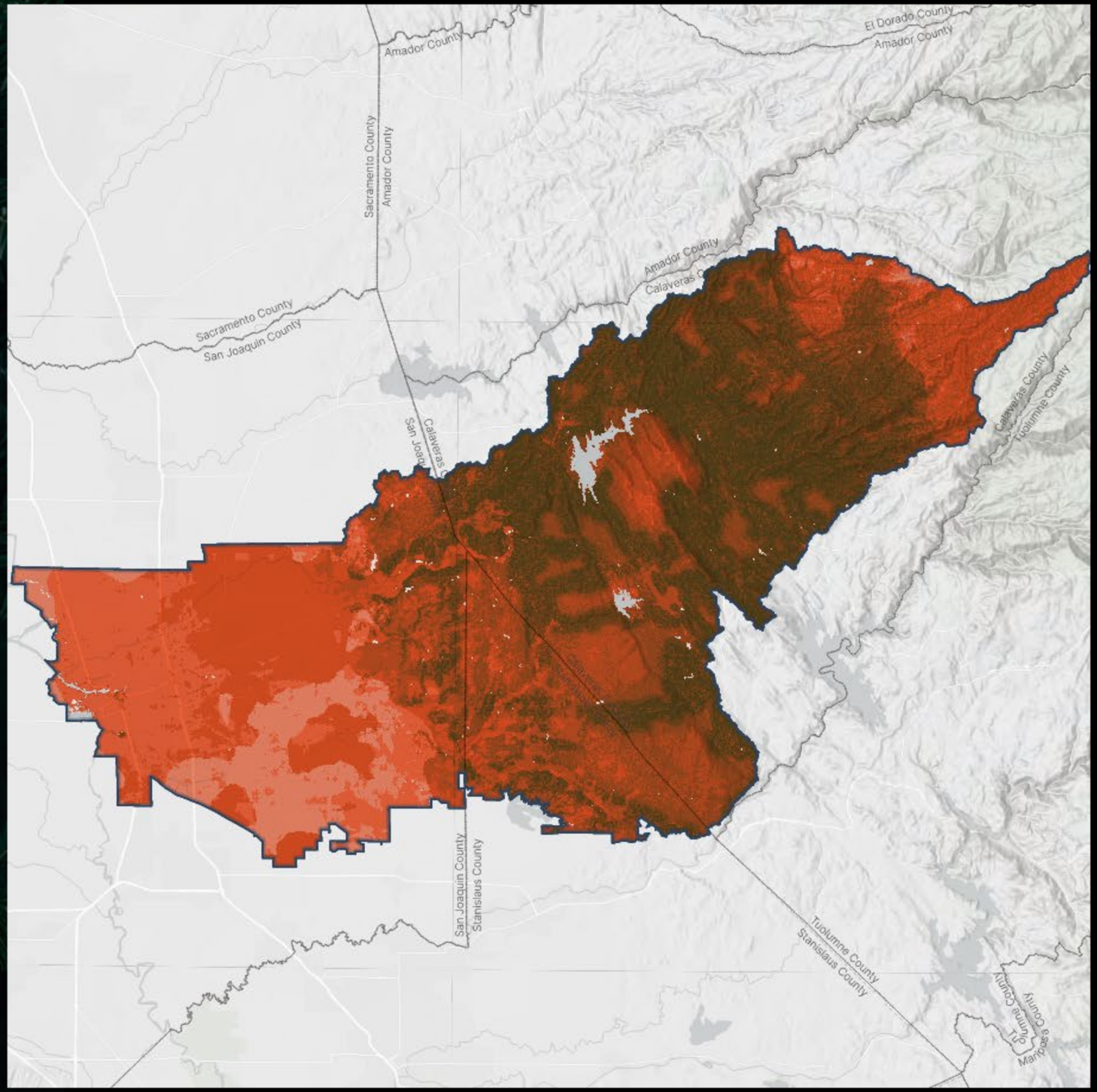
The annual ignition probabilities reflect the conditions recorded in 2022, as observed in the Fire Occurrence Database (FOD), which was used for model training.

Climate change, vegetation shifts, and evolving social factors could alter ignition patterns over time. This dataset does not characterize the dynamic intra-annual variability observed in ignition probability and the input features. For more information on this dataset please visit Vibrant Planet Data Commons (https://www.vpdatacommons.org/datasets/human-ignition-probability-west).

IGNITION FREQUENCY + DENSITY

0.000170

average ignitions/sq km/year



File Name: ignition_frequi_density.tif

LEAST — MOST

Powered by PYROLOGIX

Resilient Landscapes

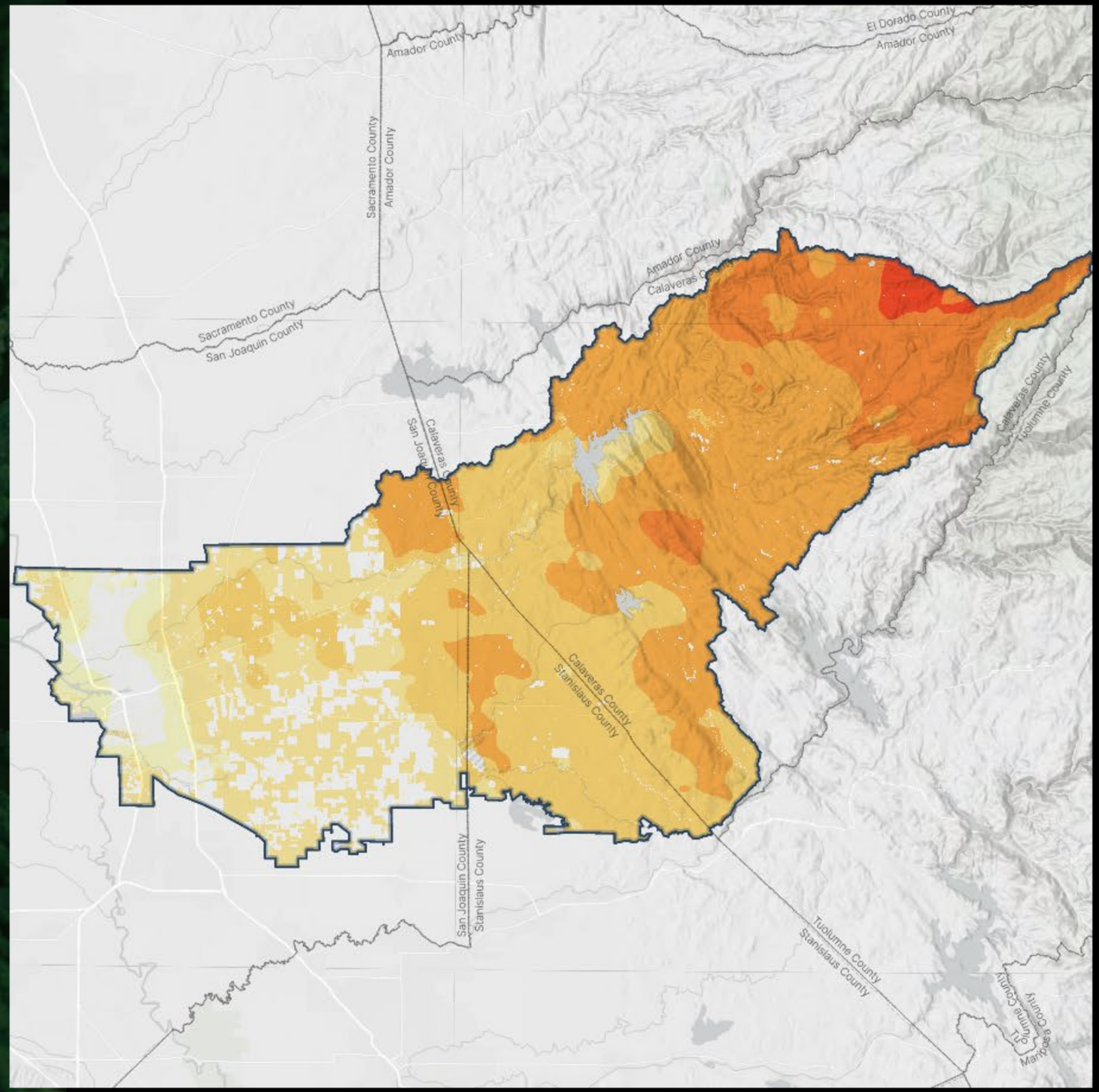
BURN PROBABILITY - ANNUAL

Burn probability (BP) shows the probability of an area burning at any time during a single calendar year. A higher BP means wildfire is more likely to occur in an area.

The FSim large-fire simulator is used to quantify wildfire likelihood. FSim is a comprehensive fire occurrence, growth, behavior, and suppression simulation system that uses locally relevant fuel, weather, topography, and historical fire occurrence information to make a spatially resolved estimate of the contemporary likelihood and intensity of wildfire across the landscape (Finney et al. 2011).

FSim focuses on the relatively small fraction of wildfires that escape initial attack and become "large" (greater than 247 acres). Since the occurrence of large fires is relatively rare, FSim generates many thousands of simulated iterations to capture a sample size large enough to generate burn probabilities for the entire landscape.

A given FSim iteration spans one entire year. There is no temporal component to FSim beyond a single wildfire season consisting of up to 365 days. FSim performs independent (and varying) iterations of one year, defined by the fuel, weather, topography, and wildfire occurrence inputs provided. FSim does not account for a simulated wildfire's potential influence on the likelihood or intensity of future wildfires (even within the same simulation year). FSim integrates all simulated iterations into a probabilistic representation of wildfire likelihood. Each year represents an independent realization of how fires might burn given the current fuelscape and historical weather conditions.



File Name: burn_probability_1_year.tif

LOWEST — HIGHEST

Powered by PYROLOGIX

Resilient Landscapes

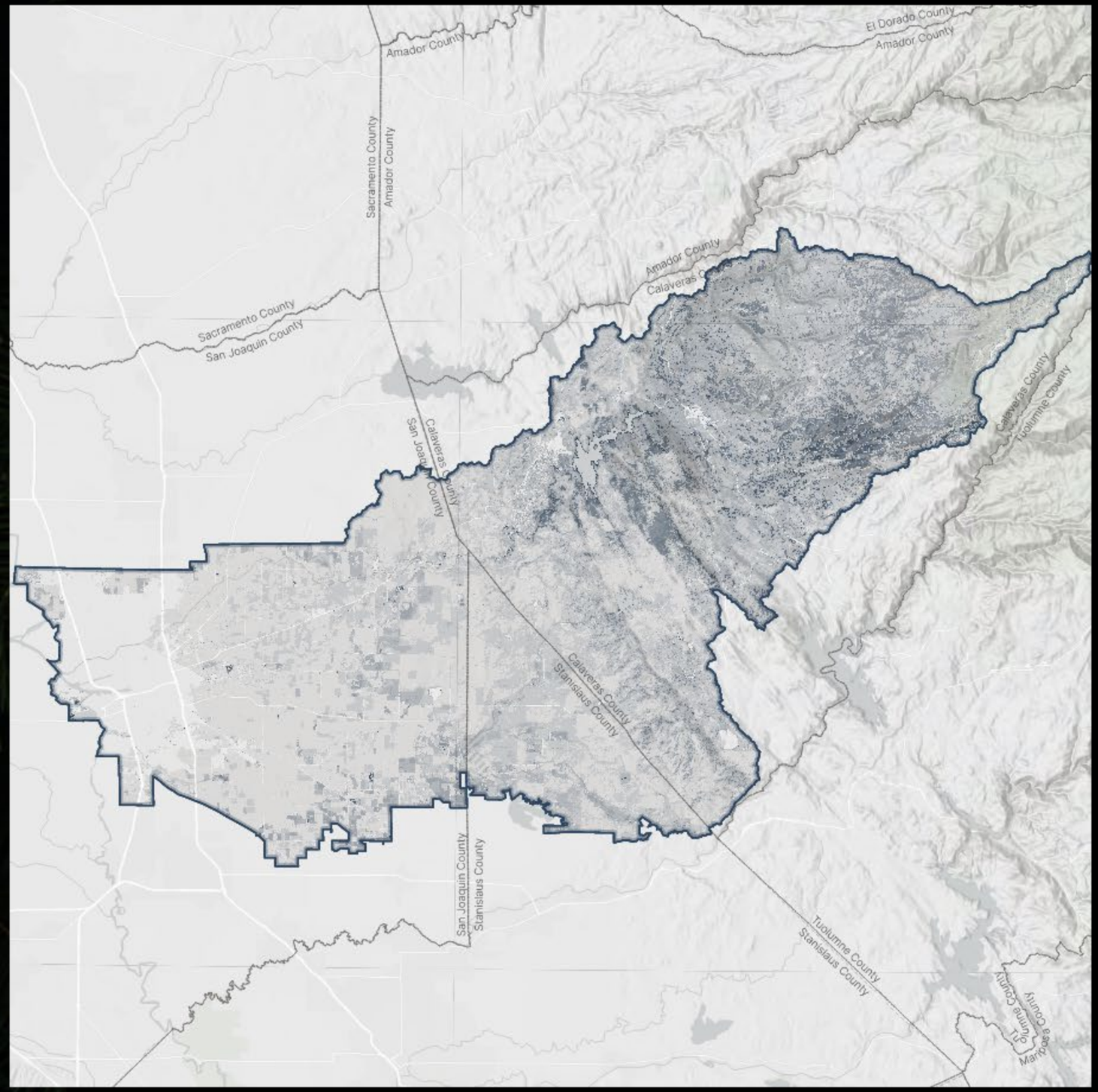
AVERAGE EFFICIENCY OF WATER USE

Efficiency of water use shows the average annual amount of water used (inches of water) divided by the productivity (tons of carbon) per acre. This metric is intended as a balanced measure of ecosystem health and resilience that weighs reducing total water use against ecosystem growth.

This layer is a stand-level version of water use efficiency, which is often measured at the leaf and tree level, presented as a reciprocal of the standard metric to emphasize the water use component. It is calculated using evapotranspiration from Senay, et al (2021) and net primary productivity from Robinson, et al (2018).

In order to understand the effect of treatments on efficiency of water use (EWU) Vibrant Planet analyzed 6505 individual past treatments over the period of 2010-2019. This approach compares observed changes in EWU to changes in untreated reference regions to isolate the impact of the treatment from the influence of interannual climatic variation (Larsen et al, 2019; Yackulic et al, 2025).

The metric is presented in project proposals as the difference between average conditions and predicted post-treatment conditions. This provides a method to evaluate realized benefits of treatment to water availability.



File Name: mean_euw.tif

LOWEST USE — HIGHEST USE

Powered by PYROLOGIX

Resilient Landscapes

INCREASE IN SOIL EROSION - NO ACTION

The change in expected erosion rate following a fire with no prior intervention relative to current conditions. Erosion rate is predicted using a gridded implementation of the Revised Universal Soil Loss Equation with current and expected post-fire difference driven by changes in soil cover.

The loss or reduction of the live forest canopy, herbaceous ground cover, and surface litter due to wildfire increases the expected rate of erosion, threatening downslope water resources, infrastructure, and revegetation potential. This layer shows the expected change in erosion rates between current conditions and post-fire conditions.

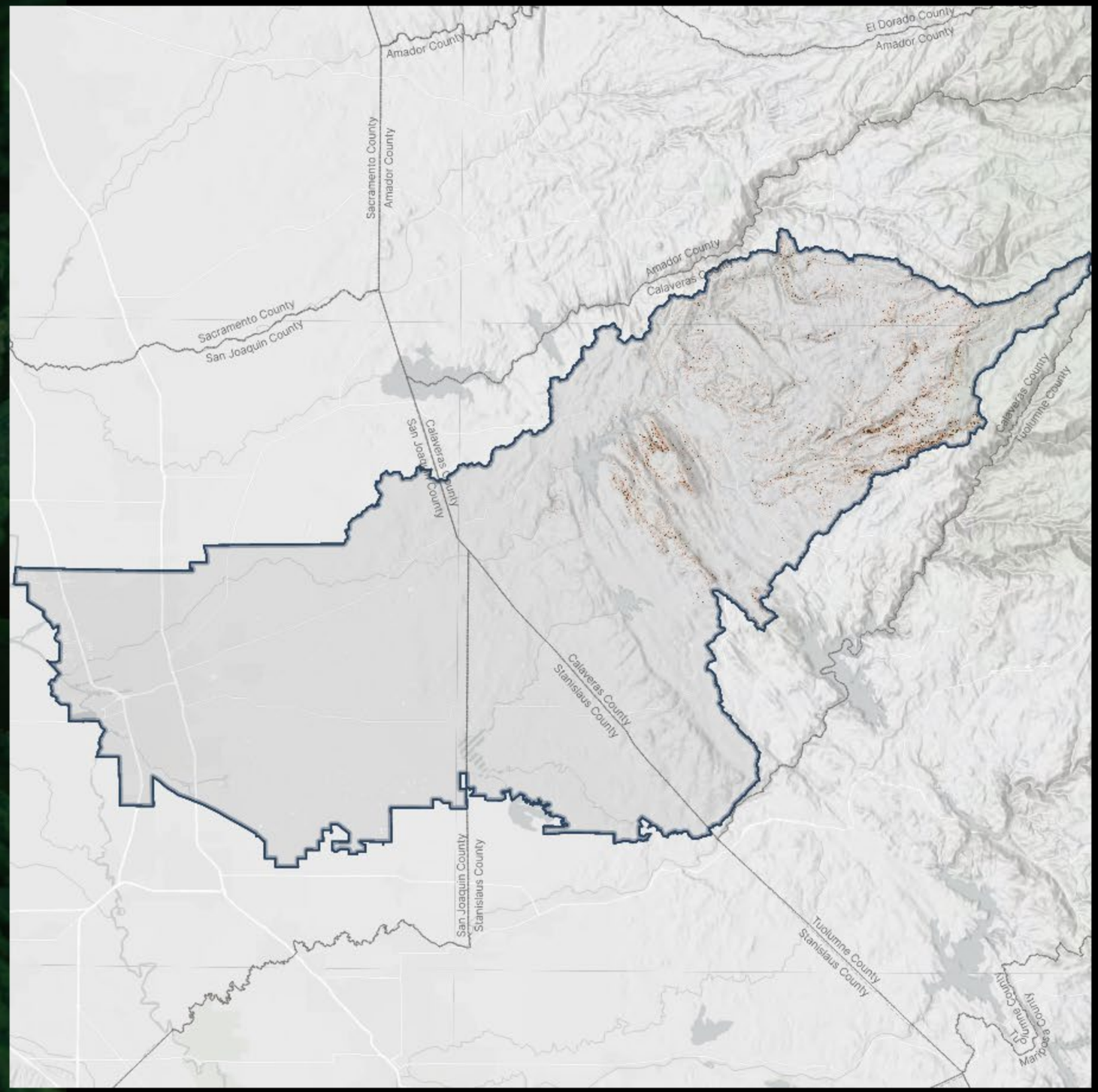
Erosion rates for current and future conditions are modeled using the Revised Universal Soil Loss Equation (RUSLE) (Renard, 1997) adapted for use over gridded datasets (Winchell et al, 2008; Gannon et al, 2020; and others). Data were drawn from US NRCS (Soil Survey Staff, 2023), USGS (U.S. Geological Survey 2024; Rigge et al, 2025), and EDSAC (Gupta et al., 2024; Panagos et al., 2023). Post-fire erosion rates are adjusted to represent change in soil cover shown in Vibrant Planet's standard forest simulations of disturbance and treatment.

Reducing the expected post-fire erosion can be achieved through management aimed at reducing the burn probability and predicted fire intensity. During planning the potential for increased erosion rates is included in the Vibrant Planet Platform response functions to weigh the cost of intervention against the cost of no-action.

NO-ACTION POST-FIRE EROSION

39 tons/acre/year

Average rate across the upper watershed



File Name: soil_loss_increase_no_action.tif

LOWEST RATE — HIGHEST RATE

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Wildfire Mitigation Strategy

Wildfire Mitigation Strategy

MITIGATION PLANNING AREA

PLANNING AREA

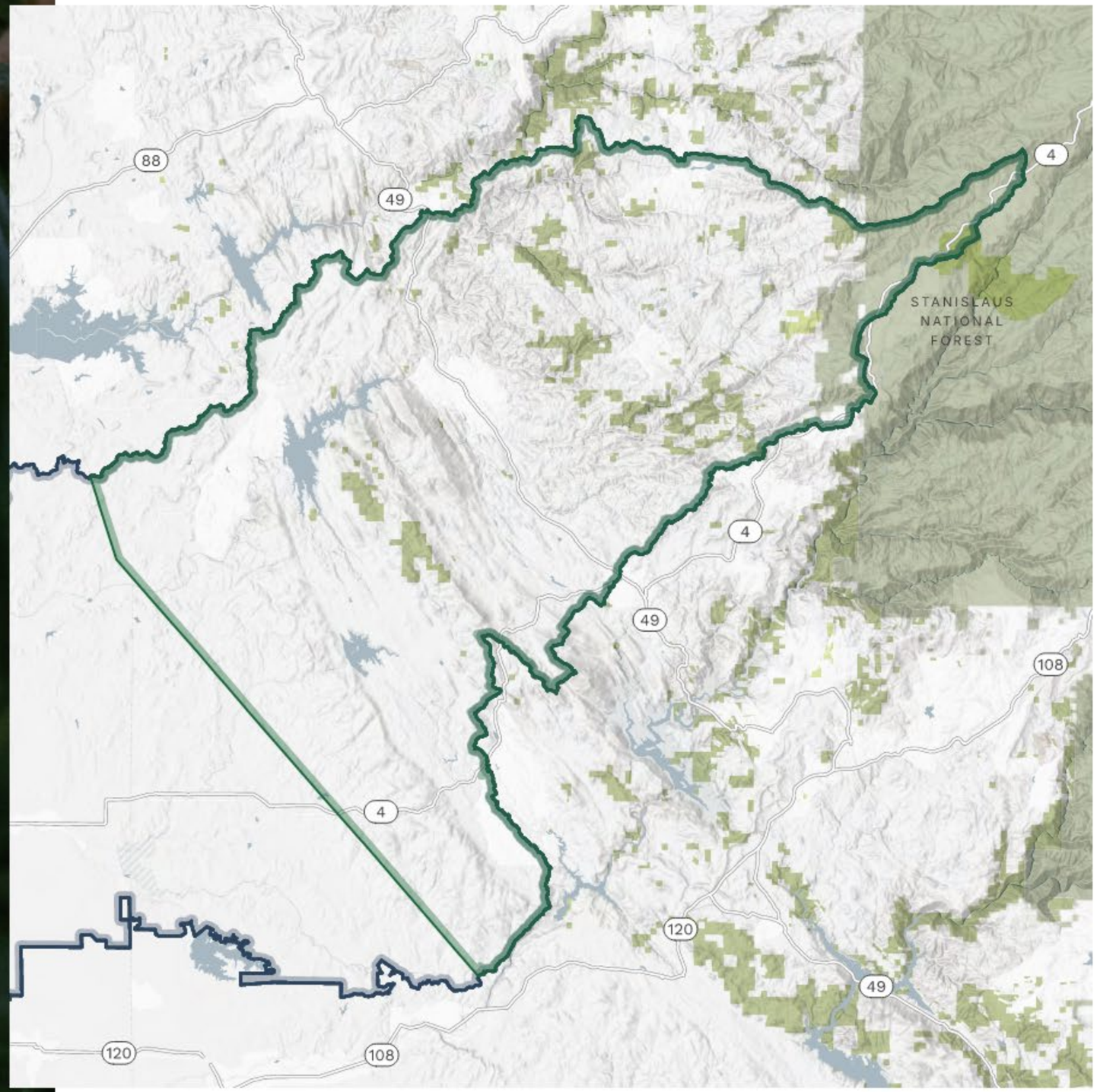
353,414

acres

The Calaveras County portion (green outline) of the Calaveras River Watershed AOI was selected as the area of interest the Wildfire Mitigation Strategy. This region of the watershed is comprised of oak woodland foothills, small mountain communities, and managed forest.

It has in recent history, seen destructive wildfire that poses a hazard to these community and ecosystem resources. Managing for resilience to wildfire is a priority identified in both the Calaveras County Water District 2023 Local Hazard Mitigation Plan and the 2021 Calaveras County Multi-Jurisdictional Hazard Mitigation Plan. The county boundary specifically was chosen to align this study with the commonly used jurisdictional boundary used in those plans. Future funding opportunities at the County level were also considered in the selection of this boundary.

The focus of this Wildfire Mitigation Strategy is the reduction of risk to communities and water resources in the Upper Calaveras River Watershed. Management methods were selected by the Vibrant Planet feasibility criteria. Project planning and sequencing represents a focus on Assets, Safety and Water high value resources and assets. The project sequencing and associated outcome metrics in the following sections reflect these goals and align with the Watershed Resilience Program.



Wildfire Mitigation Strategy

WEIGHTING RISK

HVRA eNVC are summed to groups of "Objectives" (ex: Assets, Safety, Water) to create Objective-level eNVC. Weights can be provided, at the Objective level, to indicate that the HVRAs in some Objectives may be of higher societal value than others to a given community, organization, or simply a given planning effort. For example, a Firewise Community focused QWRA might focus on Assets and Safety, giving a higher emphasis to those Objectives, while a watershed restoration planning effort might give higher weight to Water and Wildlands Health. All Objectives weighted greater than zero are included in the final weighted risk assessment; weights used in this assessment are provided in the table.

OBJECTIVE	NAME	SUMMARY	SOURCE
Assets	Energy Facilities	Power Plants, Power Substations	Homeland Infrastructure Foundation-Level Data (HIFLD)
Assets	Structures	Buildings larger than 430 square feet	ORNL, FEMA, OneGeo
Assets	Transmission Lines	Transmission Lines	HIFLD
Safety	Emergency Service Facilities	Local Law Enforcement locations, Hospitals, Fire Stations	HIFLD
Safety	Structure Transmission Zone	Wildland areas with potential to expose nearby homes to fire	Oak Ridge National Laboratory (ORNL), FEMA, OneGeo, Simulated Fire Perimeters based on FSim and literature
Safety	Wildland Urban Interface	Quarter-mile defense zone around structures	ONRL, FEMA, OneGeo
Water	Lakes	Non-flowing, contained water bodies including perennial reservoirs	National Hydrography Dataset
Water	Perennial Rivers and Streams	Water flow lines that are perennial in nature	USGS National Hydrography
Water	Public Water Supply	USACE Inventory of Dams, USGS Hydrography Dataset, Western States Water Council Dataset	Lakes and Reservoirs with use for public drinking water supply
Water	Sediment Catchments for Water Supply	USGS Hydrography Dataset, Gridded National Soil Survey, USGS 3DEP Data	Areas of a landscape that could contribute sedimentation to specific waterbodies
Wildlands Health	Riparian Areas	USFS Riparian Area base map USGS Hydrography Dataset	Areas adjacent to water sources where ecosystem function is influenced by aquatic ecosystem

OBJECTIVE	WEIGHT
Assets	5
Safety	5
Water	1
Wildlands Health	1

Wildfire Mitigation Strategy

RESPONSE TO WILDFIRE

High Value Resources and Assets (HVRAs) are important sites or features on the landscape that can be positively or negatively influenced by wildfire. The response to wildfire for each HVRA is estimated by linking a change in value to different levels of fire intensity.

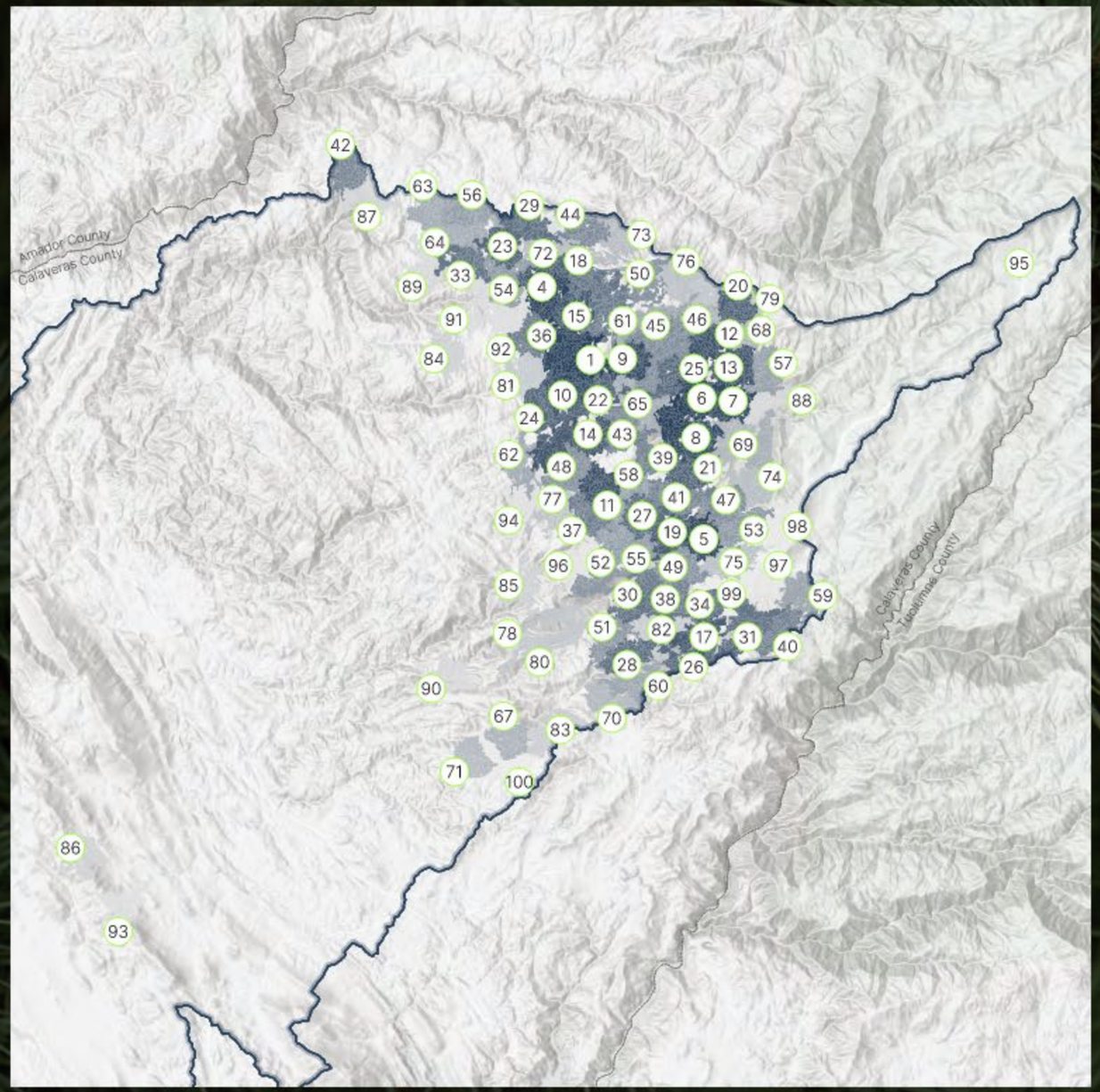
Response to wildfire depends on how each HVRA is impacted by different levels of fire intensity (measured by six flame length classes as shown in the adjacent table). Response functions are used to represent this change in value following a wildfire disturbance. Response functions range in value from -1 (representing 100% potential loss of value) to 1 (representing a 100% potential increase of value). Each HVRA is assigned a response to each flame-length class and responses vary depending on each HVRA's susceptibility to fire. A common pattern for some HVRAs reflects increasing loss with increasing fire intensity, while other HVRA show neutral or beneficial effects to all but the highest flame-length classes. More information about individual HVRAs can be found at the Vibrant Planet Knowledge Center (https://go.vibrantplanet.net/learn/sara-fact-sheets).

Combining the probability of fire at each flame length class with the assigned response value produces an estimated change in value for each HVRA. This calculation is performed at each flame-length class, then summed over all six classes to produce a measure called Net Value Change.

HVRA NAME	> 0 - 2 FT	2 - 4 FT	4 - 6 FT	6 - 8 FT	8 - 12 FT	> 12 FT
Emergency Service Facilities	-0.125	-0.225	-0.4	-0.6	-0.8	-0.925
Energy Facilities	-0.125	-0.225	-0.4	-0.6	-0.8	-0.925
Lakes	0.13	0.08	-0.138	-0.413	-0.68	-0.888
Perennial Rivers and Streams	0.13	0.08	-0.138	-0.413	-0.68	-0.888
Public Water Supply	0.13	0.08	-0.138	-0.413	-0.68	-0.888
Riparian Areas	-0.657	-0.657	-0.664	-0.679	-0.895	-1
Sediment Catchments for Water Supplies	-0.059	-0.059	-0.063	-0.067	-0.123	-0.326
Structure Transmission Zone	-0.2	-0.3	-0.5	-0.6	-0.7	-0.8
Structures	-0.1	-0.2	-0.4	-0.6	-0.8	-0.9
Transmission Lines	-0.13	-0.17	-0.3	-0.5	-0.63	-0.7
Wildland Urban Interface (Defense Zone)	-0.1	-0.3	-0.6	-0.8	-0.9	-1

Wildfire Mitigation Strategy

PROJECT SEQUENCING



File Name: proposal-all projects.shp

Projects are sequenced, or ranked from 1-100 with Project 1 being the most impactful for risk reduction based wildfire hazard and objective emphasis.

Mitigation projects were targeting a per project size of 500 contiguous acres. One hundred projects were identified as part of this analysis to allow for maximum operational flexibility and collaboration. Each project comes with recommended management action and a suite of no action and post action metrics and analysis assuming that the management action is implemented.

Additionally, estimates of gross cost, potential product benefit and total cost are included along with ownership. A summary of the 100 projects, including change in flame length, erosion rate, and other community and water metrics is included in the appendices. The analysis assumes the recommended management action was implemented. For more information about the suite of attributes see the Vibrant Planet Knowledge Center.

PROJECTS

50,112 acres

recommended for treatment

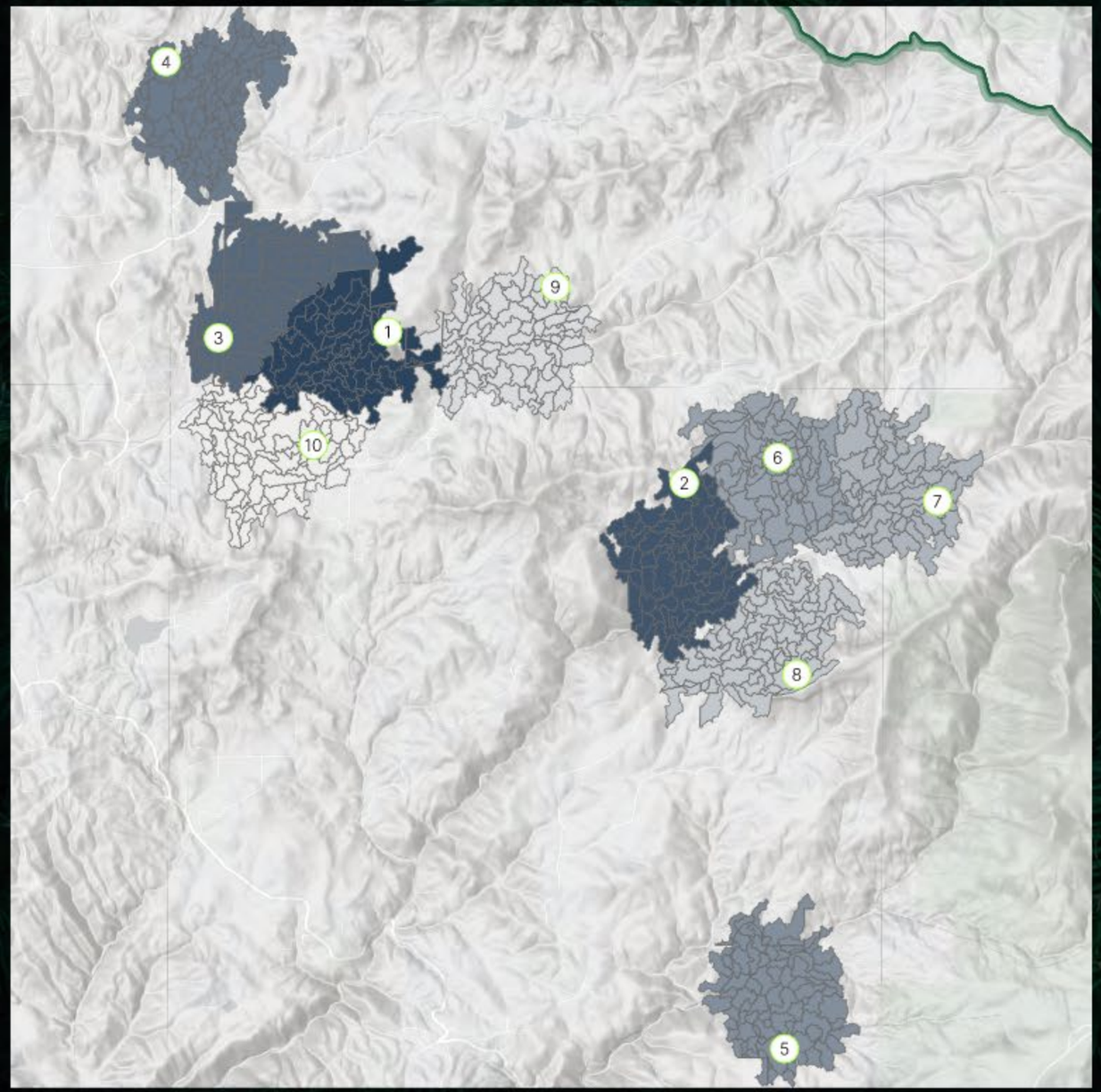
TOTAL COST

$121,194,797

Cost after timber volume offset

Wildfire Mitigation Strategy

TOP TEN PROJECT REVIEW



File Name: proposal.shp

LOWER IMPACT — HIGHER IMPACT

Projects are ranked from 1-10, with Project 1 being the most impactful at reducing wildfire risk. These projects, representing a potential initial body of potential work were further assessed for their specific impact on risk reduction to communities and water resources. A project by project breakdown is also provided in the appendices.

This subset of the 10 identified projects was further assessed for post action impact, including change in flame length, structure exposure, change in hazard classification, erosion rate, and other community and water metrics. The analysis assumes the recommended management action was implemented.

PROJECTS

4,998 acres

recommended for treatment

PROJECT	ACRES	FLAME LENGTH	FLAME LENGTH (POST ACTION)	TOTAL COST	EROSION RATE	EROSION RATE (POST ACTION)
1	497	10.5 ft	1.3 ft	$1,148,404.00	90.3 tons/acre	24.3 tons/acre
2	496	11.8 ft	1.4 ft	$1,482,851.00	92.8 tons/acre	30.1 tons/acre
3	502	8.4 ft	1.2 ft	$1,393,827.00	23.4 tons/acre	7.8 tons/acre
4	499	9.2 ft	1.3 ft	$1,298,256.00	36.5 tons/acre	13.8 tons/acre
5	500	12.2 ft	0.9 ft	$1,655,355.00	96 tons/acre	26.3 tons/acre
6	505	8.4 ft	1.1 ft	$1,017,328.00	40.8 tons/acre	16.6 tons/acre
7	503	9.3 ft	1.1 ft	$894,491.00	37.4 tons/acre	12.9 tons/acre
8	498	9.5 ft	1.4 ft	$1,307,822.00	33.9 tons/acre	13.1 tons/acre
9	501	9.4 ft	0.9 ft	$1,506,026.00	50.1 tons/acre	17.3 tons/acre
10	497	8.5 ft	1 ft	$1,320,062.00	36.8 tons/acre	13.5 tons/acre

Wildfire Mitigation Strategy

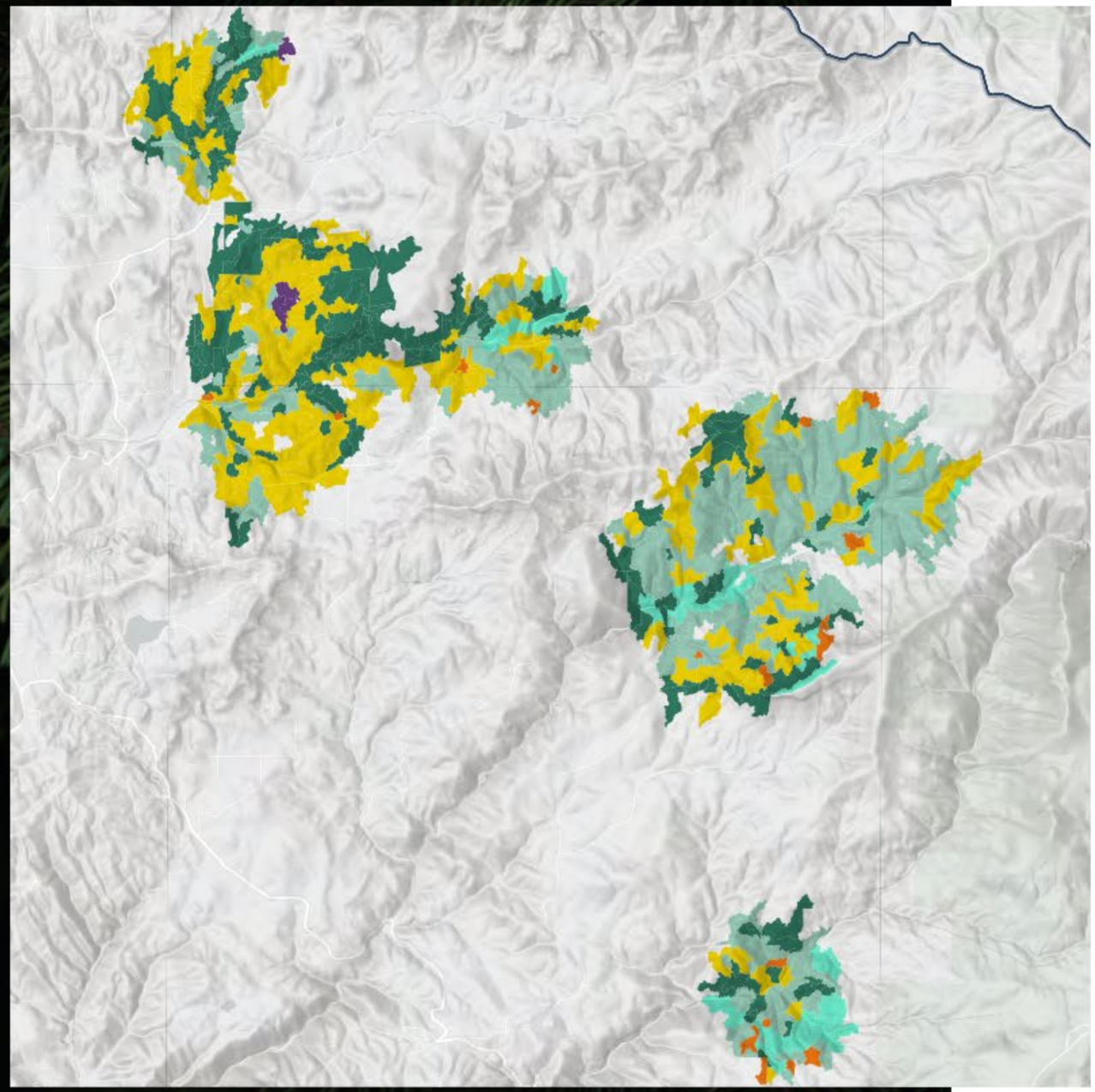
MANAGEMENT METHODS

Management methods described in this document are intended to describe the recommended method that may be applied to any particular management unit, however the prescription and intensity may vary depending on vegetation density and other factors. It is recommended that on-site ground verification occurs prior to implementation.

METHOD	DESCRIPTION
Complex Mechanical Removal	The Complex Mechanical Removal category, including steep slope clearcut, steep slope thinning, and urban clearing, refers to steep slope logging systems such as skyline, helicopter and tethered logging ideal for low impact/steep slope treatment and associated timber removal. Although these systems have fewer operability limitations than ground based systems, it is generally cost-prohibitive to cut and remove all the target woody vegetation. As a result, steep slope management commonly only targets larger diameter woody vegetation and usually results in millable product (MBF) and thus some cost offset.
Herbicides	Herbicide use, including broad and targeted applications, may be applied as a management tool to effectively manage undesired plant species for ecological resilience or restoration purposes. All herbicides are regulated by the Environmental Protection Agency and all applicable rules and guidelines and limitations would be followed. Herbicide use may be limited by social concerns.
Herbivory	Herbivory may be used prior to or after other treatment methods, or may be used in isolation for fuels reduction. This may include the use of goats, sheep, or other livestock. Often herbivory is used for vegetation maintenance and effectiveness is dependent on time of year and the types of vegetation that are palatable to the specific livestock.
Manual	Manual thinning, including manual clearcuts, urban clearing, and manually removing invasives, generally only affects woody vegetation. Manual methods refer to the use of manual labor and do not require heavy machinery. Manual methods are implemented on foot utilizing hand tools or small handheld power equipment such as chainsaws, pole saws or other similar types of equipment. Herbaceous vegetation like grass and forbs are generally unaffected except in targeted invasive species treatment. No removal of cut material is assumed except for invasive species management where certain species may be removed offsite. Manual thinning may be combined with a followup treatment such as pile burn or may be left on site as lop and scatter.
Mechanical Rearrangement	Mechanical Rearrangement, including mastication, mowing, and grapple piling, are intended to rearrange fuels and distribute them relatively evenly across the treated ground. Mastication and mowing can be accomplished by tracked equipment with an articulating head or wheeled machines equipped with a rotating drum. Intensity is determined by the need to reduce the effects of unplanned disturbance, existing vegetation management plans, and operational or social limitations. Grapple pile, synonymous with machine pile, is intended to pile existing residual downed fuel in a pile built higher than hand methods would allow. Tracked or wheeled equipment is utilized. Treatment is consistently and equally applied across an area and is focused on significantly reducing fine and medium fuels to contain a fire's rate of spread. Piled material is left on site to be burned at a later date. Grapple/machine pile burn windows are often longer when compared to the burn window of a hand pile.
Mechanical Removal	Mechanical Removal, including mechanical thinning, clearcutting, small diameter removal, thinning, and variable density thinning, refers to traditional whole tree or cut-to-length ground based logging and timber removal systems. Although these systems have operability limitations, they are generally cost-effective to cut and remove woody vegetation down to a four inch DBH. Management goals include, but are not limited to, reducing the severity of planned or unplanned fire, increasing forest resilience to drought, improving ecological function, or a site change for development. Ground Based Mechanical treatments generally only target woody vegetation and commonly results in a product benefit.
Revegetation	Revegetation, including all growth forms, herbaceous, shrubs and trees are focused in areas where natural revegetation is not predicted to occur within a target time frame and/or where specific species are desired. Revegetation alone does not impact existing vegetation or soil, but when used in combination with other techniques to prepare the site can have more impact.
Rx Fire	Rx Fire, including aerial ignition and Rx ground fire low intensity, involves the intentional lighting of fire for the purpose of management. Desired flame height is selected and burn plans are developed to target specific conditions; applicability may be limited based on many factors such as proximity to structures, smoke impacts or social acceptability.

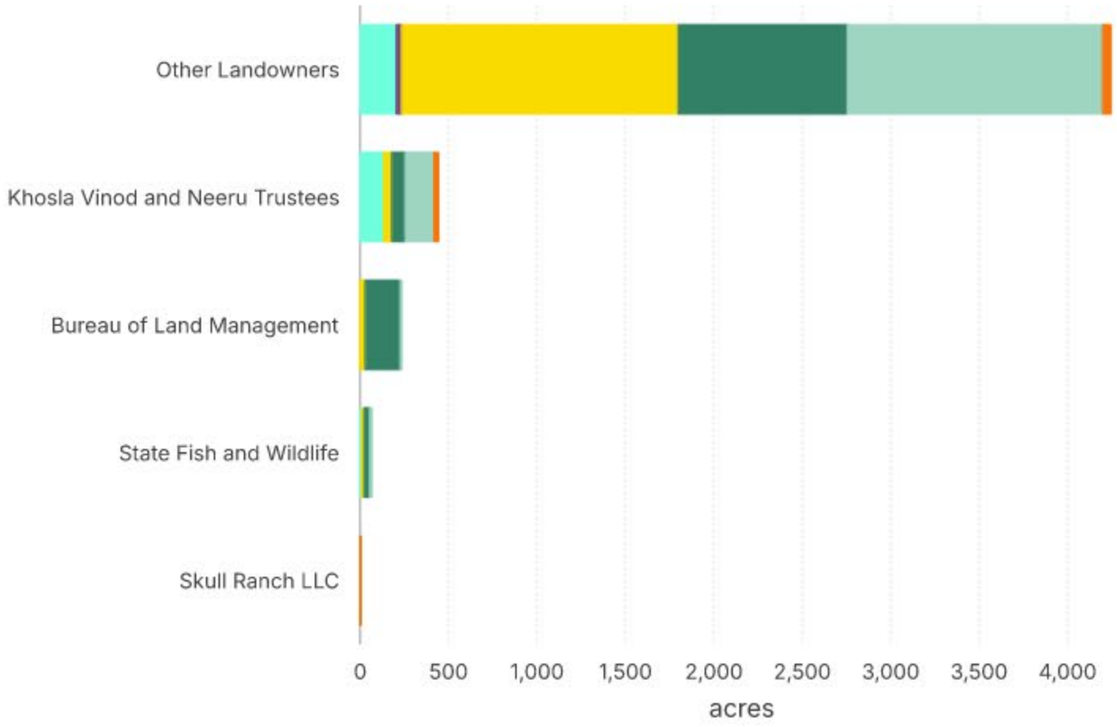
Wildfire Mitigation Strategy

RECOMMENDED MANAGEMENT



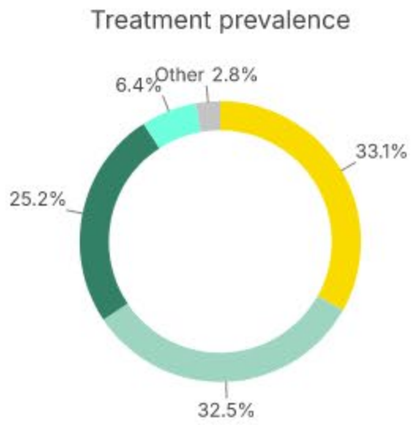
File Name: proposal.shp

Management methods described in this document are intended to describe the recommended method that may be applied to any particular management unit, however the treatment prescription and intensity may vary depending on vegetation density and other factors. It is recommended that on-site ground verification occurs prior to implementation.



TREATMENT TYPE

- Complex Mechanical Removal
- Herbivory
- Mechanical Removal
- Manual
- Mechanical Rearrangement
- Rx Fire



Wildfire Mitigation Strategy

COST + PRODUCT BENEFIT

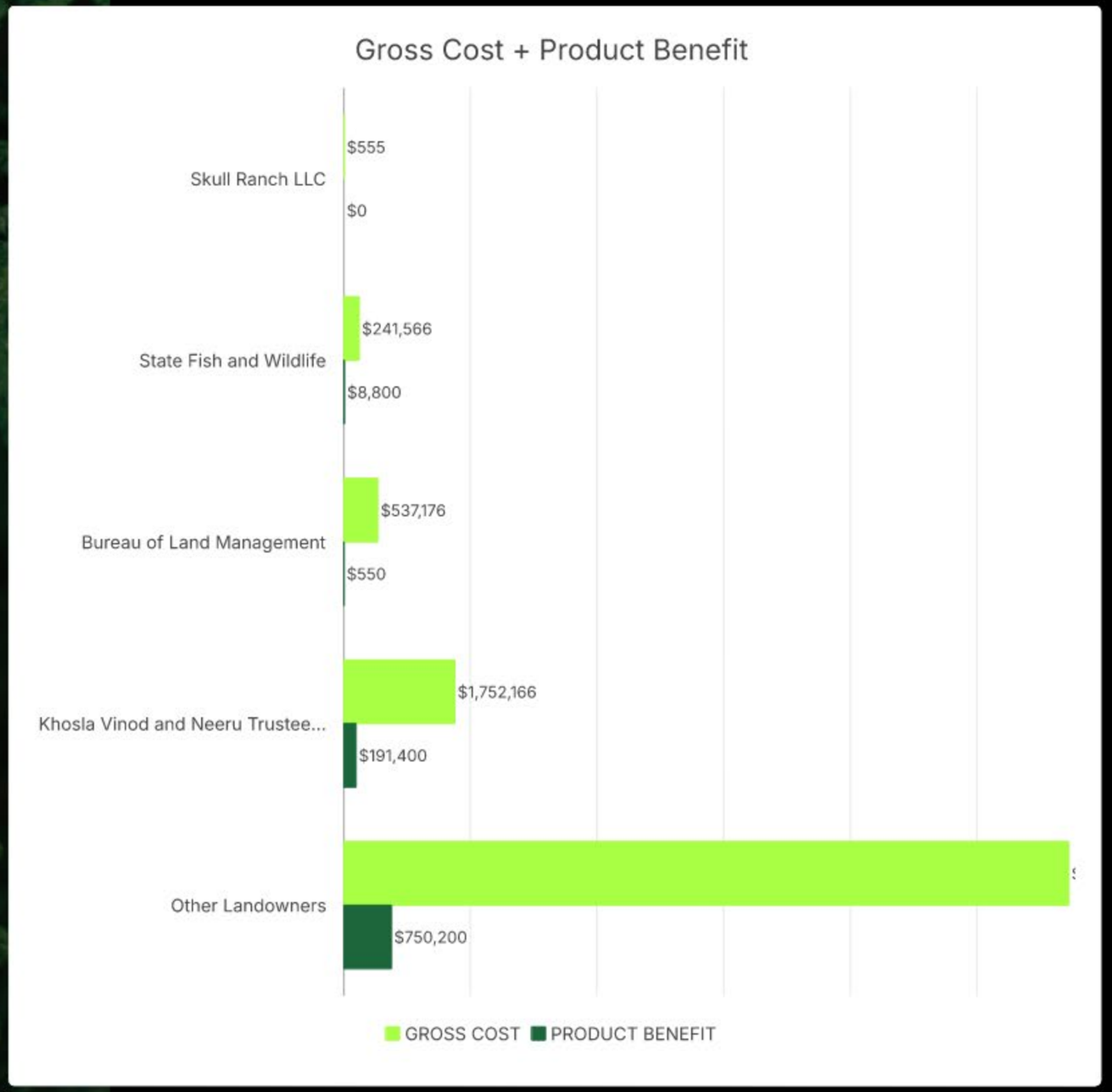
Predicted benefits are calculated from a myriad of resources including remotely sensed datasets, models, estimated log prices, average regional logging costs, and expertise and is intended to be used as a conservative benchmark for management planning and business operation projections.

ACRES TREATED
combined footprint of all projects
4,999

ESTIMATED TREATMENT COST
per acre
$2,610

MBF
thousand board feet
20,625

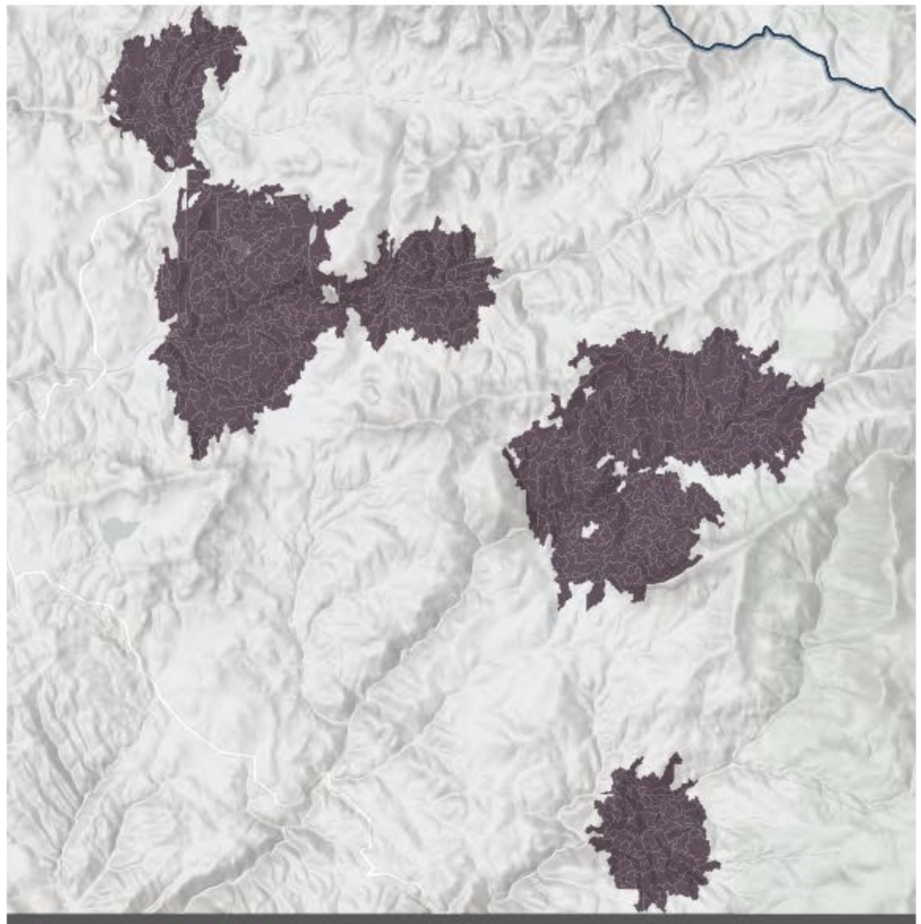
SUBMERCHANTABLE BIOMASS
bone dry tons
141



Wildfire Mitigation Strategy

CHANGE IN STRUCTURE EXPOSURE

The Structure Exposure Score (SES) dataset is an index of risk to structures, measuring wildfire hazard exposure specifically to structures, that incorporates fire intensity, ember load, and annual burn probability. These maps depict the change in Structure Exposure Score classes as a result of management action.



File Name: proposal.shp

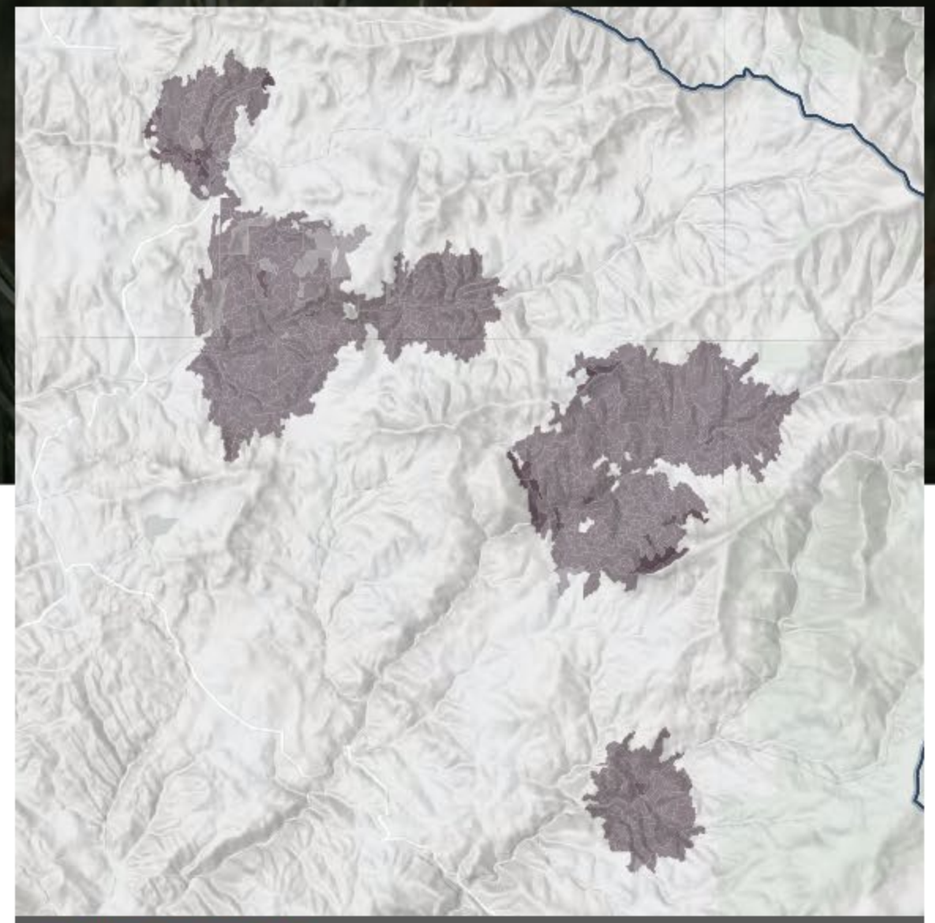
POST ACTION

Anticipated structure exposure classes after management action has been taken.

NO ACTION

Current structure exposure classes prior to implementation of management actions.

- HIGHEST
- HIGH
- MODERATE
- LOW
- VERY LOW
- LITTLE TO NONE



File Name: proposal.shp

SES CLASS	NO ACTION	POST ACTION	PERCENT CHANGE
Highest	263	2	-99%
High	2	9	350%
Moderate	0	253	0%
Low	0	1	0%
Very Low	0	0	0%
Little to None	0	0	0%

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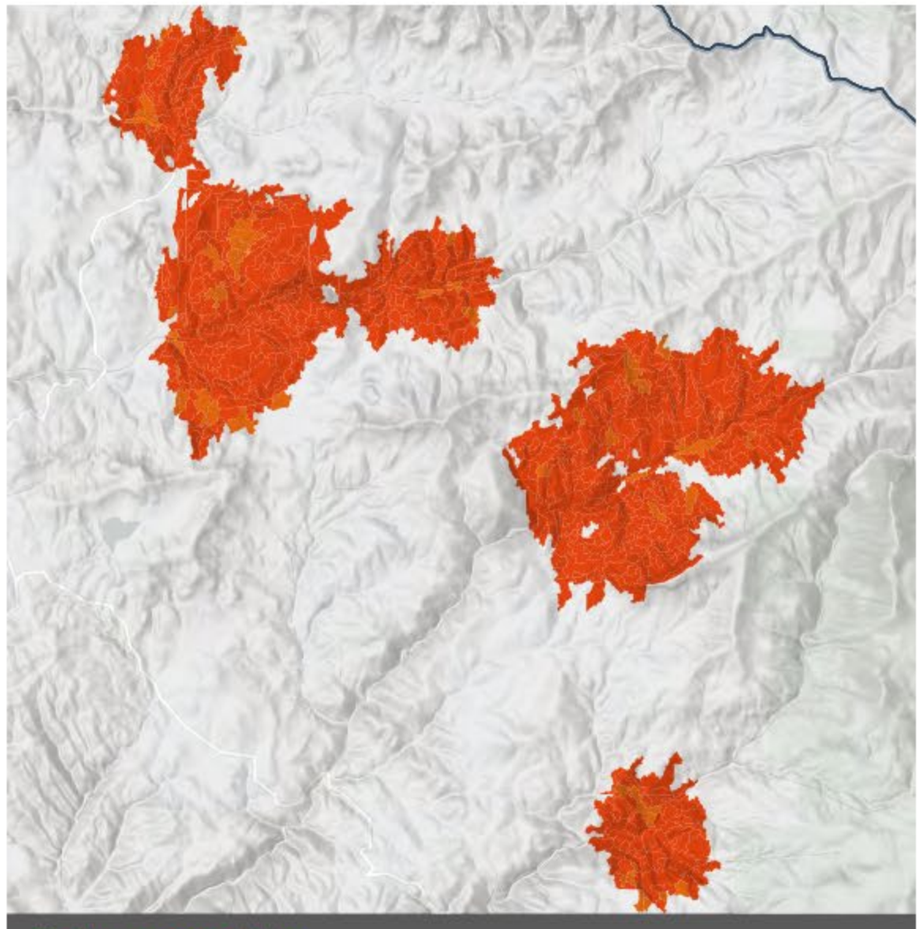
Wildfire Mitigation Strategy

CHANGE IN HAZARD

Hazard is classified into categorical classes using a logarithmic scale, where each class is an order of magnitude higher in hazard than the previous class. Going from very low to low, for instance, is a much smaller change in hazard than going from low to moderate.



File Name: proposal.shp

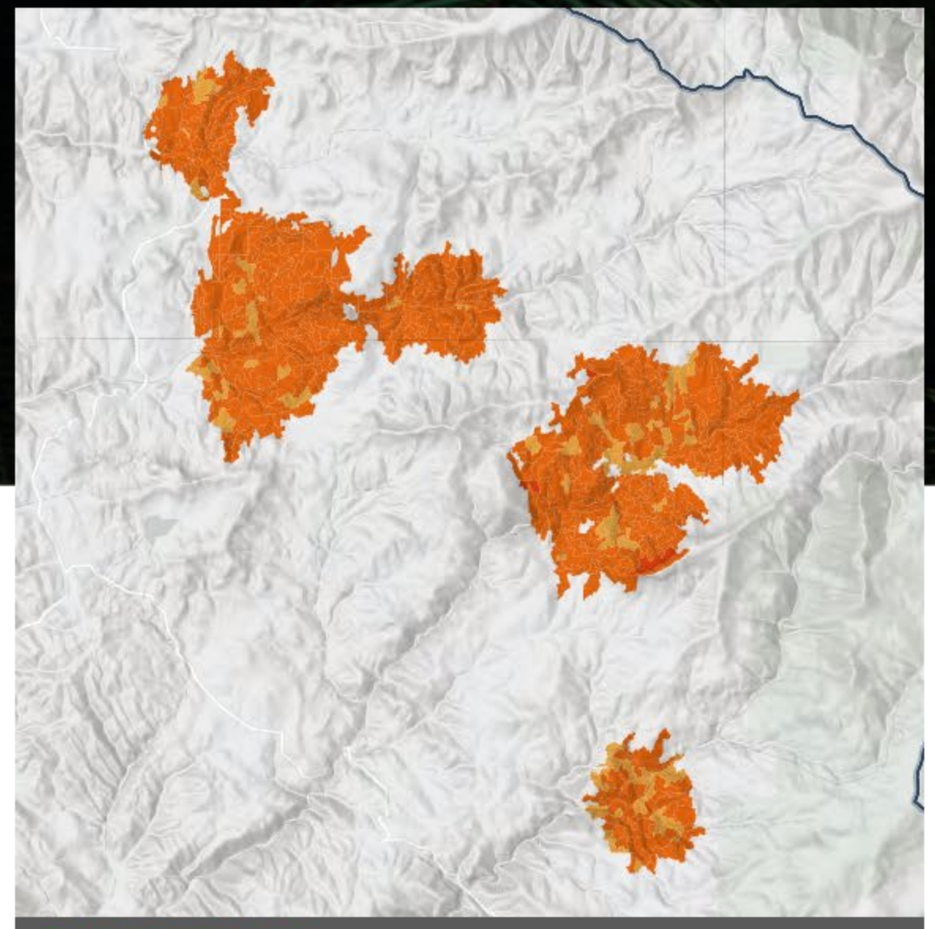
POST ACTION

Anticipated hazard classes after management action has been taken.

NO ACTION

Current hazard classes prior to implementation of management actions.

- HIGHEST
- HIGH
- MODERATE
- LOW
- VERY LOW
- LITTLE TO NONE



File Name: proposal.shp

HAZARD CLASS	NO ACTION	POST ACTION	PERCENT CHANGE
Highest	0	0	0%
High	4,656	38	-99%
Moderate	341	4,466	1,209%
Low	0	494	0%
Very Low	0	0	0%
Little to None	0	0	0%

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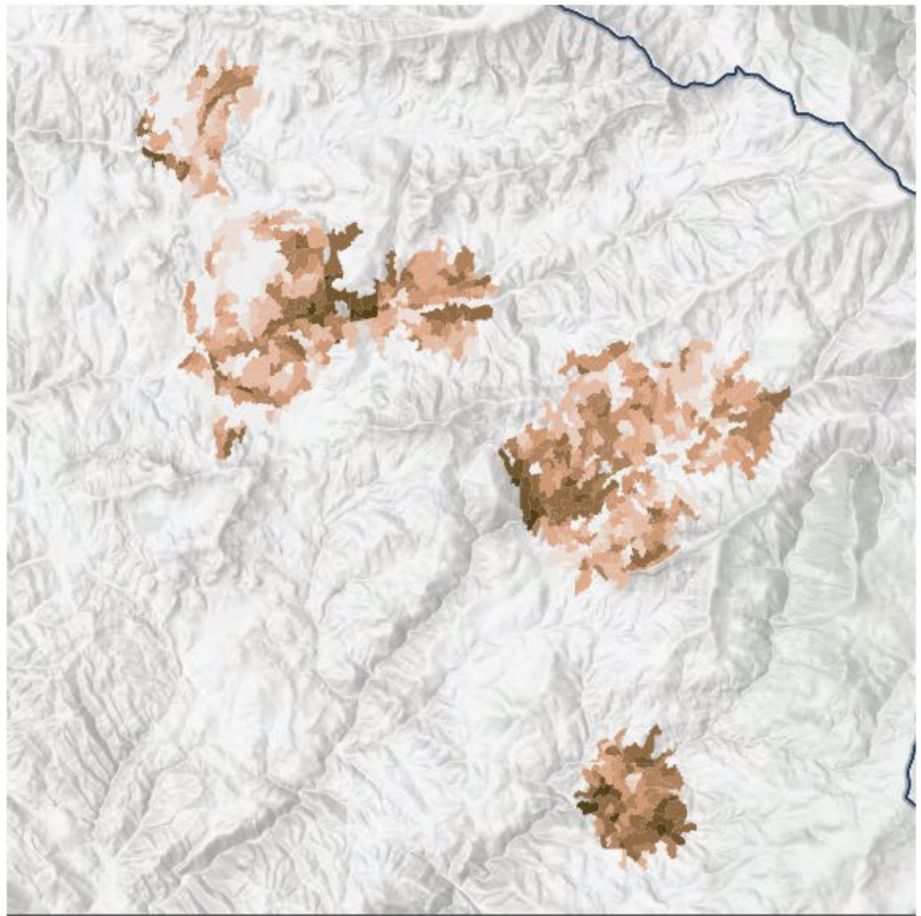
Wildfire Mitigation Strategy

CHANGE IN EROSION RATE

The change in expected erosion rate following a fire, both under no action and post action conditions, with no prior intervention relative to current conditions. Erosion rate is predicted using a gridded implementation of the Revised Universal Soil Loss Equation with current and expected post-fire difference driven by changes in soil cover.



File Name: proposal.shp

POST ACTION

Anticipated erosion rate (tons/acre) after management action has been taken.

NO ACTION

Current erosion rate (tons/acre) prior to implementation of management actions.

LOWEST RATE — HIGHEST RATE

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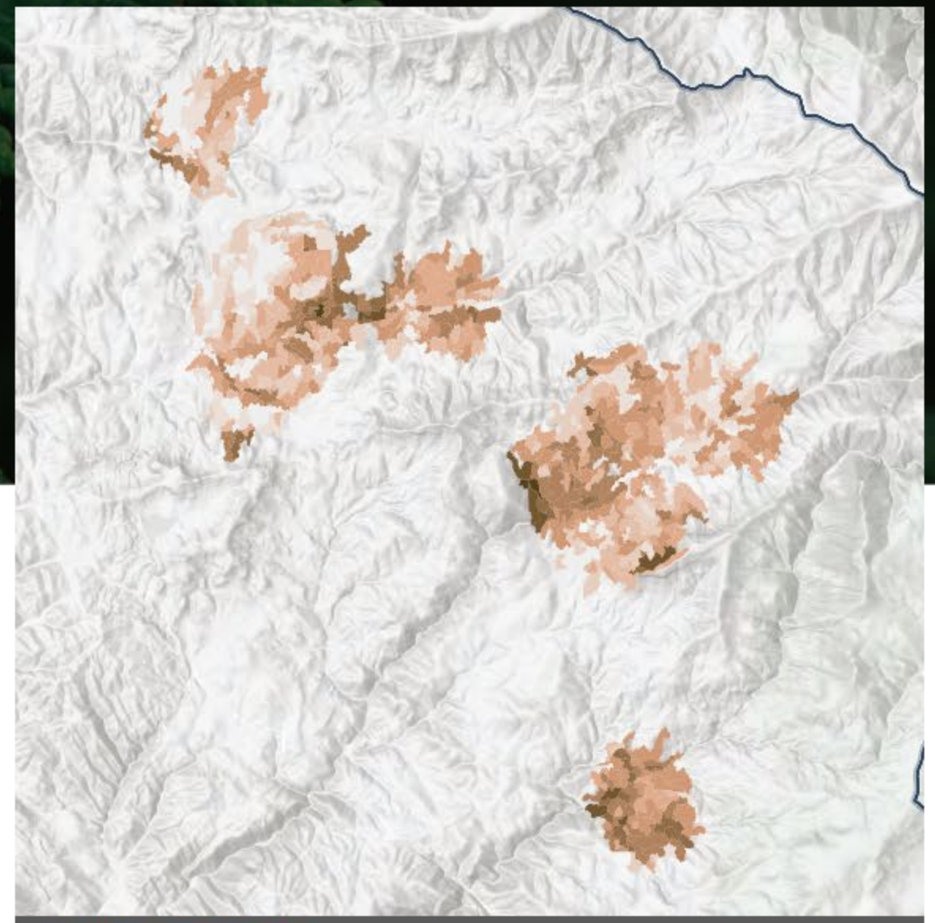


File Name: proposal.shp

PROJECT	ACRES	EROSION RATE	EROSION RATE (POST ACTION)
1	497	90.3 tons/acre	24.3 tons/acre
2	496	92.8 tons/acre	30.1 tons/acre
3	502	23.4 tons/acre	7.8 tons/acre
4	499	36.5 tons/acre	13.8 tons/acre
5	500	96 tons/acre	26.3 tons/acre
6	505	40.8 tons/acre	16.6 tons/acre
7	503	37.4 tons/acre	12.9 tons/acre
8	498	33.9 tons/acre	13.1 tons/acre
9	501	50.1 tons/acre	17.3 tons/acre
10	497	36.8 tons/acre	13.5 tons/acre

Wildfire Mitigation Strategy

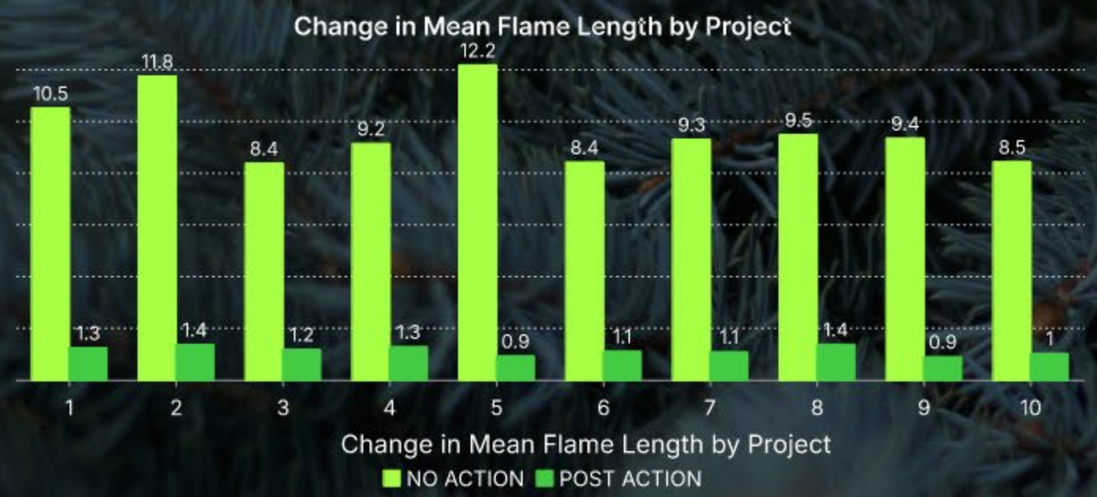
ESTIMATED IMPACT - COMMUNITIES

The metrics here represent change within the direct project footprints and assumes all projects were implemented.

PLAN SCOPE
number of projects — 10

TOTAL PROJECT ACRES
proposed for treatment — 4,998

NET TREATMENT COST
gross cost minus timber offset — $13,024,422



vibrant planet

PROJECT AREA BENEFITS

WILDFIRE HAZARD METRIC	DESCRIPTION	NO ACTION	POST ACTION	PERCENT CHANGE
Characteristic Flame Length (Feet)	Flame lengths represent fire intensity. A reduction in flame length will also result in a reduction in wildfire hazard. Many SARAs, but not all, respond poorly to high-intensity fires.	9.9	1.2	-88%
Estimated 10-year Burn Probability	Burn probability (BP) shows how likely an area is to burn sometime in the next 10 years. A higher BP means fire is more likely in an area.	17.87%	14.99%	-16%
Expected Annual Acres Burned	Using BP, this metric indicates how many acres are expected to burn in a single year. Note that this metric does not reflect intensity.	97	81	-16%
Expected Acres Burned within 10 Years	Similar to the metric above, this indicates how many acres are expected to burn within 10 years.	893	749	-16%
Rate of Spread (Chains per Hour)	Spread rate indicates how quickly a fire will grow. A reduction in spread rate often increases fire management opportunities and corresponds to lower intensities.	10.7	1.8	-83%
Rate of Spread (MPH)	Similar to the metric above, but spread rate is expressed in miles per hour (MPH) rather than chains per hour.	0.134	0.023	-83%
Number of Highly Exposed Structures	Management efforts can shift structures from high exposure to lower exposure. Significantly reducing wildfire exposure to those structures could avoid as much as $114.3 million in losses, based on an average rebuild cost of $300/sq ft and an average structure size of 1,500 sq ft.	265	11	-96%
Source Acres of Ember Load to Buildings	Structures can be exposed to fires by embers from nearby wildland vegetation. This metric shows how much of a management area (either unit, project, or planning area) contributes embers to nearby structures.	2893	1121	-61%

Wildfire Mitigation Strategy

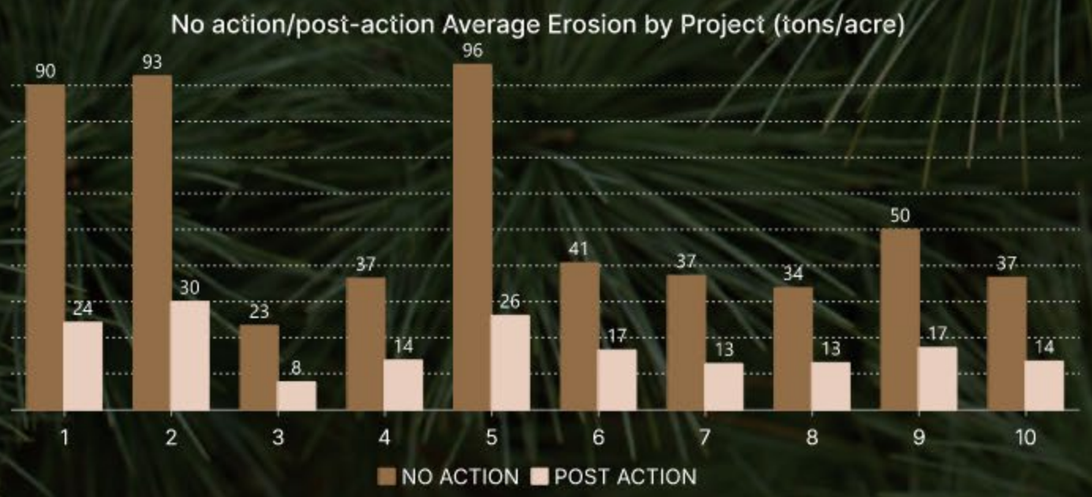
ESTIMATED IMPACT - WATER RESOURCES

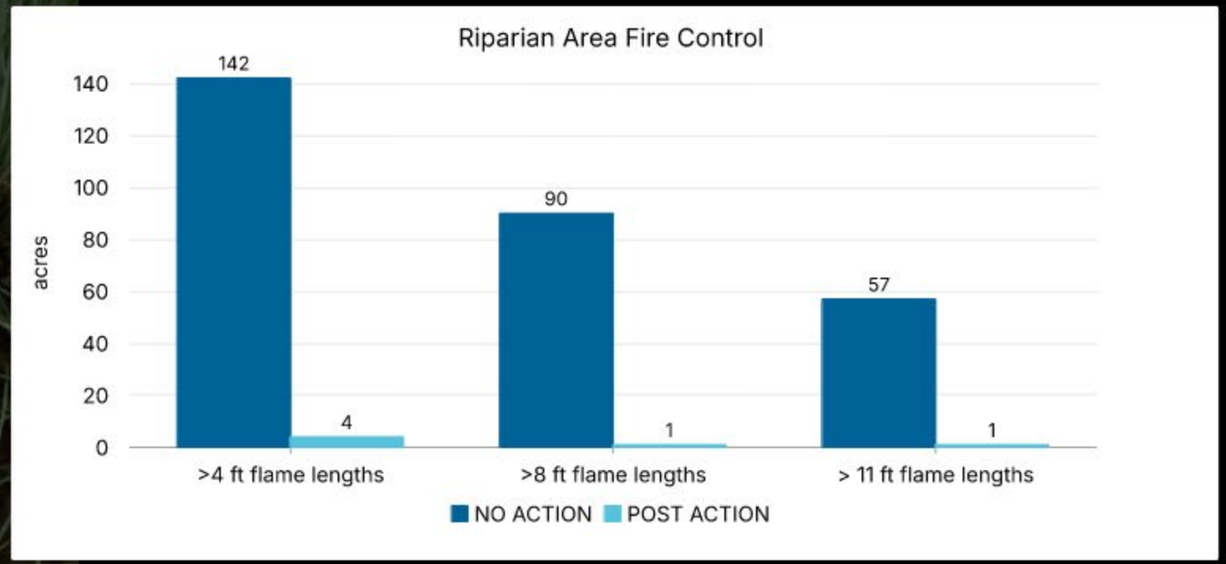
Vibrant Planet measures both the direct impact of treatments within the project footprint areas, and the cumulative impact of management across the landscape area. The metrics here represent change within the direct project footprints and assumes all projects were implemented.

PLAN SCOPE
number of projects — 10

TOTAL PROJECT ACRES
proposed for treatment — 4,998

AVERAGE EROSION RATES
no action/post action across all projects — 53.2/17.4 tons/acre





PROJECT	ACRES	SEDIMENT YIELD	SEDIMENT YIELD - POST ACTION	AVG. EROSION RATE	AVG. EROSION RATE - POST ACTION	WATER USE	WATER USE - POST ACTION
1	497.2	0 tons	0 tons	90.3 tons/acre	24.3 tons/acre	1,689	1,734.7
2	496.5	0 tons	0 tons	92.8 tons/acre	30.1 tons/acre	1,860.8	1,825.4
3	502.3	0 tons	0 tons	23.4 tons/acre	7.8 tons/acre	2,204.3	2,242.1
4	499.1	0 tons	0 tons	36.5 tons/acre	13.8 tons/acre	2,147.1	2,175.9
5	500.1	0 tons	0 tons	96 tons/acre	26.3 tons/acre	2,347.4	2,299.1
6	504.6	0 tons	0 tons	40.8 tons/acre	16.6 tons/acre	1,975.3	1,918
7	503.1	0 tons	0 tons	37.4 tons/acre	12.9 tons/acre	1,774.9	1,701.3
8	497.7	0 tons	0 tons	33.9 tons/acre	13.1 tons/acre	2,290.2	2,259.3
9	500.6	0 tons	0 tons	50.1 tons/acre	17.3 tons/acre	2,032.5	2,015.1
10	496.6	0 tons	0 tons	36.8 tons/acre	13.5 tons/acre	2,003.9	2,010.1

Safe and Effective Wildfire Response

Safe and Effective Wildfire Response

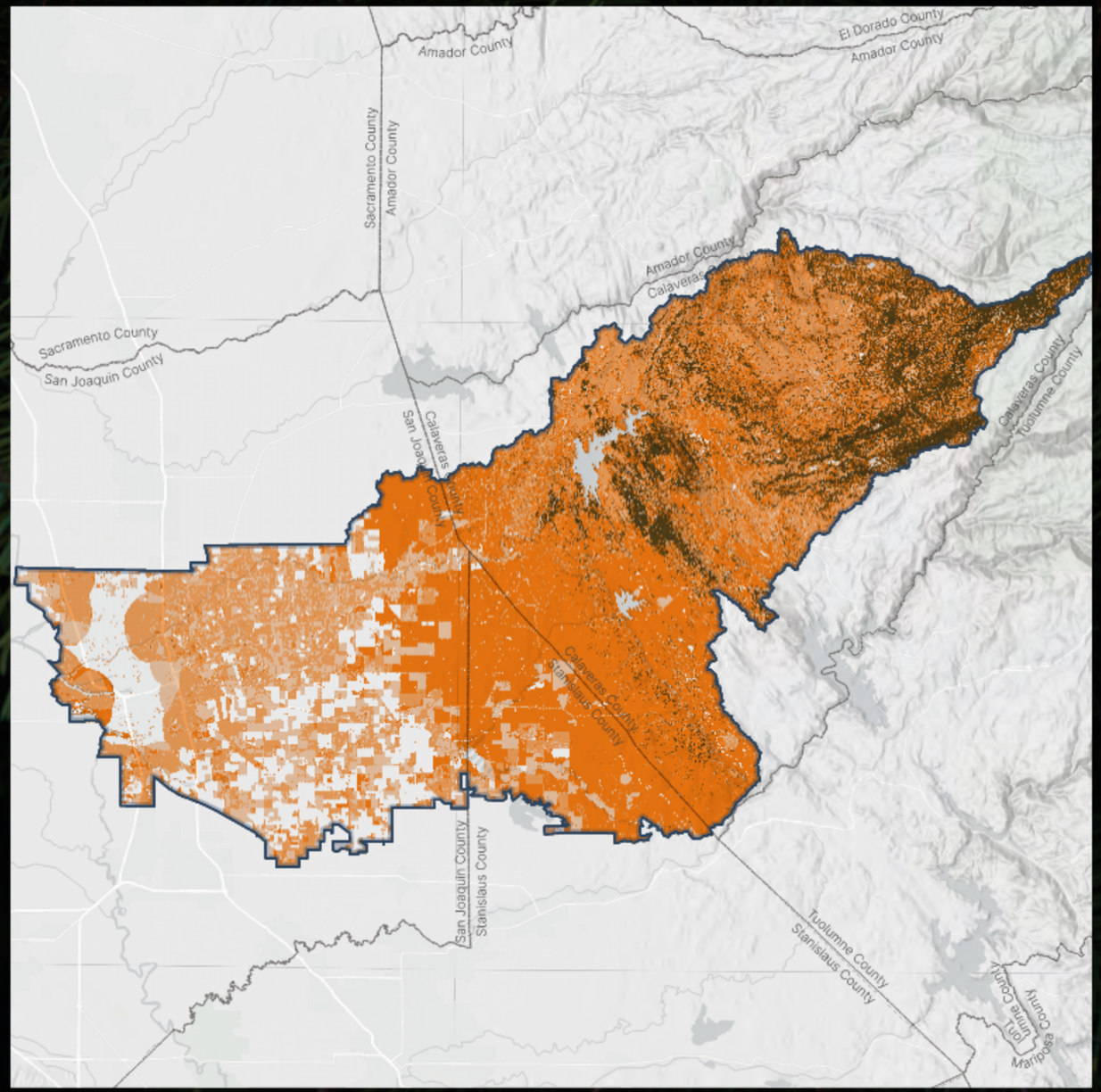
FLAME LENGTH

Characteristic Flame Length (CFL) represents the mean weighted flame length expressed in feet. Flame lengths represent fire intensity and are grouped into the following intensity classes: >0-2 ft, >2-4 ft, >4-6ft, >6-8ft, >8-12 ft, and greater than 12 ft flame lengths. Characteristic flame length can be expressed for any set of fire hazard weather conditions. This QWRA assesses mean CFL for season-long fire conditions (heading-only fire behavior) and 95th percentile (near-worst) weather conditions.

CATEGORY	FLAME LENGTH	DEFINITION
Class 1	> 0 - 2 ft	Scorch height 5-20'; typically, low severity; ground/surface fire in low fuel load and/or mild conditions. Fire burns surface fuels, small shrubs or seedlings.
Class 2	> 2 - 4 ft	Scorch height 10-40'; typically, low-to-moderate severity; ground/surface fire, moderate fuel load and/or moderate conditions. Fire burns surface fuels, shrubs and smaller trees.
Class 3	> 4 - 6 ft	Scorch height 20-60'; typically, moderate severity; ground/surface fire in moderate fuel and moderate-to-severe conditions. Fire burns surface fuels, shrubs and smaller trees, as well as individual mature trees.
Class 4	> 6 - 8 ft	Scorch height 30-80'; typically, moderate-to-high severity; some ground/surface fire transitioning to canopy fire in moderate-to-heavy fuel and moderate-to-severe conditions. Fire burns surface fuels, shrubs and smaller trees, and some smaller clumps of mature trees.
Class 5	> 8 - 12 ft	Scorch height 50-100'; typically, high severity; some ground/surface fire transitioning to canopy fire in moderate-to-heavy fuel load and moderate-to-severe conditions. Fire burns very hot, killing larger clumps of mature trees as well as consuming under-story and surface fuels.
Class 6	> 12 ft	Scorch height exceeds tree height; high severity; crown/canopy fire in heavy fuel in moderate-to-severe conditions. Fire burns very hot, killing nearly all mature trees in a wider area, as well as consuming under-story and surface fuels.

Safe and Effective Wildfire Response

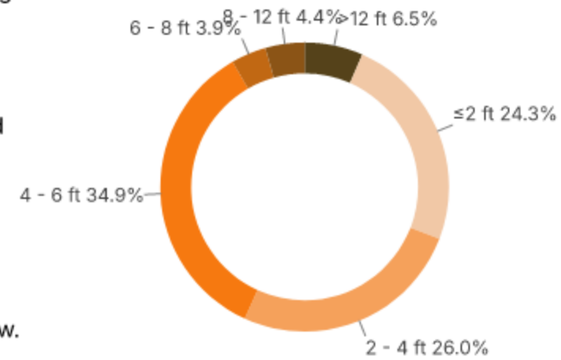
MEAN CHARACTERISTIC FLAME LENGTH



File Name: mean_flame_length.tif

Characteristic Flame Length represents the mean weighted flame length expressed in feet. Flame lengths represent fire intensity, bucketed into six classes.

Mean CFL expressed in feet and classified using six intensity classes. Characteristic Flame Length is a summary statistic that reflects a distribution of flame length probabilities. It is calculated using heading-only fire behavior and is weighted according to weather-type probability, incorporating both temporal frequencies and the influence of high-spread conditions from fire modeling completed by Pyrologix, using the wildfire modeling program WildEST, based on conditions 10 years from now.



In order to mimic wildfire penetration into developed (“non-burnable”) areas adjacent to large, contiguous areas of wildland fuels that are traditionally represented as non-burnable, Pyrologix estimates wildfire hazard in developed areas through "oozing." A first step in doing this is to identify islands of burnable fuel smaller than 500 ha using the 30 m burnable-fuel raster and temporarily set the non-zero BP values within the patches to no data. This prevents oozing BP values from those patches, reflecting the relatively low probability of small, vegetated patches to start urban conflagrations. For all other areas mapped with non-zero BP values (in contiguous patches larger than 500 ha), we expanded BP values into adjacent non-burnable areas. Mean flame lengths were then calculated using this adjusted BP layer. For additional information see Wildfire Risk to Communities: Methods for developing spatial datasets of landscape-wide wildfire risk components for the United States (Scott et al., 2024).

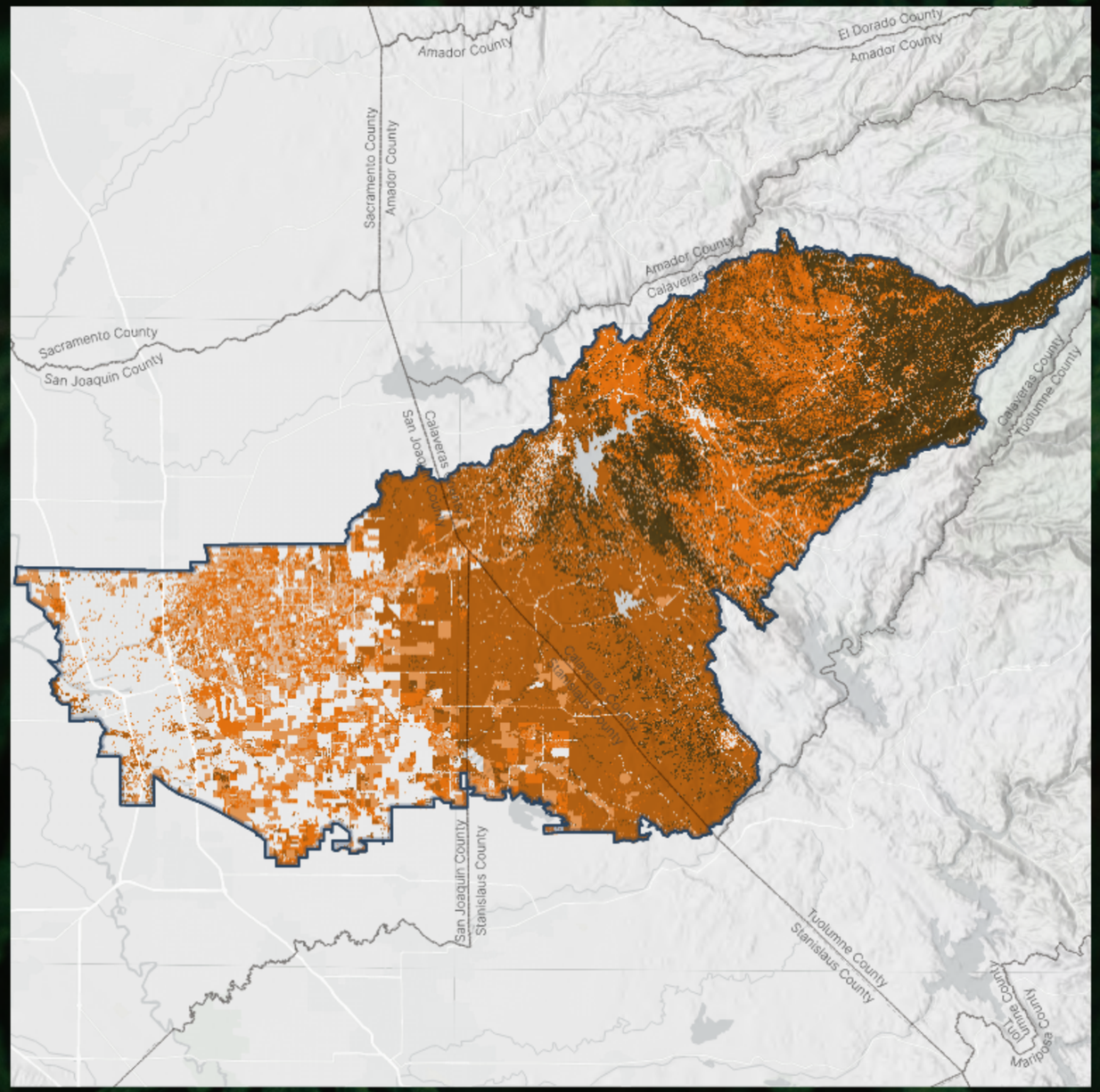
FLAME LENGTH

44,377 acres

of predicted flame length >12 ft

Safe and Effective Wildfire Response

95TH PERCENTILE FLAME LENGTH



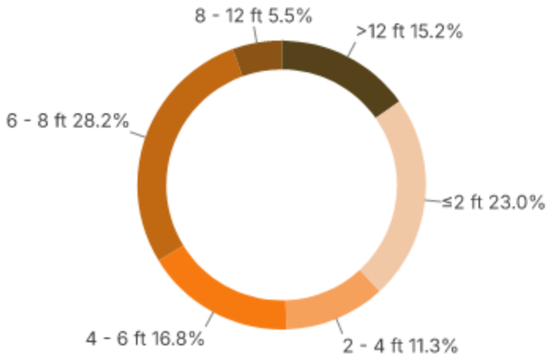
File Name: 95th_percentile_flame_length.tif

0 ft | 0-2 | 2-4 | 4-6 | 6-8 | 8-12 | >12 ft

95th percentile flame length represents the average of the 95th percentile through the maximum flame lengths, weighted by weather probability occurrence. This metric can inform fire behavior potential for the near-worst weather conditions.

The 95th percentile flame length is calculated from the Weather Type Probabilities (WTPs) across the entire fire season. Some wildfire-safety applications require knowledge of fire behavior potential for the near-worst weather conditions. In the past, this was accomplished by separately finding the near-worst wind speed and near-worst moisture content—typically the 95th, 97th, or 98th percentiles of those measures at a weather station. However, those two variables are not necessarily independent, so the 95th percentile wind speed may not ever occur at the 95th percentile moisture content. Moreover, wind direction is not typically used in such an analysis.

To avoid those challenges of addressing wind speed, wind direction, and moisture content together in one measure of the "95th percentile," WildEST computes the 95th percentile flame length value for a pixel as the WTP weighted average of the weather types that comprise a cumulative WTP of 0.05 (5%) when ranked highest to lowest by flame length. Thus, the 95th percentile flame length is actually the average of the 95th percentile through the maximum, weighted by their WTPs. The 95th percentile data is also post-processed to mimic wildfire penetration into developed areas.



95TH PERCENTILE FLAME LENGTH

191,667 acres

of predicted flame length >12 ft

Safe and Effective Wildfire Response

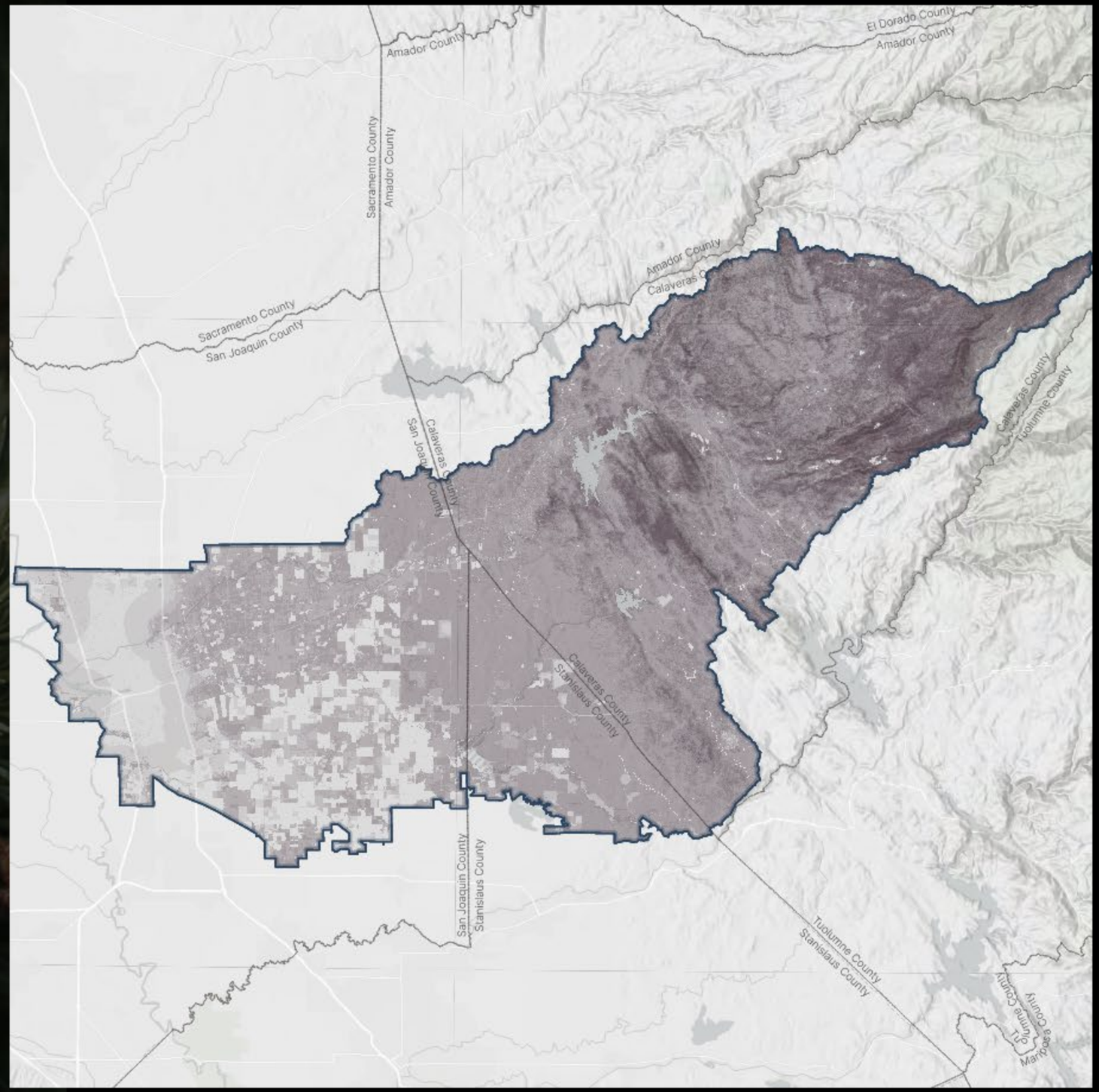
WILDFIRE EXPOSURE SCORE

The Wildfire Exposure Score (WES) dataset provides an index of wildfire exposure to structures. It combines wildfire likelihood with potential damage to homes—including ember exposure from nearby fuel—and is calculated for all parts of the landscape.

Wildfire Exposure Score (WES) is an integrated measure combining the likelihood of wildfire (Burn Probability) with potential consequences of wildfire to resources or asset at a given location (Damage Potential). In this dataset, consequence is modeled using a response function that accounts for potential loss to structures as a function of flame length, along with ember exposure from nearby vegetation. Together, these factors provide a general estimate of potential wildfire damage to homes.

WES calculations are applied broadly across the landscape regardless of whether a structure is present. It serves as a relative index of wildfire impacts based on landscape characteristics and does not incorporate the specific building materials of individual structures. Although WES offers an estimate of exposure relevant to homes, it does not include data on the actual presence or locations of structures. WES maps can be paired with additional data on structure locations and assets of interest.

WES uses a geometric-interval classification to define ten exposure classes where each class break is 1.5 times larger than the previous break. A location in Class 7 is 1.5 times more exposed than one in Class 6, and so on. This classification supports meaningful grouping of structures by exposure class to inform inspection, risk assessment, and hardening strategies.



File Name: wildfire_exposure_score.tif

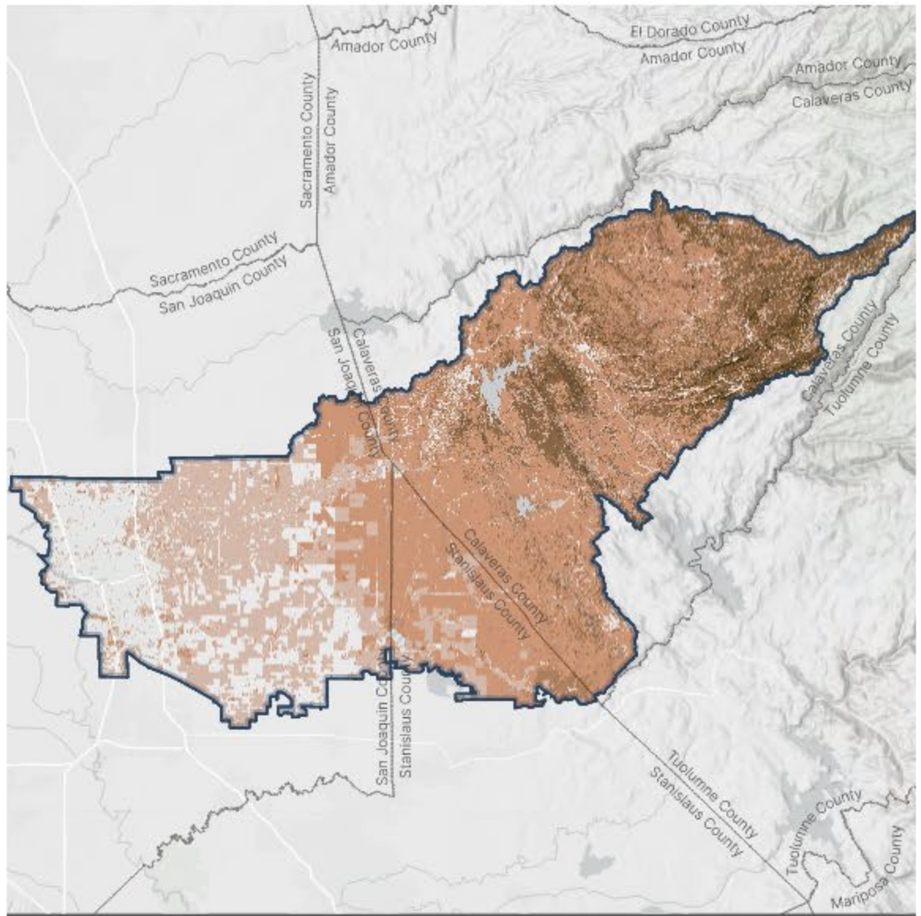
LOWEST — HIGHEST

Powered by PYROLOGIX

Safe and Effective Wildfire Response

EMBER LOAD + PRODUCTION INDEXES

The Conditional Ember Load Index (cELI) shows where embers may land on a landscape, which is helpful for identifying where to harden buildings against ember ignition. The Conditional Ember Production index (cEPI) rates the potential for ember production if a fire were to occur. Ember characteristics are useful for proactive fuels management, response planning, and structural hardening.



File Name: ember_production_index.tif

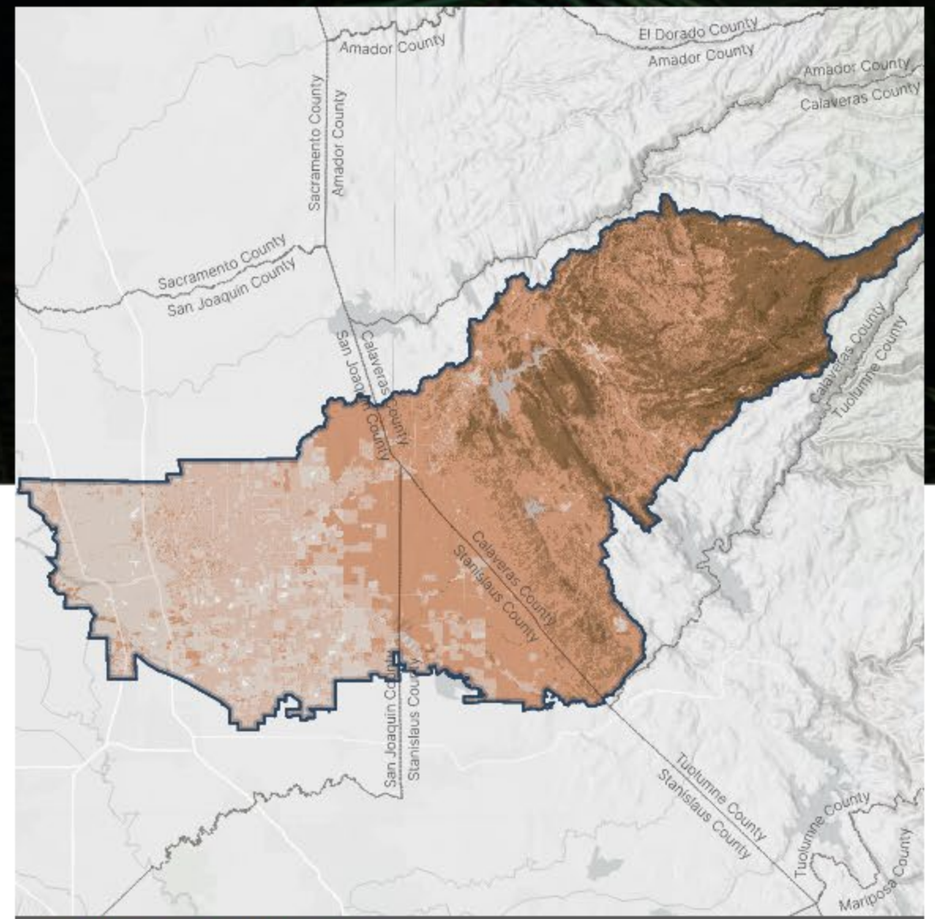
CONDITIONAL EMBER LOAD INDEX

Darker color indicates more embers may land in a given location.

CONDITIONAL EMBER PRODUCTION INDEX

Darker color indicates more embers may be produced in a given location.

LOWEST — HIGHEST



File Name: ember_load_index.tif

The Conditional Ember Load Index (cELI) is an index of the relative number of embers that land at a given landscape location, including embers that land on non burnable pixels that do not produce embers. The cELI does not account for burn probability and can be used to identify where on the landscape hardening buildings to resist ember ignition may be needed.

The Conditional Ember Production Index (cEPI) is an index of the relative number of embers lofted at a given landscape pixel if a fire were to occur. The cEPI represents the relative number of embers produced at a pixel as a function of the fire environment. Being "conditional," cEPI does not account for variation in burn probability across the landscape.

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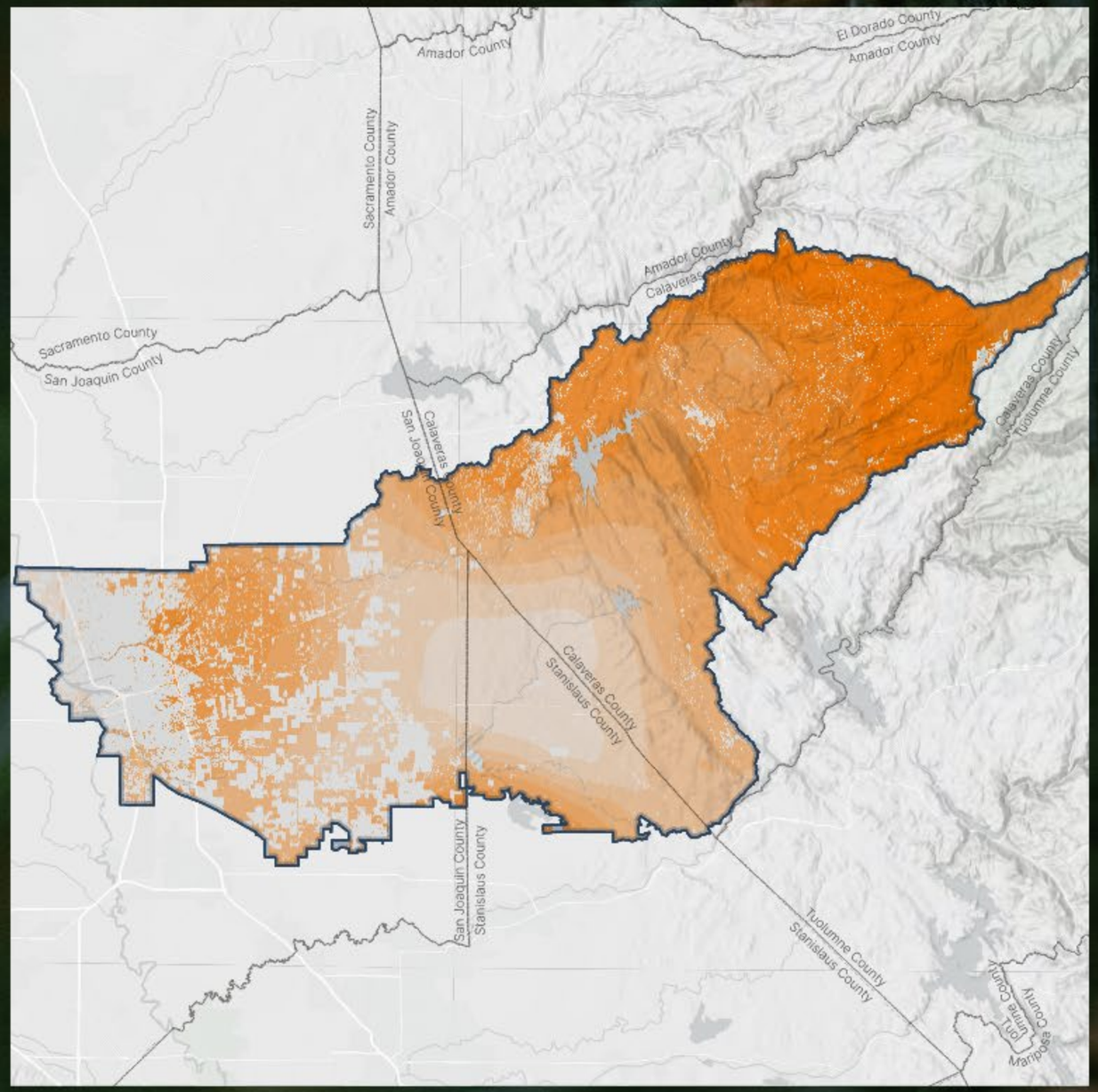
Safe and Effective Wildfire Response

STRUCTURE TRANSMISSION ZONE



File Name: structure_transmission_zone.tif

LOWEST — HIGHEST

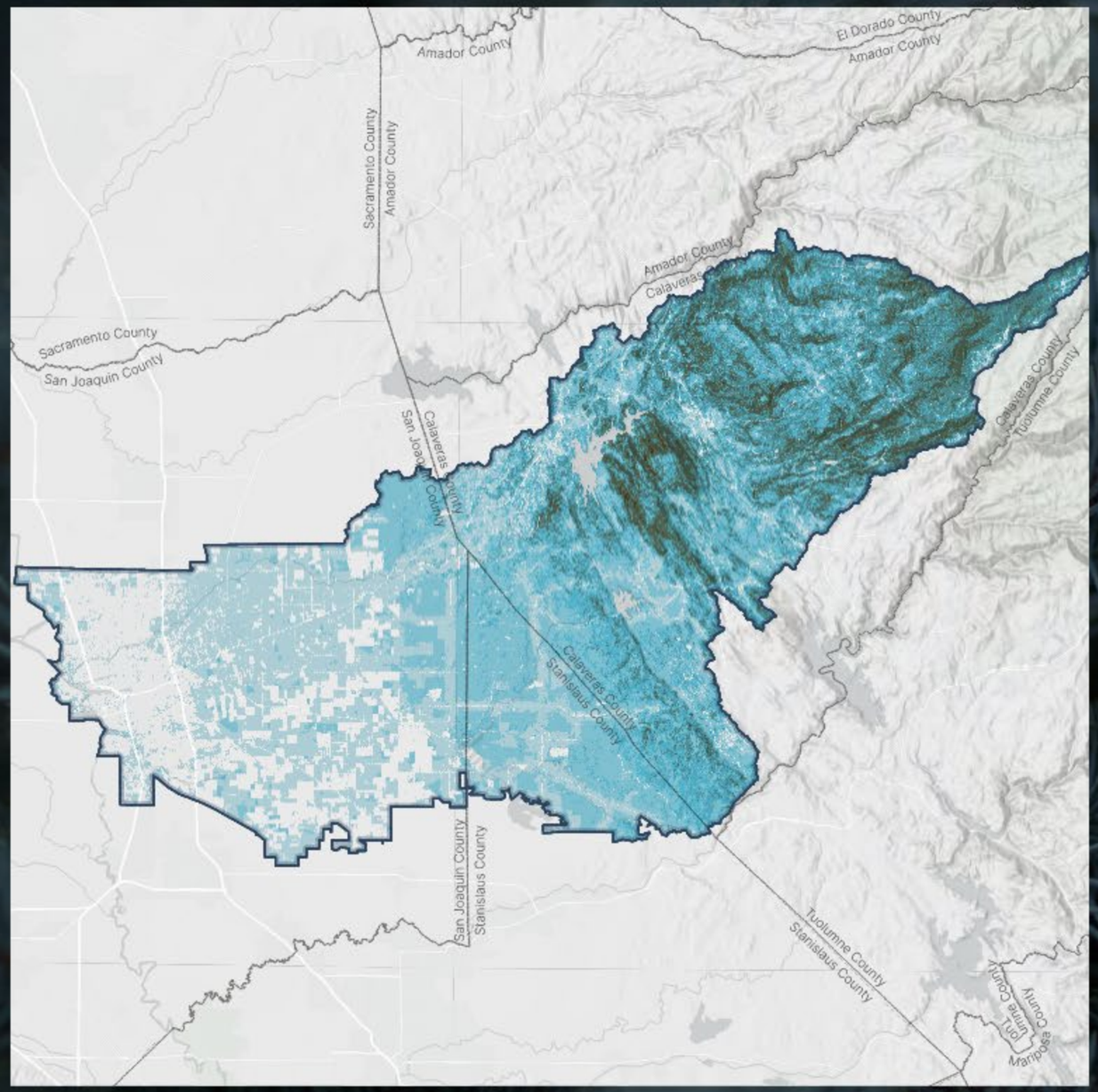
The Structure Transmission Zone raster values represent the number of structures per square kilometer per year that would be exposed to fire igniting at any given pixel location. Higher values indicate that a wildfire ignition could expose more buildings to a fire.

The Structure Transmission Zone is made up of wildland areas managed by humans that are, in this case, soley of interest due to their potential to expose nearby homes to fire. Specifically, this data provides an estimate of how many structures annually could be exposed to wildfire if a wildfire ignited in any given pixel of the raster layer. This is used to consider both the relative likelihood of an ignition and the consequence of the ignition in terms of the number of structures affected. It does not show the location of structure exposure where adverse effects could occur, but instead shows strategic areas where suppression of fire ignitions and alteration of fuels may reduce risk to communities.

This data layer is generated by comparing a collection of FSim fire model perimeters with a comprehensive structure dataset to estimate the number of structures impacted by each FSim simulated fire. Most analysis is completed using the spatial analysis functions in the terra R package (Hijmans et al., 2023).

Safe and Effective Wildfire Response

SUPPRESSION DIFFICULTY INDEX



File Name: suppression_difficulty_index.tif

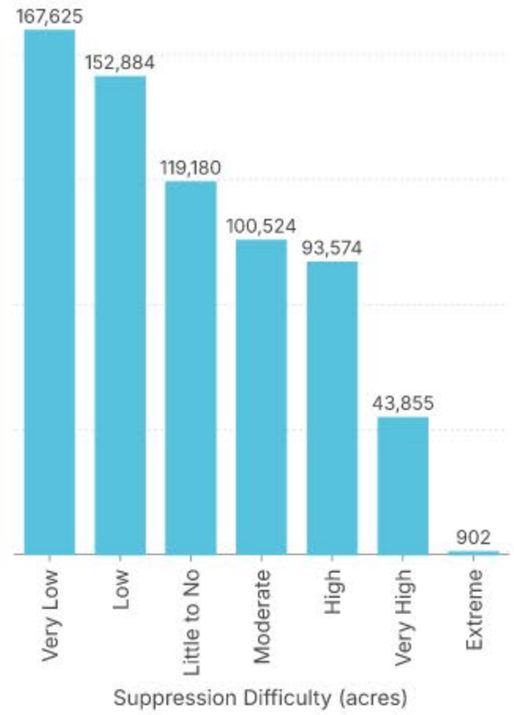
LITTLE TO NO DIFFICULTY — EXTREME DIFFICULTY

The Suppression Difficulty Index (SDI) quantifies the relative difficulty of ground-based fire suppression activities. The SDI can be used to help inform strategic and tactical fire management decisions.

The Suppression Difficulty Index (SDI) is an index—first developed as a non-spatial measure by Rodriguez y Silva et al. (2014) and later as a spatially explicit measure (O'Connor et al. 2016, Rodriguez y Silva et al. 2020)—that quantifies the relative difficulty of ground-based fire suppression activities. It factors in 25 topography, fuels, fire behavior, firefighter line production rates in various fuel types, and accessibility (distance from roads/trails) to assess relative suppression difficulty. The SDI can be used to help inform strategic and tactical fire management decisions.

WildEST utilizes the version of SDI methodology adopted for general use by the USDA Forest Service for the 2020 fire season, with minor modifications. The standard SDI process calculates slope steepness from a Digital Elevation Model and sometimes produced SDI artifacts due to the slope steepness calculation, so Pyrologix uses LANDFIRE's slope steepness directly.

Fire behavior inputs to the SDI model (flame length and heat per unit area) are typically calculated for a single weather condition for each pixel. Instead, we used the WildEST results for flame length and heat per unit area, which incorporate fine-scale spatial variability in the frequencies of weather types and the greater influence of high-spread conditions, as inputs to the SDI model. The SDI dataset provided here reflects disturbances only through 2023, and does not include disturbances from 2024.



SUPPRESSION DIFFICULTY

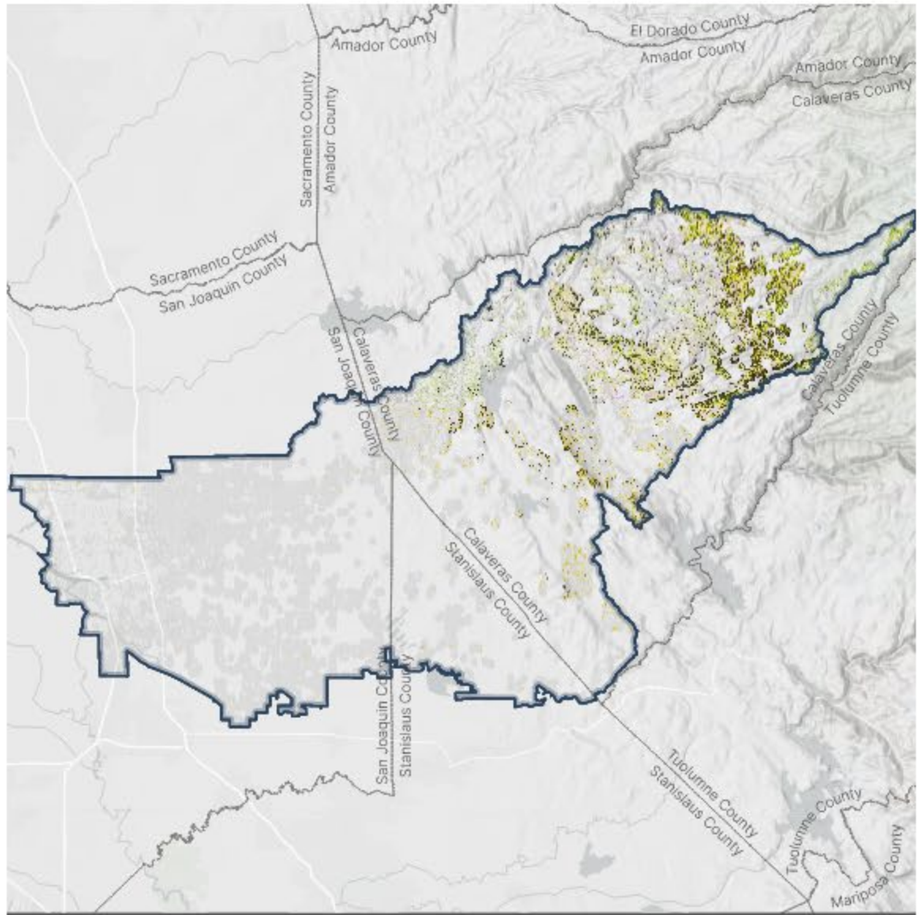
138,331 acres

of high or greater difficulty class

Safe and Effective Wildfire Response

WUI LIMIT OF MANUAL + MECHANICAL CONTROL

This metric identifies areas of WUI likely to have flame lengths exceeding direct manual and mechanical control capabilities. WUI Limit of Manual Control refers to areas with flame lengths greater than 4 feet, and Limit of Mechanical Control greater than 8 feet. Direct manual fire control (firefighters using hand tools to engage with the head of a fire) is generally considered feasible for flame lengths up to 4 feet. Wildfires with flame lengths greater than 8 feet generally exceed the ability for firefighters to use direct mechanical wildfire control tactics. Indirect wildfire attack tactics are typically used when flame lengths exceed 8 feet.



File Name: wui_limit_mechanical_control.tif

MANUAL CONTROL

0.32

probability that a location in the WUI is beyond manual control

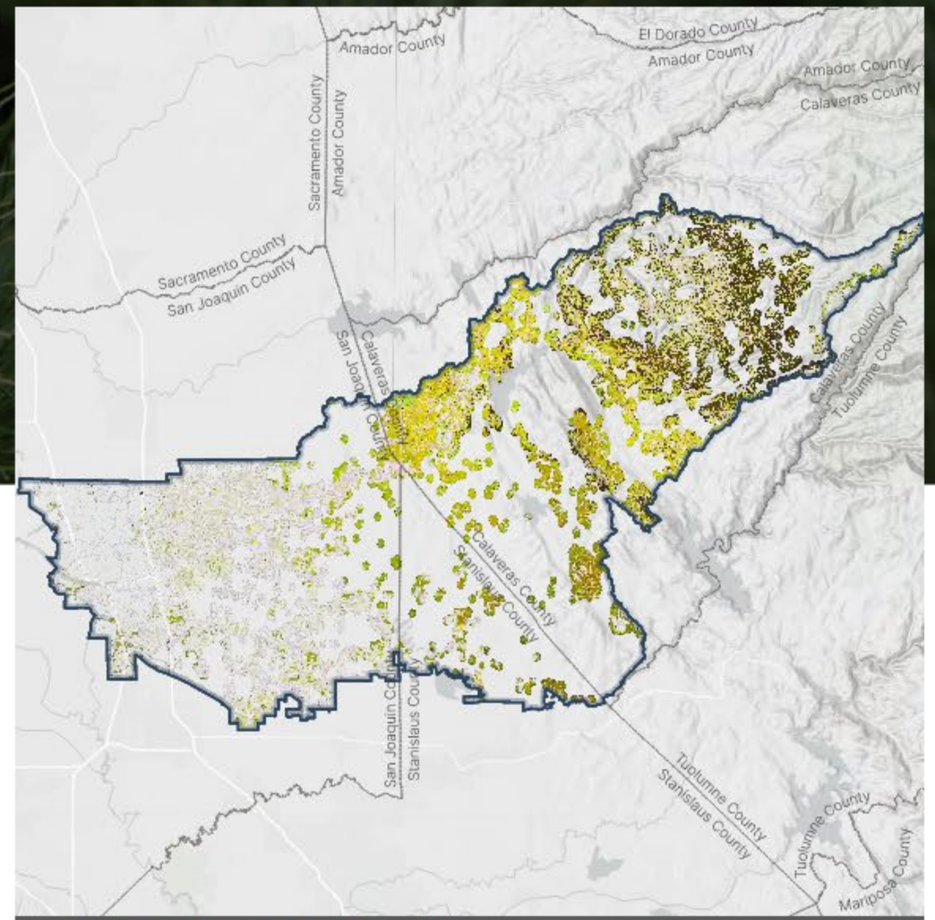
MECHANICAL CONTROL

0.10

probability that a location in the WUI is beyond mechanical control

0% 100% PROBABILITY

Powered by PYROLOGIX



File Name: wui_limit_manual_control.tif

Operational-control exceedance probability (FLEPs) rasters indicate the probability that the head-fire flame length in each pixel will exceed defined thresholds for certain types of operational control. The three levels of control are manual control, mechanical control, and extreme fire behavior (Andrews and Rothermel 1982). These probabilities are estimated by summing the WTP values for all weather types for which head-fire FL exceeds the threshold value.

Therefore, the probability-of-exceeding-control raster displays the likelihood of exceeding 4-foot, or 8-foot, heading flame lengths.

This information could be used as a supplement to the Suppression Difficulty Index (O'Connor et al. 2016) when planning wildfire suppression operations for a given area of the landscape. When summarized across a planning area, the FLEPs serve as a relative measure of fire suppression availability within the planning area and can be computed for the current condition fuelscape as well as a treated scenario.

Appendix A - Project Summaries

Project Summaries

PROJECTS 1-50

PROJECT	ACRES	FLAME LENGTH	FLAME LENGTH (POST ACTION)	TOTAL COST	EROSION RATE	EROSION RATE (POST ACTION)
1	497	10.5 ft	1.3 ft	$1,148,404.00	90.3 tons/acre	24.3 tons/acre
2	496	11.8 ft	1.4 ft	$1,482,851.00	92.8 tons/acre	30.1 tons/acre
3	502	8.4 ft	1.2 ft	$1,393,827.00	23.4 tons/acre	7.8 tons/acre
4	499	9.2 ft	1.3 ft	$1,298,256.00	36.5 tons/acre	13.8 tons/acre
5	500	12.2 ft	0.9 ft	$1,655,355.00	96 tons/acre	26.3 tons/acre
6	505	8.4 ft	1.1 ft	$1,017,328.00	40.8 tons/acre	16.6 tons/acre
7	503	9.3 ft	1.1 ft	$894,491.00	37.4 tons/acre	12.9 tons/acre
8	498	9.5 ft	1.4 ft	$1,307,822.00	33.9 tons/acre	13.1 tons/acre
9	501	9.4 ft	0.9 ft	$1,506,026.00	50.1 tons/acre	17.3 tons/acre
10	497	8.5 ft	1 ft	$1,320,062.00	36.8 tons/acre	13.5 tons/acre
11	501	13 ft	1 ft	$1,337,175.00	68.4 tons/acre	17.6 tons/acre
12	503	9.8 ft	1.1 ft	$1,374,510.00	61.1 tons/acre	21.1 tons/acre
13	503	7.5 ft	1.2 ft	$1,278,892.00	23.2 tons/acre	10.5 tons/acre
14	475	9.5 ft	0.9 ft	$1,105,966.00	39.2 tons/acre	12.6 tons/acre
15	496	7.4 ft	1.5 ft	$1,033,640.00	21.1 tons/acre	9.2 tons/acre
16	502	9.4 ft	1.3 ft	$882,948.00	34.2 tons/acre	12.7 tons/acre
17	502	12.5 ft	1.8 ft	$1,336,272.00	113.9 tons/acre	29.5 tons/acre
18	506	9.1 ft	1.1 ft	$1,257,248.00	36.9 tons/acre	12.7 tons/acre
19	492	13 ft	1 ft	$1,226,475.00	115.2 tons/acre	27.1 tons/acre
20	478	9.7 ft	1.7 ft	$1,398,953.00	69.6 tons/acre	23.6 tons/acre
21	503	8.7 ft	1 ft	$1,206,931.00	29.4 tons/acre	11.1 tons/acre
22	490	8.5 ft	1.2 ft	$1,107,673.00	38 tons/acre	13.7 tons/acre
23	501	8.2 ft	1.2 ft	$1,222,196.00	33.8 tons/acre	13.6 tons/acre
24	512	8.4 ft	1.5 ft	$1,112,502.00	30.9 tons/acre	12.1 tons/acre
25	499	9.1 ft	1.3 ft	$1,170,942.00	54.2 tons/acre	20.6 tons/acre

PROJECT	ACRES	FLAME LENGTH	FLAME LENGTH (POST ACTION)	TOTAL COST	EROSION RATE	EROSION RATE (POST ACTION)
26	519	17.4 ft	2.6 ft	$1,761,824.00	193.6 tons/acre	55.2 tons/acre
27	511	10.8 ft	0.9 ft	$1,190,973.00	49.3 tons/acre	13 tons/acre
28	504	14.2 ft	1.7 ft	$1,235,491.00	128.4 tons/acre	31.7 tons/acre
29	507	7.3 ft	1.1 ft	$913,151.00	29.8 tons/acre	12.3 tons/acre
30	503	11.9 ft	2.5 ft	$1,122,121.00	73.5 tons/acre	26.3 tons/acre
31	502	17.2 ft	1.9 ft	$1,363,491.00	158.4 tons/acre	42.7 tons/acre
32	499	8.6 ft	1.4 ft	$1,061,173.00	28.8 tons/acre	9.5 tons/acre
33	502	8.2 ft	1 ft	$883,405.00	38.2 tons/acre	14.9 tons/acre
34	496	8.8 ft	1.3 ft	$1,160,085.00	57.4 tons/acre	19.6 tons/acre
35	499	9.4 ft	1.2 ft	$1,305,944.00	49.7 tons/acre	15.8 tons/acre
36	495	6.8 ft	1.7 ft	$1,136,724.00	19.2 tons/acre	9.9 tons/acre
37	502	7.9 ft	1.5 ft	$1,494,603.00	34.1 tons/acre	14.5 tons/acre
38	499	11.7 ft	2.4 ft	$1,023,088.00	98.4 tons/acre	32.6 tons/acre
39	500	14.1 ft	1.5 ft	$1,039,579.00	111 tons/acre	31.3 tons/acre
40	502	12.1 ft	4.3 ft	$1,505,721.00	87 tons/acre	41.1 tons/acre
41	501	9 ft	0.8 ft	$919,024.00	43.1 tons/acre	15.5 tons/acre
42	502	8.8 ft	1.7 ft	$1,220,280.00	60.3 tons/acre	24.9 tons/acre
43	500	10.9 ft	1 ft	$1,137,510.00	61.8 tons/acre	17 tons/acre
44	518	7.1 ft	1.4 ft	$872,563.00	23.4 tons/acre	11 tons/acre
45	500	7.8 ft	1.3 ft	$902,334.00	24.4 tons/acre	10 tons/acre
46	501	9.5 ft	1.2 ft	$1,336,057.00	56.7 tons/acre	18.7 tons/acre
47	504	13.7 ft	0.9 ft	$1,150,611.00	103.1 tons/acre	23.6 tons/acre
48	502	6.4 ft	1.2 ft	$1,382,048.00	18.4 tons/acre	10.3 tons/acre
49	512	9.7 ft	1.2 ft	$926,898.00	54.8 tons/acre	20.3 tons/acre
50	510	9.6 ft	2.2 ft	$998,119.00	52.9 tons/acre	19 tons/acre

Project Summaries

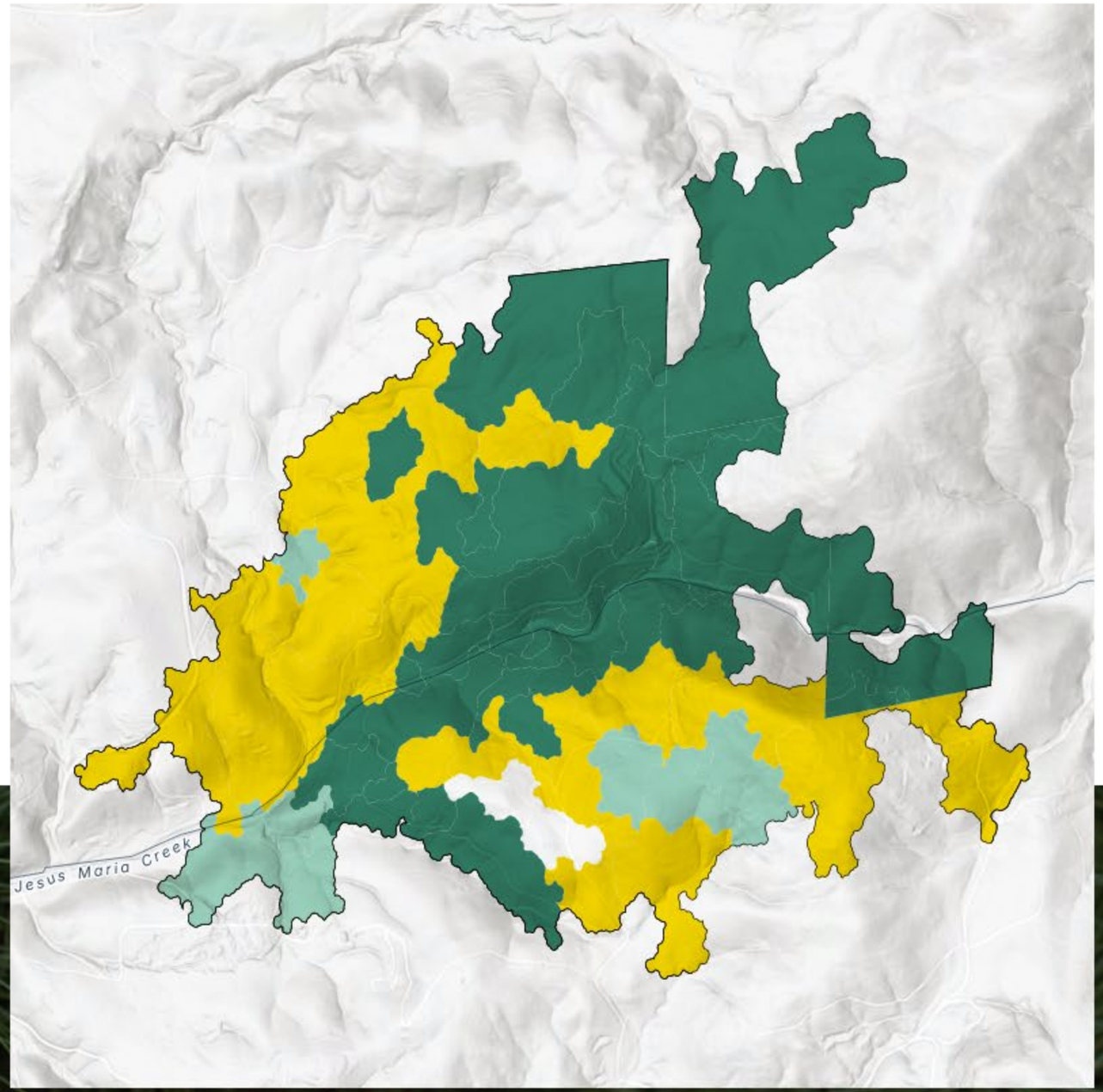
PROJECTS 51-100

PROJECT	ACRES	FLAME LENGTH	FLAME LENGTH (POST ACTION)	TOTAL COST	EROSION RATE	EROSION RATE (POST ACTION)
51	497	12.6 ft	1.8 ft	$1,174,252.00	75.4 tons/acre	23.8 tons/acre
52	500	9.8 ft	1.7 ft	$932,011.00	42.2 tons/acre	15 tons/acre
53	510	11.5 ft	1.2 ft	$1,052,012.00	62.1 tons/acre	16.9 tons/acre
54	496	7.1 ft	1.8 ft	$1,251,121.00	33.2 tons/acre	16.7 tons/acre
55	503	8.3 ft	1.9 ft	$1,441,440.00	35.5 tons/acre	16.5 tons/acre
56	505	7 ft	1.5 ft	$1,077,646.00	21.6 tons/acre	11.3 tons/acre
57	501	11.5 ft	2.3 ft	$1,633,298.00	57 tons/acre	20.4 tons/acre
58	503	10.9 ft	1.3 ft	$1,153,486.00	66.2 tons/acre	18.5 tons/acre
59	501	11.7 ft	2.7 ft	$1,408,925.00	63.5 tons/acre	25.3 tons/acre
60	500	16.6 ft	2.4 ft	$1,172,547.00	159.8 tons/acre	46.8 tons/acre
61	503	9.5 ft	1.7 ft	$1,144,653.00	39 tons/acre	14.6 tons/acre
62	507	6.7 ft	1.8 ft	$1,065,530.00	18.3 tons/acre	10.1 tons/acre
63	499	9 ft	1.6 ft	$984,501.00	44.7 tons/acre	16.7 tons/acre
64	503	6.7 ft	1 ft	$820,041.00	20.6 tons/acre	9.7 tons/acre
65	477	10.2 ft	1.7 ft	$1,066,857.00	66.7 tons/acre	23.1 tons/acre
66	501	20.9 ft	4.2 ft	$2,518,515.00	95.4 tons/acre	27.7 tons/acre
67	498	13 ft	2.1 ft	$1,401,315.00	86.3 tons/acre	29.6 tons/acre
68	498	8.8 ft	1.7 ft	$1,148,203.00	49.4 tons/acre	18.1 tons/acre
69	500	8.6 ft	2.3 ft	$1,456,090.00	37.7 tons/acre	17.1 tons/acre
70	499	13.4 ft	1.4 ft	$1,315,776.00	71.9 tons/acre	19 tons/acre
71	501	10.8 ft	1.6 ft	$1,411,412.00	62.1 tons/acre	22.2 tons/acre
72	513	6.9 ft	1.3 ft	$974,602.00	21.9 tons/acre	9.9 tons/acre
73	502	8.9 ft	1.5 ft	$1,231,587.00	30.7 tons/acre	12.1 tons/acre
74	503	14.6 ft	3.6 ft	$1,795,028.00	83.7 tons/acre	34.6 tons/acre
75	502	10 ft	1.3 ft	$1,197,777.00	52.4 tons/acre	17.9 tons/acre
76	501	9.6 ft	2.4 ft	$1,042,541.00	41.3 tons/acre	17.2 tons/acre
77	510	6.2 ft	1.7 ft	$1,215,197.00	14.6 tons/acre	8.5 tons/acre
78	500	13.4 ft	1.6 ft	$1,072,732.00	139.8 tons/acre	36 tons/acre
79	499	8.7 ft	2.4 ft	$1,234,482.00	41.4 tons/acre	17.8 tons/acre
80	524	11.6 ft	1.7 ft	$954,803.00	66.4 tons/acre	22.1 tons/acre
81	501	5.5 ft	2.2 ft	$1,088,167.00	15.5 tons/acre	10.6 tons/acre
82	488	9.9 ft	1.8 ft	$1,026,270.00	49.1 tons/acre	17 tons/acre
83	504	9.5 ft	1.3 ft	$1,584,469.00	66.7 tons/acre	21.4 tons/acre
84	500	6 ft	1.7 ft	$1,118,312.00	19 tons/acre	12.5 tons/acre
85	514	9.2 ft	1.4 ft	$1,171,497.00	44.6 tons/acre	17.6 tons/acre
86	503	7.9 ft	1.6 ft	$1,003,625.00	39.8 tons/acre	17 tons/acre
87	511	7.1 ft	1.7 ft	$1,174,042.00	58 tons/acre	27.3 tons/acre
88	498	17.3 ft	4 ft	$2,280,278.00	77.4 tons/acre	26.8 tons/acre
89	503	5.7 ft	1.4 ft	$827,381.00	23.9 tons/acre	15.1 tons/acre
90	501	10.6 ft	2.3 ft	$1,242,373.00	53.1 tons/acre	20 tons/acre
91	507	6.5 ft	1.8 ft	$872,890.00	50.7 tons/acre	28 tons/acre
92	452	6.1 ft	1.7 ft	$972,117.00	36.1 tons/acre	19.2 tons/acre
93	510	7.6 ft	1.3 ft	$1,040,065.00	51.4 tons/acre	19.3 tons/acre
94	502	7.4 ft	1.5 ft	$1,207,555.00	31.1 tons/acre	15.2 tons/acre
95	502	12.4 ft	3.2 ft	$1,533,541.00	23.2 tons/acre	6.2 tons/acre
96	514	6.6 ft	2.1 ft	$1,155,450.00	35.5 tons/acre	20.1 tons/acre
97	500	8.5 ft	2.2 ft	$1,222,113.00	32.8 tons/acre	13.3 tons/acre
98	503	7.5 ft	2.2 ft	$821,480.00	23 tons/acre	11 tons/acre
99	498	8.4 ft	2 ft	$1,202,758.00	42.4 tons/acre	17 tons/acre
100	499	7.9 ft	1.2 ft	$1,182,472.00	41.3 tons/acre	15.7 tons/acre

Appendix B - Project Snapshots

Project Snapshot

PROJECT 1



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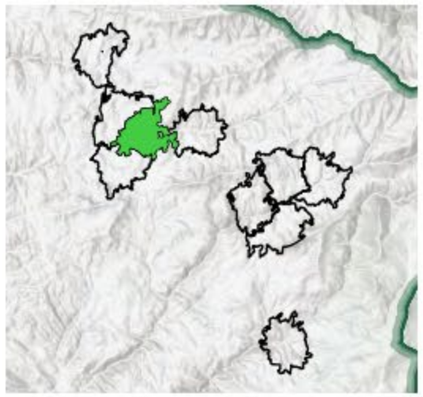


This project covers 497 acres. Implementing the recommended management action is predicted to reduce average flame lengths to 1.3 ft (from 10.5 ft) and the rate of spread to 0.03 mph (from 1 mph).

WATER CO-BENEFITS

Post-implementation estimated average soil erosion rates are 24.3 tons/acre (from 90.3 tons/acre).

Total sediment yield post-implementation is 0 tons (from 0 tons).

Acres of riparian areas likely to exhibit extreme fire behavior went from 6 to 0 post action.

PRODUCT BENEFIT

Estimated timber removal volume for this project is 922 MBF with an additional 13 tons of submerchantable biomass removal.

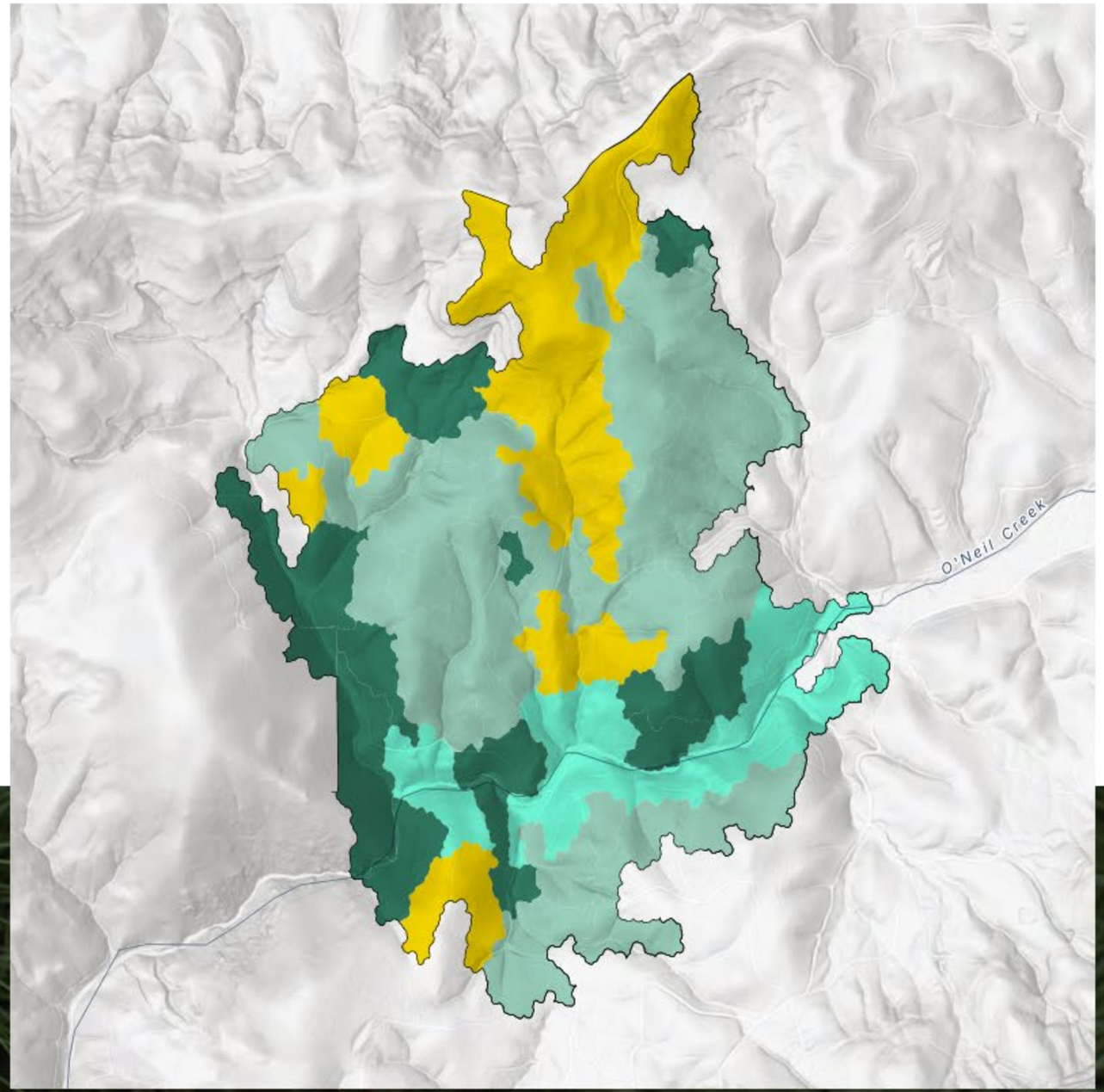
Product benefit is estimated at $59,400.00, with an implementation cost of $1,207,804.00.

TREATMENT TYPE

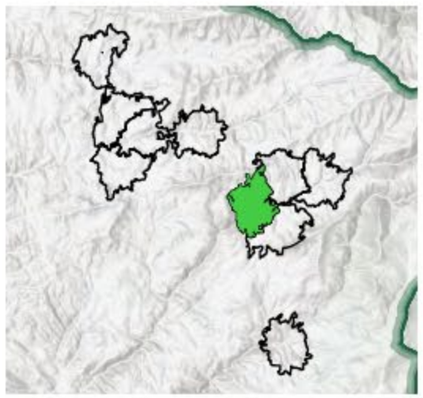
- Complex Mechanical Removal
- Herbivory
- Mechanical Removal
- Manual
- Mechanical Rearrangement
- Rx Fire

Project Snapshot

PROJECT 2



File Name: proposal.shp



This project covers 496 acres. Implementing the recommended management action is predicted to reduce average flame lengths to 1.4 ft (from 11.8 ft) and the rate of spread to 0.02 mph (from 2 mph).

WATER CO-BENEFITS

Post-implementation estimated average soil erosion rates are 30.1 tons/acre (from 92.8 tons/acre).

Total sediment yield post-implementation is 0 tons (from 0 tons).

Acres of riparian areas likely to exhibit extreme fire behavior went from 8 to 0 post action.

PRODUCT BENEFIT

Estimated timber removal volume for this project is 1,568 MBF with an additional 5 tons of submerchantable biomass removal.

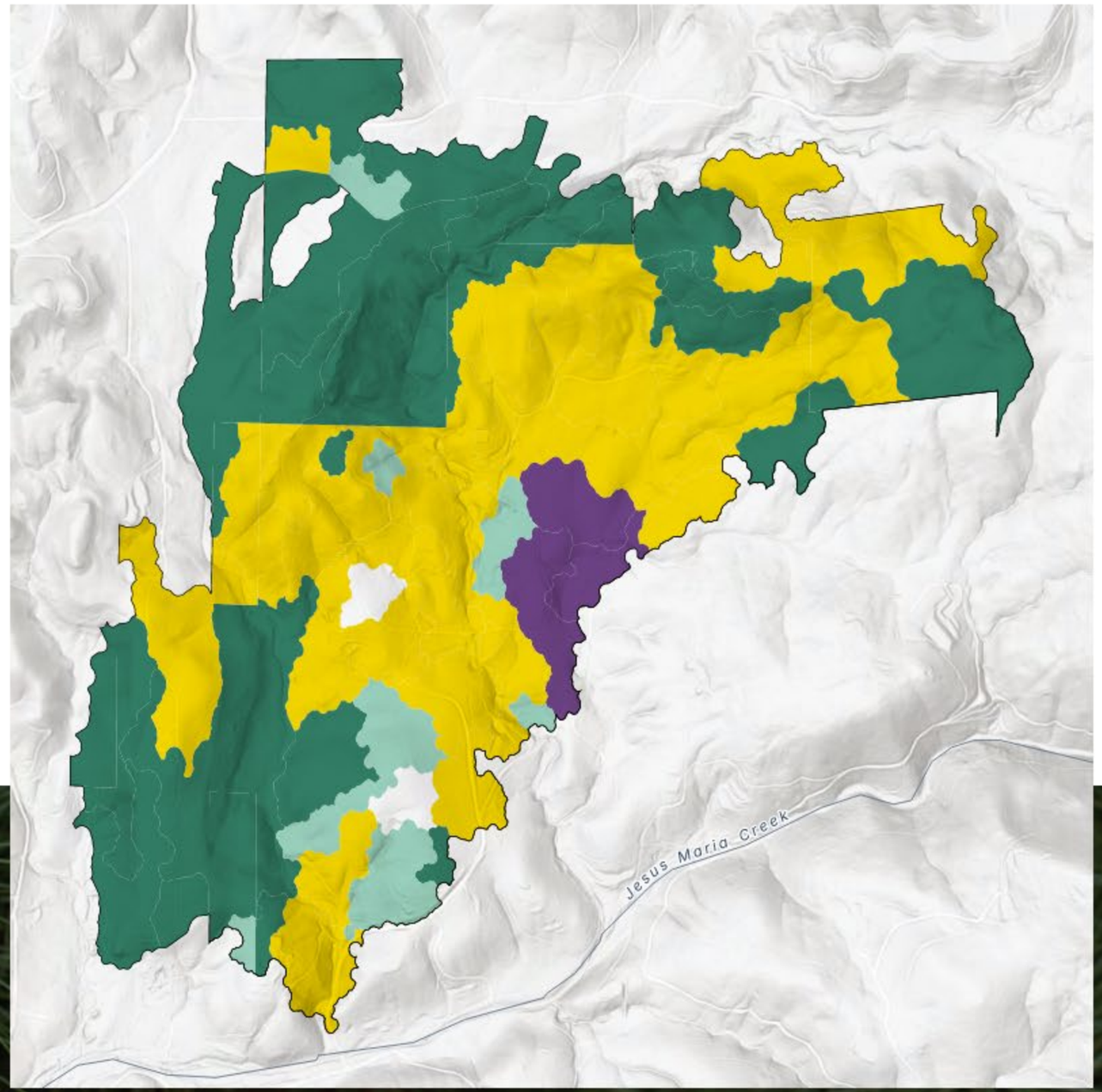
Product benefit is estimated at $83,050.00, with an implementation cost of $1,565,901.00.

TREATMENT TYPE

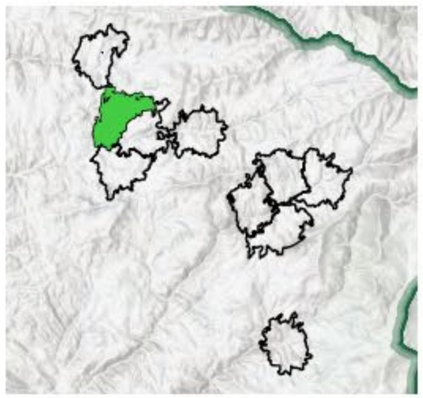
- Complex Mechanical Removal
- Herbivory
- Mechanical Removal
- Manual
- Mechanical Rearrangement
- Rx Fire

Project Snapshot

PROJECT 3



File Name: proposal.shp



This project covers 502 acres. Implementing the recommended management action is predicted to reduce average flame lengths to 1.2 ft (from 8.4 ft) and the rate of spread to 0.03 mph (from 3 mph).

WATER CO-BENEFITS

Post-implementation estimated average soil erosion rates are 7.8 tons/acre (from 23.4 tons/acre).

Total sediment yield post-implementation is 0 tons (from 0 tons).

Acres of riparian areas likely to exhibit extreme fire behavior went from 0 to 0 post action.

PRODUCT BENEFIT

Estimated timber removal volume for this project is 729 MBF with an additional 7 tons of submerchantable biomass removal.

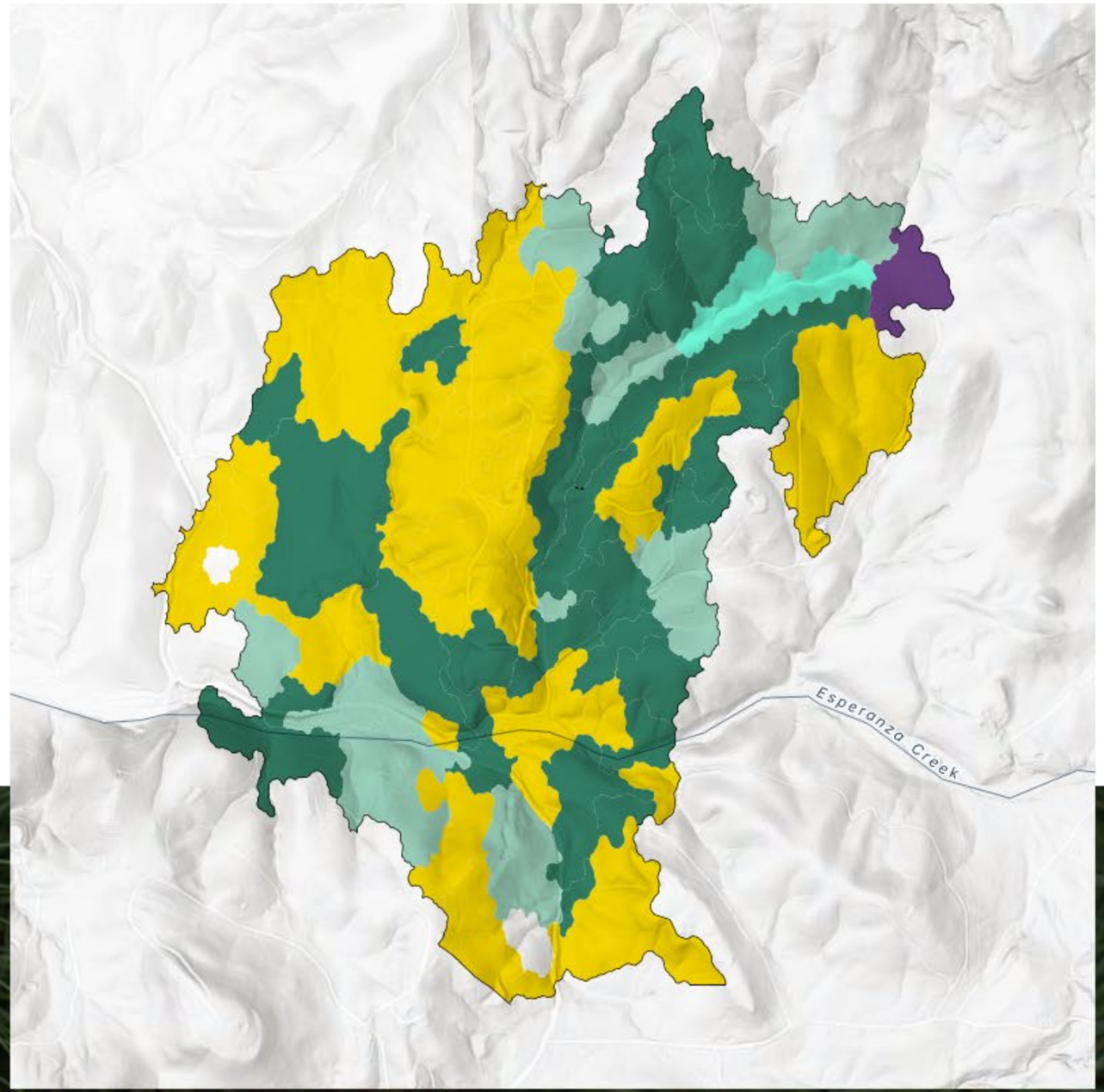
Product benefit is estimated at $41,250.00, with an implementation cost of $1,435,077.00.

TREATMENT TYPE

- Complex Mechanical Removal
- Herbivory
- Mechanical Removal
- Manual
- Mechanical Rearrangement
- Rx Fire

Project Snapshot

PROJECT 4



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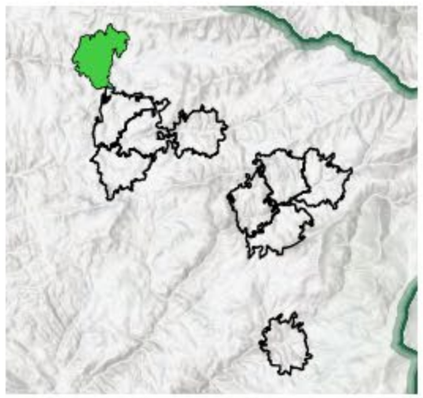


This project covers 499 acres. Implementing the recommended management action is predicted to reduce average flame lengths to 1.3 ft (from 9.2 ft) and the rate of spread to 0.02 mph (from 4 mph).

WATER CO-BENEFITS

Post-implementation estimated average soil erosion rates are 13.8 tons/acre (from 36.5 tons/acre).

Total sediment yield post-implementation is 0 tons (from 0 tons).

Acres of riparian areas likely to exhibit extreme fire behavior went from 7 to 0 post action.

PRODUCT BENEFIT

Estimated timber removal volume for this project is 1,121 MBF with an additional 10 tons of submerchantable biomass removal.

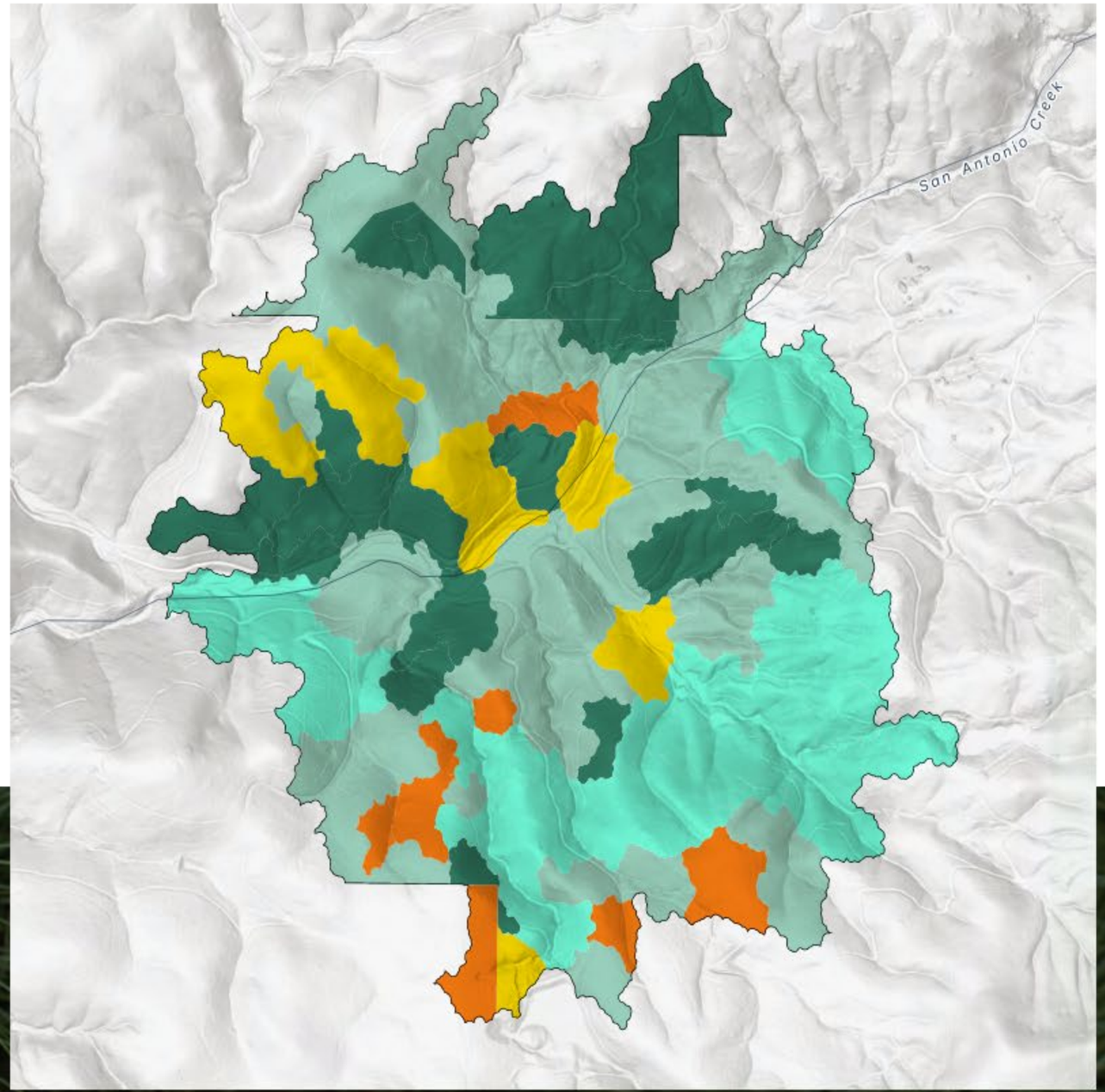
Product benefit is estimated at $51,700.00, with an implementation cost of $1,349,956.00.

TREATMENT TYPE

- Complex Mechanical Removal
- Herbivory
- Mechanical Removal
- Manual
- Mechanical Rearrangement
- Rx Fire

Project Snapshot

PROJECT 5



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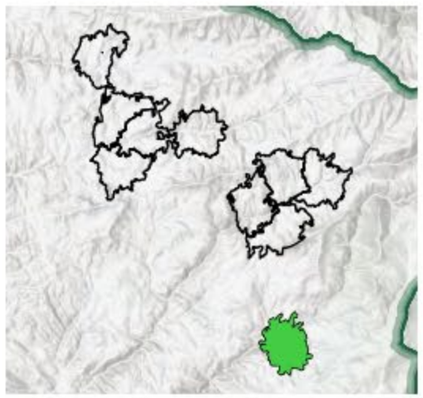


This project covers 500 acres. Implementing the recommended management action is predicted to reduce average flame lengths to 0.9 ft (from 12.2 ft) and the rate of spread to 0.01 mph (from 5 mph).

WATER CO-BENEFITS

Post-implementation estimated average soil erosion rates are 26.3 tons/acre (from 96.0 tons/acre).

Total sediment yield post-implementation is 0 tons (from 0 tons).

Acres of riparian areas likely to exhibit extreme fire behavior went from 14 to 0 post action.

PRODUCT BENEFIT

Estimated timber removal volume for this project is 3,295 MBF with an additional 26 tons of submerchantable biomass removal.

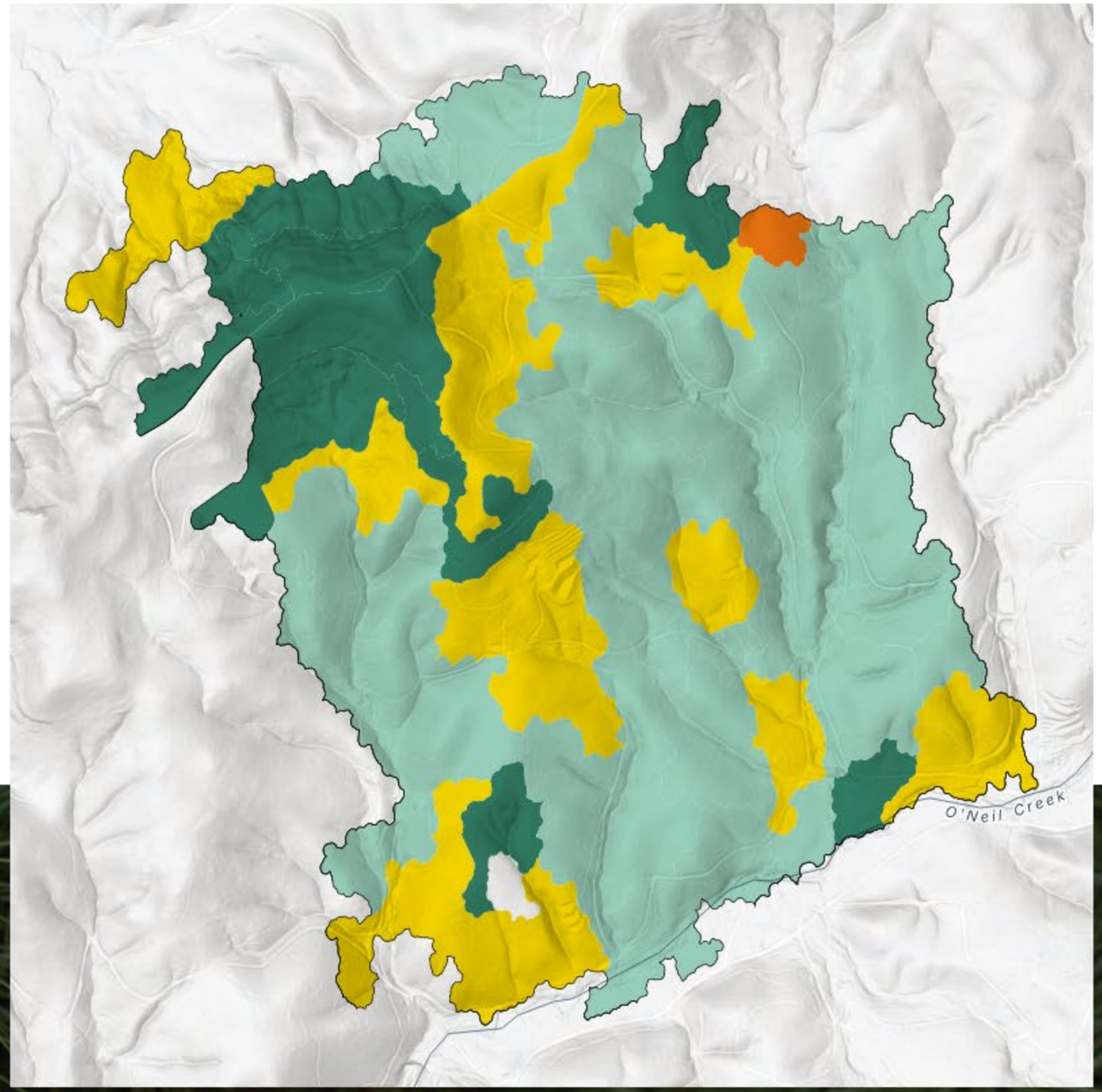
Product benefit is estimated at $191,400.00, with an implementation cost of $1,846,755.00.

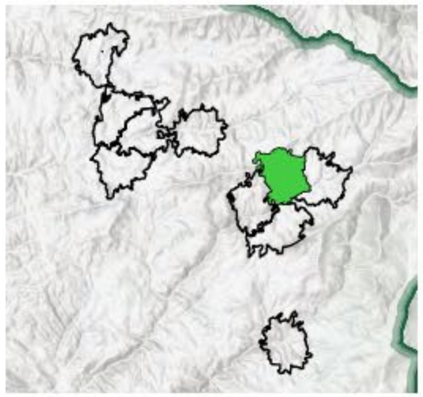
TREATMENT TYPE

- Complex Mechanical Removal
- Herbivory
- Mechanical Removal
- Manual
- Mechanical Rearrangement
- Rx Fire

Project Snapshot

PROJECT 6





This project covers 505 acres. Implementing the recommended management action is predicted to reduce average flame lengths to 1.1 ft (from 8.4 ft) and the rate of spread to 0.02 mph (from 6 mph).

WATER CO-BENEFITS

Post-implementation estimated average soil erosion rates are 16.6 tons/acre (from 40.8 tons/acre).

Total sediment yield post-implementation is 0 tons (from 0 tons).

Acres of riparian areas likely to exhibit extreme fire behavior went from 3 to 0 post action.

PRODUCT BENEFIT

Estimated timber removal volume for this project is 2,704 MBF with an additional 9 tons of submerchantable biomass removal.

Product benefit is estimated at $70,400.00, with an implementation cost of $1,087,728.00.

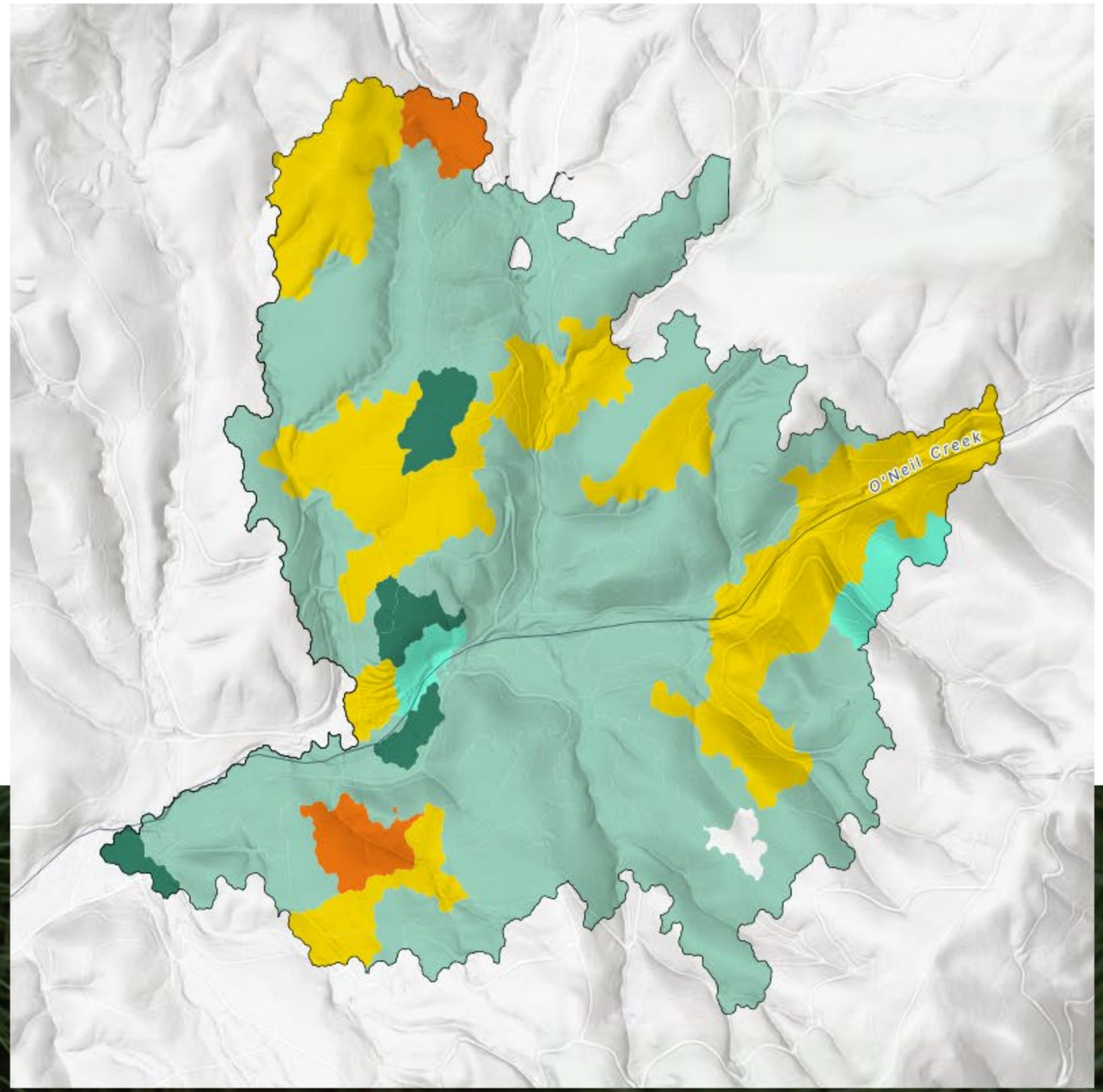
TREATMENT TYPE

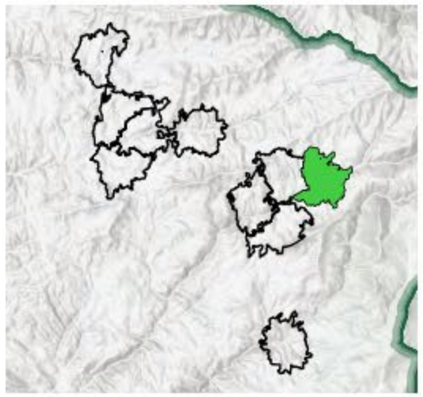
- Complex Mechanical Removal
- Herbivory
- Mechanical Removal
- Manual
- Mechanical Rearrangement
- Rx Fire

File Name: proposal.shp

Project Snapshot

PROJECT 7





This project covers 503 acres. Implementing the recommended management action is predicted to reduce average flame lengths to 1.1 ft (from 9.3 ft) and the rate of spread to 0.02 mph (from 7 mph).

WATER CO-BENEFITS

Post-implementation estimated average soil erosion rates are 12.9 tons/acre (from 37.4 tons/acre).

Total sediment yield post-implementation is 0 tons (from 0 tons).

Acres of riparian areas likely to exhibit extreme fire behavior went from 7 to 0 post action.

PRODUCT BENEFIT

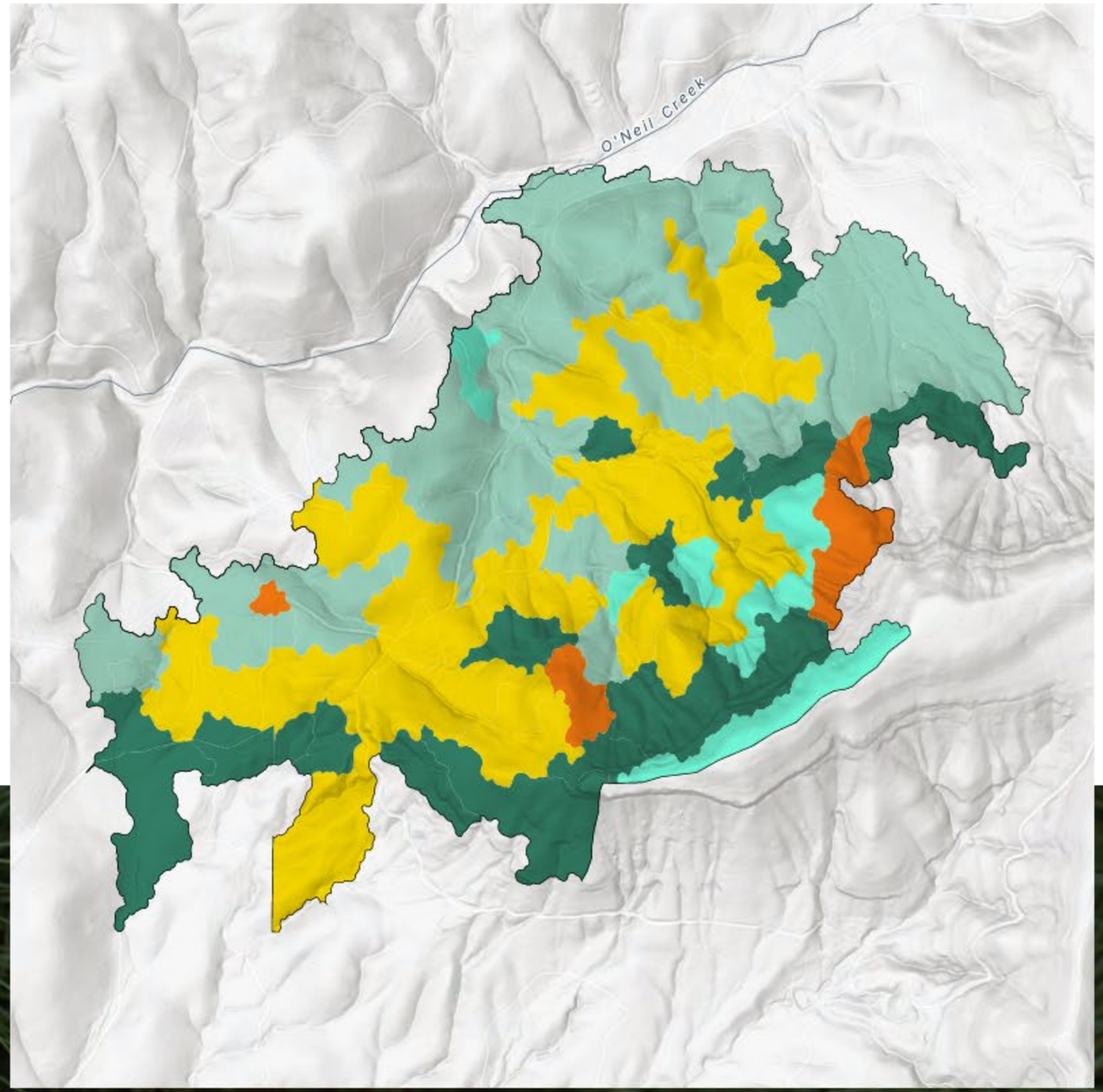
Estimated timber removal volume for this project is 4,141 MBF with an additional 13 tons of submerchantable biomass removal.

Product benefit is estimated at $141,350.00, with an implementation cost of $1,035,841.00.

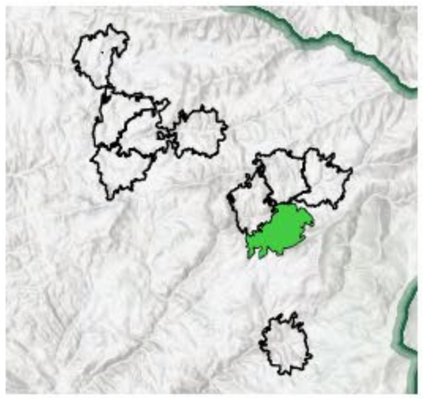
File Name: proposal.shp

Project Snapshot

PROJECT 8



File Name: proposal.shp



This project covers 498 acres. Implementing the recommended management action is predicted to reduce average flame lengths to 1.4 ft (from 9.5 ft) and the rate of spread to 0.02 mph (from 8 mph).

WATER CO-BENEFITS

Post-implementation estimated average soil erosion rates are 13.1 tons/acre (from 33.9 tons/acre).

Total sediment yield post-implementation is 0 tons (from 0 tons).

Acres of riparian areas likely to exhibit extreme fire behavior went from 1 to 0 post action.

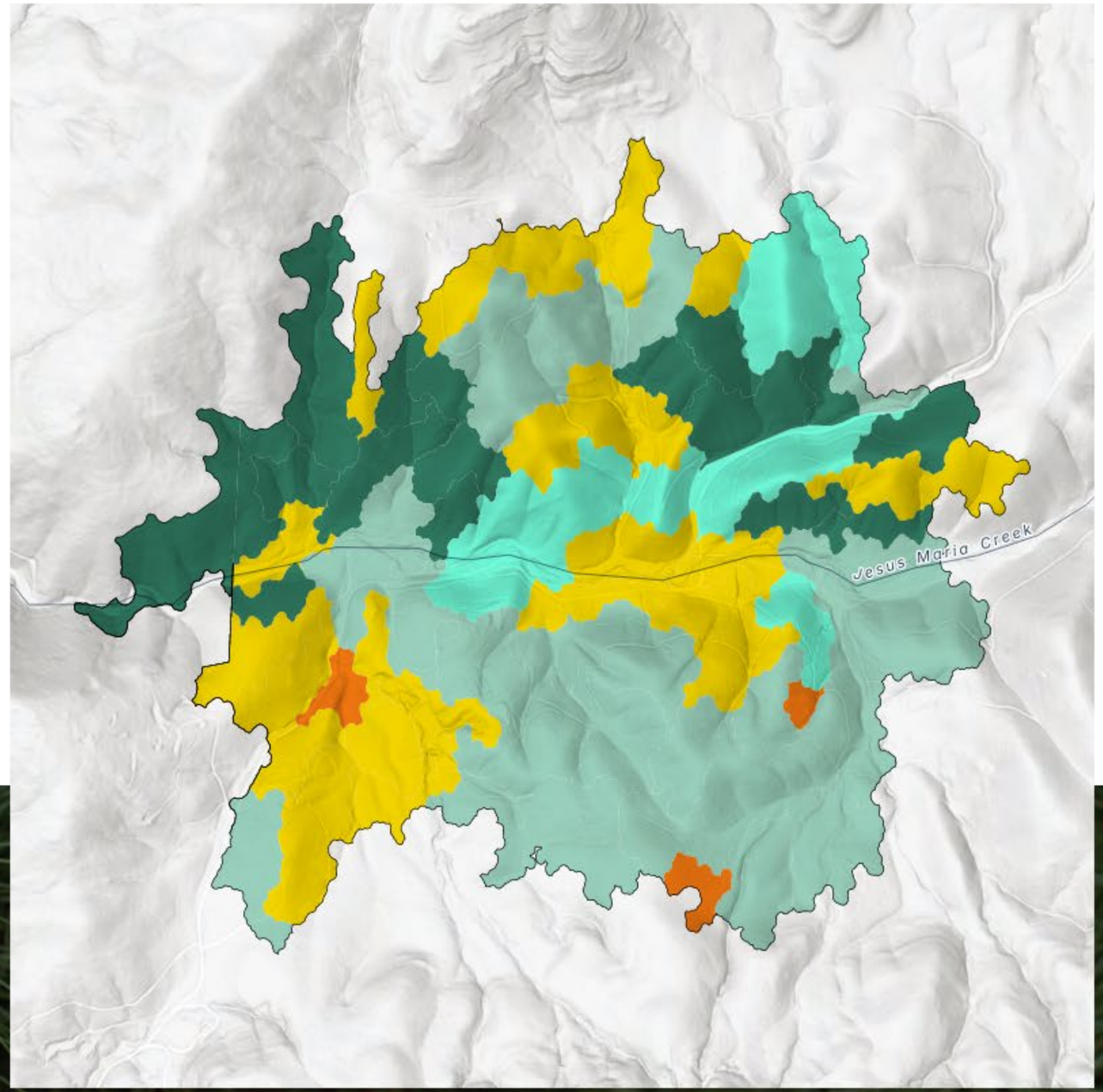
PRODUCT BENEFIT

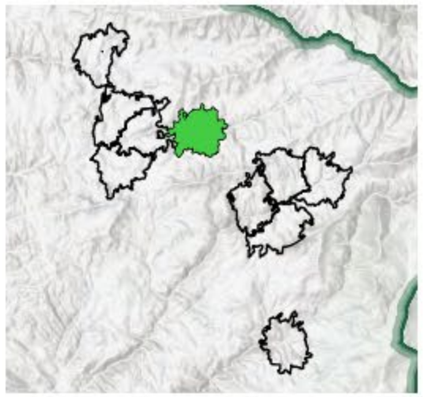
Estimated timber removal volume for this project is 2,250 MBF with an additional 10 tons of submerchantable biomass removal.

Product benefit is estimated at $81,400.00, with an implementation cost of $1,389,222.00.

Project Snapshot

PROJECT 9





This project covers 501 acres. Implementing the recommended management action is predicted to reduce average flame lengths to 0.9 ft (from 9.4 ft) and the rate of spread to 0.02 mph (from 9 mph).

WATER CO-BENEFITS

Post-implementation estimated average soil erosion rates are 17.3 tons/acre (from 50.1 tons/acre).

Total sediment yield post-implementation is 0 tons (from 0 tons).

Acres of riparian areas likely to exhibit extreme fire behavior went from 6 to 0 post action.

PRODUCT BENEFIT

Estimated timber removal volume for this project is 2,002 MBF with an additional 21 tons of submerchantable biomass removal.

Product benefit is estimated at $90,750.00, with an implementation cost of $1,596,776.00.

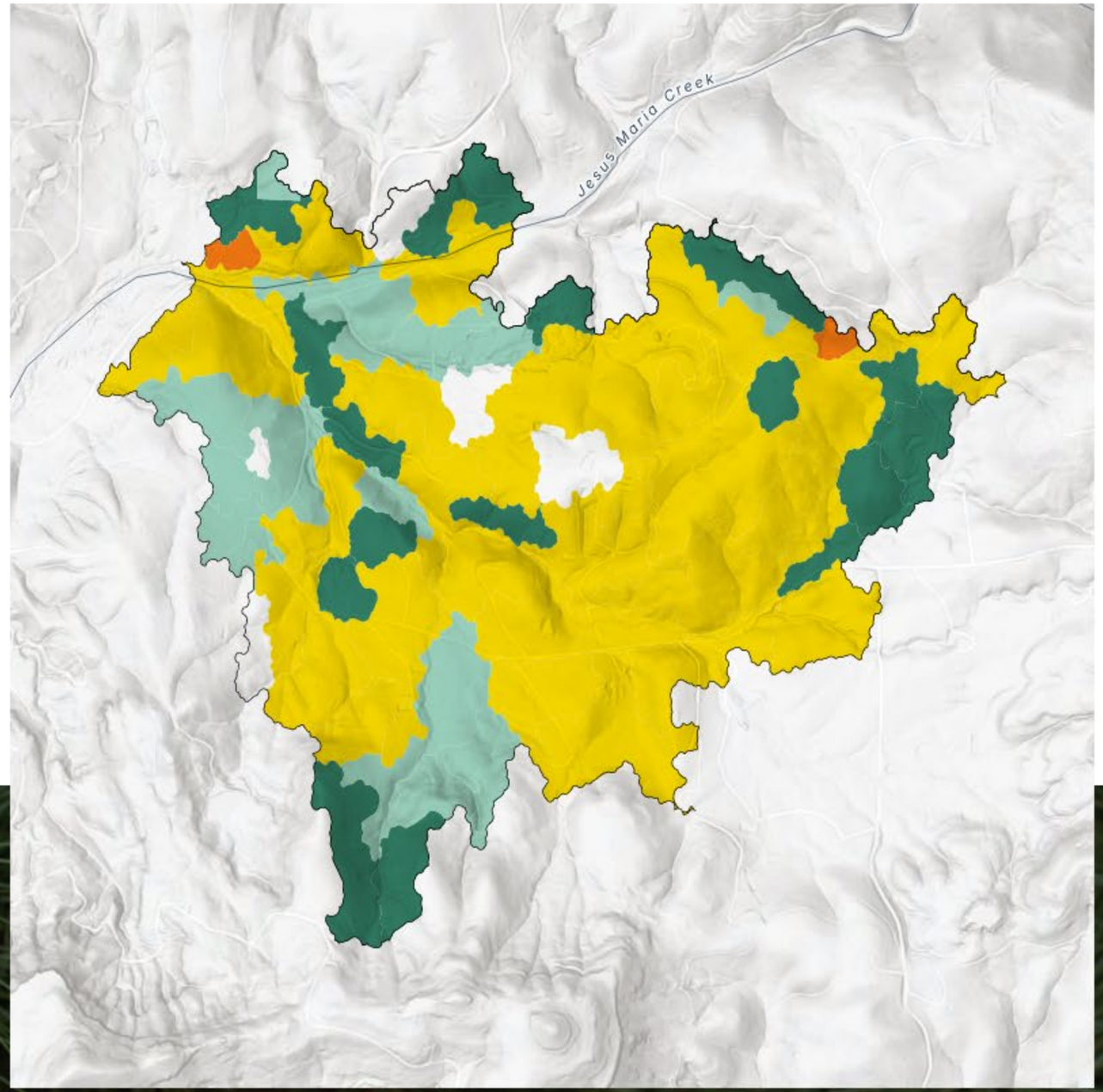
TREATMENT TYPE

- Complex Mechanical Removal
- Herbivory
- Mechanical Removal
- Manual
- Mechanical Rearrangement
- Rx Fire

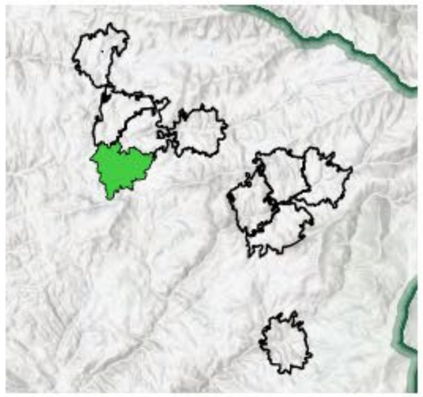
File Name: proposal.shp

Project Snapshot

PROJECT 10



File Name: proposal.shp



This project covers 497 acres. Implementing the recommended management action is predicted to reduce average flame lengths to 1.0 ft (from 8.5 ft) and the rate of spread to 0.02 mph (from 10 mph).

WATER CO-BENEFITS

Post-implementation estimated average soil erosion rates are 13.5 tons/acre (from 36.8 tons/acre).

Total sediment yield post-implementation is 0 tons (from 0 tons).

Acres of riparian areas likely to exhibit extreme fire behavior went from 5 to 0 post action.

PRODUCT BENEFIT

Estimated timber removal volume for this project is 1,894 MBF with an additional 28 tons of submerchantable biomass removal.

Product benefit is estimated at $140,250.00, with an implementation cost of $1,460,312.00.

Appendix C - High Value Resources & Assets (HVRAs)

High Value Resources & Assets

ASSETS - ENERGY FACILITIES

Asset HVRAs represent anthropogenic property and resources including structures and other infrastructure. More information about individual HVRAs can be found at the Vibrant Planet Knowledge Center.

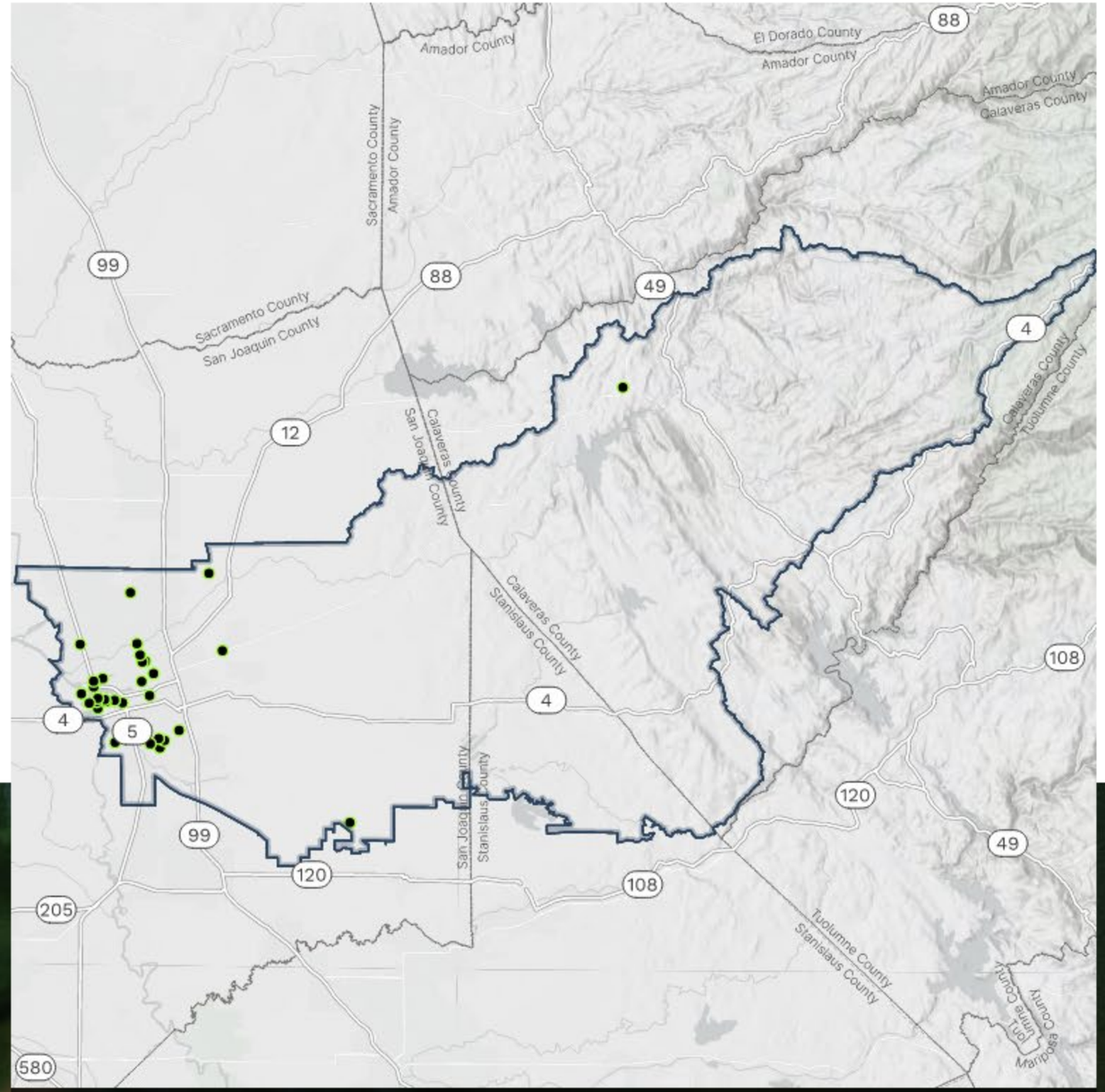
Energy Facilities encompass structures and/or facilities on the landscape that generate electricity (ex: power plants, solar farms) or modify and distribute electricity (ex: substations) further within the grid. This HVRA does not include transmission/distribution infrastructure or hydroelectric generation.

The Energy Facilities HVRA is based on geospatial locations of substations and power plants acquired from the Homeland Infrastructure Foundation-Level Data (HIFLD) program (U.S. Department of Homeland Security, 2023; U.S. Department of Homeland Security, 2021). Both the substation and power plant data layers are point features and do not represent the actual footprint of the facility. In order to more accurately identify the area which may be affected by disturbance, these point features are processed into polygons in order to better represent the HVRA footprint. For power plants, the points are intersected (using a 50 meter search radius) with the Vibrant Planet Structures layer, and the resulting building footprints are used as the footprint. Duplicates are removed, and points representing power plants that do not intersect with a structure are removed from the dataset. For power substations, all points are buffered by 100 feet in order to approximate the footprint of the substation since unlike power plants, these points do not usually correlate with a structure. The resulting power plants and power substation polygon features are merged together to form the Energy Facilities HVRA.

ENERGY FACILITIES

12

in area of interest



File Name: hvra_footprints/main.Energy Facilities.gpkg

High Value Resources & Assets

ASSETS - STRUCTURES

Asset HVRAs represent anthropogenic property and resources including structures and other infrastructure.

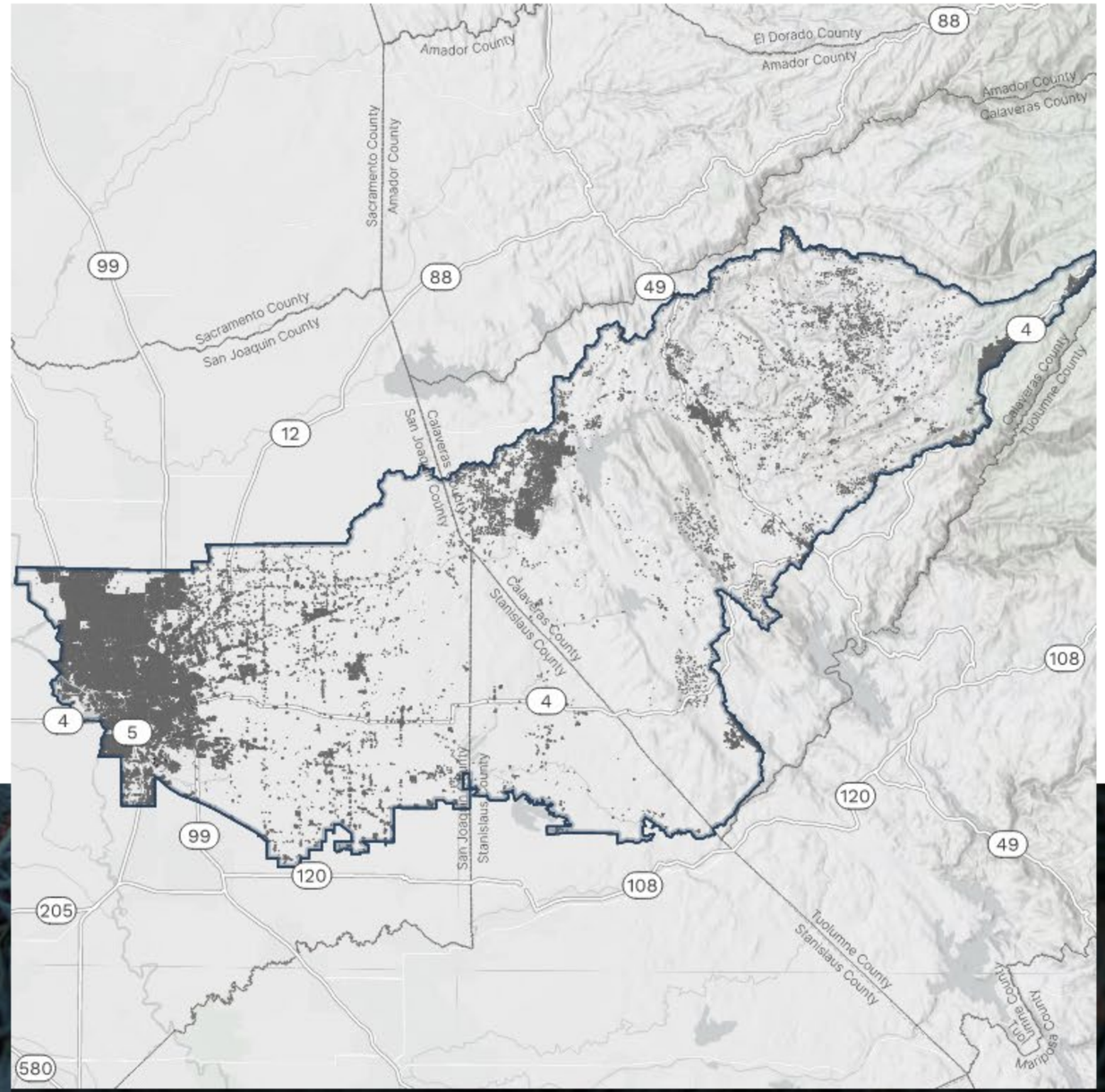
Structures encompass all buildings on a landscape larger than 430 square feet that are not categorized to another Asset or Safety HVRA (ex: Emergency Service Facilities); below this size threshold structures are generally considered secondary structures and are not considered in this analysis.

The Structures HVRA is based on geospatial locations of structures larger than 430 square feet (40 square meters) utilizing data from OneGeo augmented with building footprints from the USA Structures dataset (ONEGEO, 2023; ORNL, 2023). The USA Structures dataset was produced by Oak Ridge National Laboratory (ORNL) for the Federal Emergency Management Agency (FEMA). Because of its higher precision (more discrete structures versus larger, fewer buildings), the OneGeo dataset is used as the foundational dataset and structures from the USA Structures dataset are added where they do not intersect existing OneGeo buildings. All structures less than 430 square feet (40 square meters) are removed and any structures that are identified as part of another HVRA are also removed to avoid duplication between datasets.

STRUCTURES

149,039

buildings larger than 430 sq ft



File Name: hvra_footprints/main.Structures.gpkg

High Value Resources & Assets

ASSETS - TRANSMISSION LINES

Asset HVRAs represent anthropogenic property and resources including structures and other infrastructure.

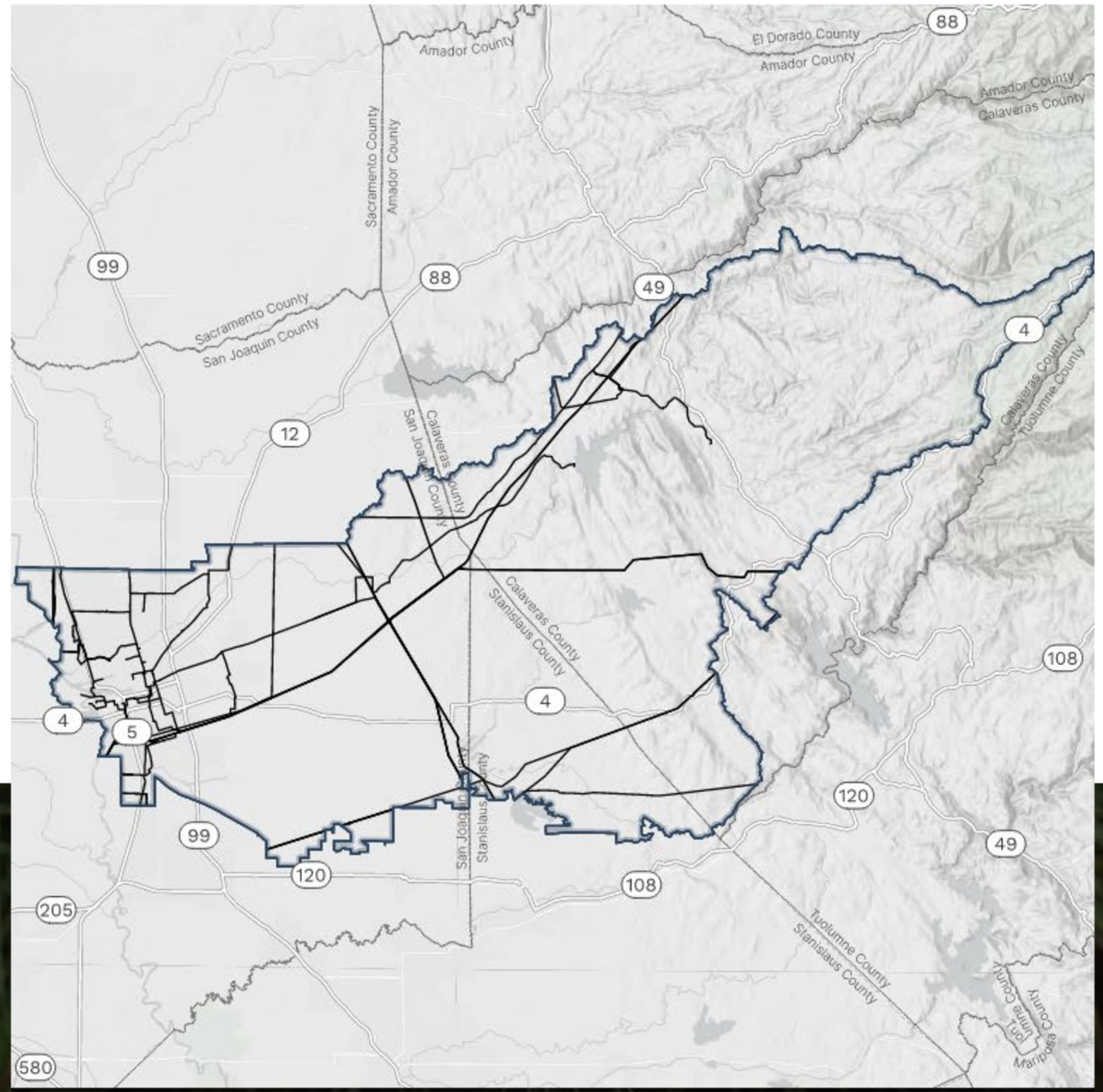
Transmission Lines include data that represent the system of structures, wires, insulators, and associated hardware that carry electric energy from one point to another. Transmission Lines are assumed to carry energy long distances at high voltage, and distribute energy indirectly to communities via intermediary infrastructure. This HVRA does not include other energy facility infrastructure (ex: Power plants).

The Transmission Lines HVRA is based on geospatial locations of transmission lines acquired from the Homeland Infrastructure Foundation-Level Data (HIFLD) program (U.S. Department of Homeland Security, 2023). This dataset primarily represents transmission lines, and notably, does not differentiate between wooden and steel infrastructure. Underground features are removed from the dataset and duplicate features are also removed.

TRANSMISSION LINES

581.3 miles

of transmission lines



File Name: hvra_footprints/main.Transmission Lines.gpkg

High Value Resources & Assets

SAFETY - EMERGENCY SERVICE FACILITIES

Aspects of the landscape/built environment that provide critical safety features during a wildfire or other disturbance are represented as HVRAs in the Safety objective.

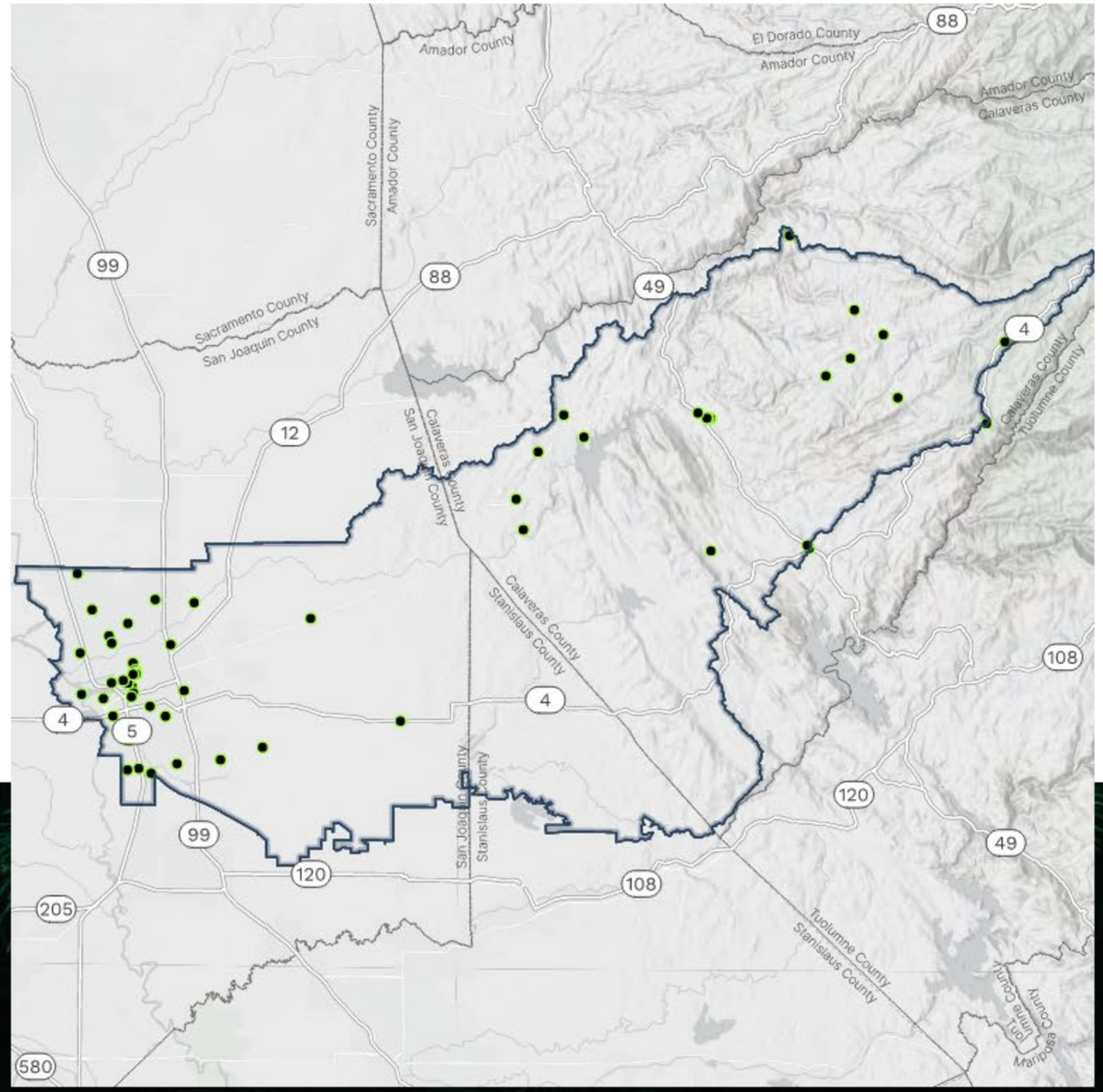
Emergency Service Facilities include first responder facilities that are essential to emergency services, such as local law enforcement locations (including dispatch centers), hospitals, and fire stations, but does not include other important municipal/civil infrastructure such as city halls, schools, public works facilities, etc.

The Emergency Service Facilities HVRA is a collection of geospatial locations for law enforcement facilities, hospitals, and fire stations acquired from the Homeland Infrastructure Foundation-Level Data (HIFLD) program (U.S. Department of Homeland Security, 2021; 2023a; 2023b). The data layers used are point features and do not represent the actual footprint of the facility and are often not comprehensive across a landscape. In order to more accurately identify the area which may be affected by disturbance, these point features are intersected (using a 50 meter search radius) with the Vibrant Planet Structures layer, and the resulting building footprints are used as the HVRA dataset. Duplicates are removed, and points representing an emergency service facility that do not intersect with a structure are removed from the dataset.

EMERGENCY SERVICES

57

emergency service facilities



File Name: hvra_footprints/main.Emergency Service Facilities.gpkg

High Value Resources & Assets

SAFETY - STRUCTURE TRANSMISSION ZONE

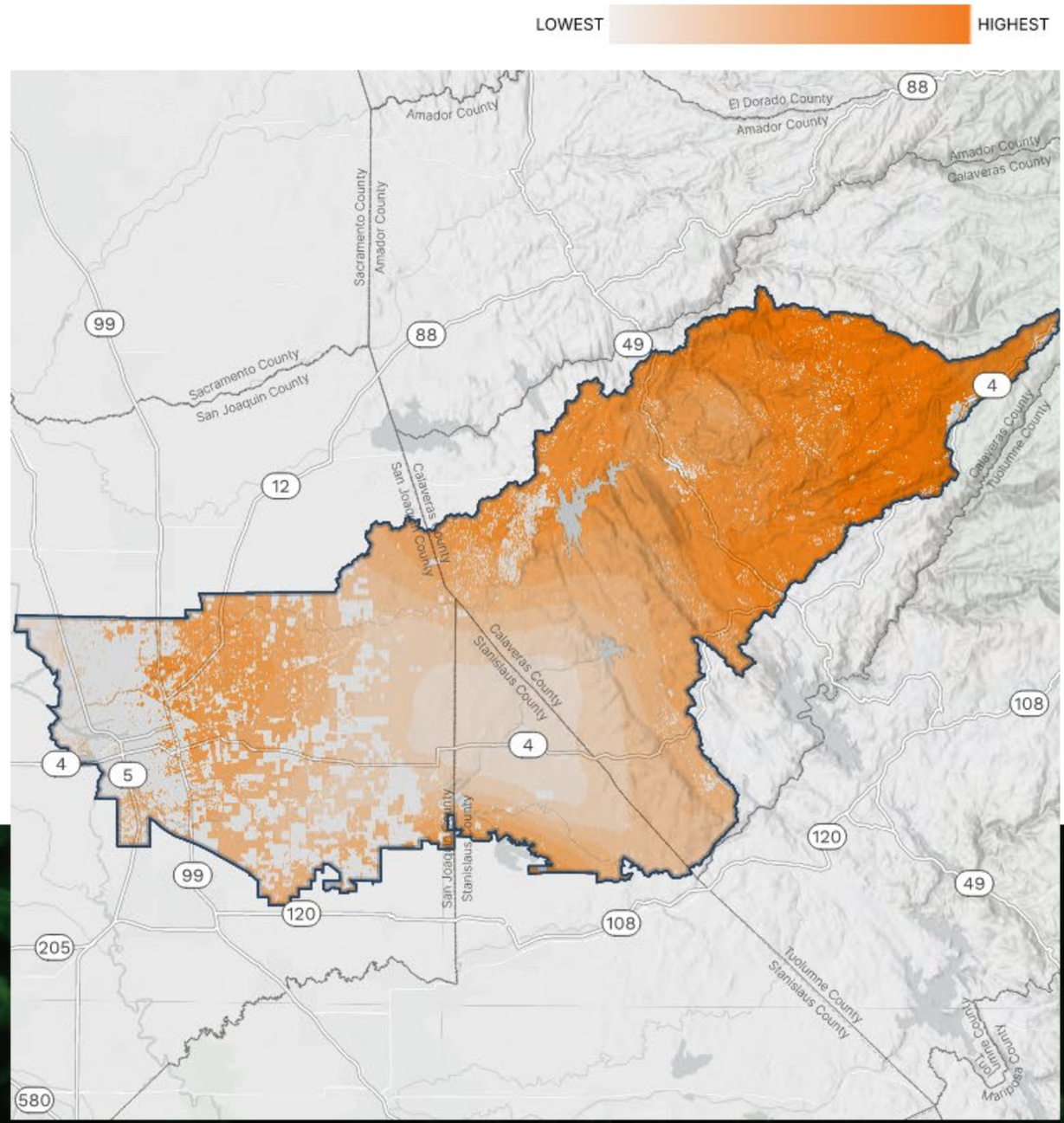
Aspects of the landscape/built environment that provide critical safety features during a wildfire or other disturbance are represented as HVRAs in the Safety objective.

The Structure Transmission Zone is made up of wildland areas managed by humans that are of interest solely due to their potential to expose nearby homes to fire. Specifically, this data provides an estimate of how many structures annually could be exposed to wildfire if a wildfire ignited in any given pixel of the raster layer, which is used to consider both the relative likelihood of an ignition and the consequence of the ignition in terms of the number of structures affected.

This HVRA is unique in that it does not show the location of structure exposure where adverse effects could occur, but instead shows strategic areas where suppression of fire ignitions and alteration of fuels may reduce risk to communities.

Treating in the Structure Transmission Zone may reduce the likelihood of a wildfire spreading to impact communities and structures or could reduce the fuel loading so that a wildfire does not overwhelm suppression resources such as home hardening and defensible space improvements that have been done.

The Structure Transmission Zone HVRA is similar in concept to the Wildland Urban Interface (WUI) (Defense Zone) HVRA in that they are both related to the safety of nearby structures and communities; however, while the Structure Transmission Zone HVRA quantifies risk to nearby structures based on potential wildfire ignitions, the WUI (Defense Zone) is a measure of distance from these structures.



File Name: structure_transmission_zone.tif

High Value Resources & Assets

SAFETY - WILDLAND URBAN INTERFACE (DEFENSE ZONE)

Aspects of the landscape/built environment that provide critical safety features during a wildfire or other disturbance are represented as HVRAs in the Safety objective.

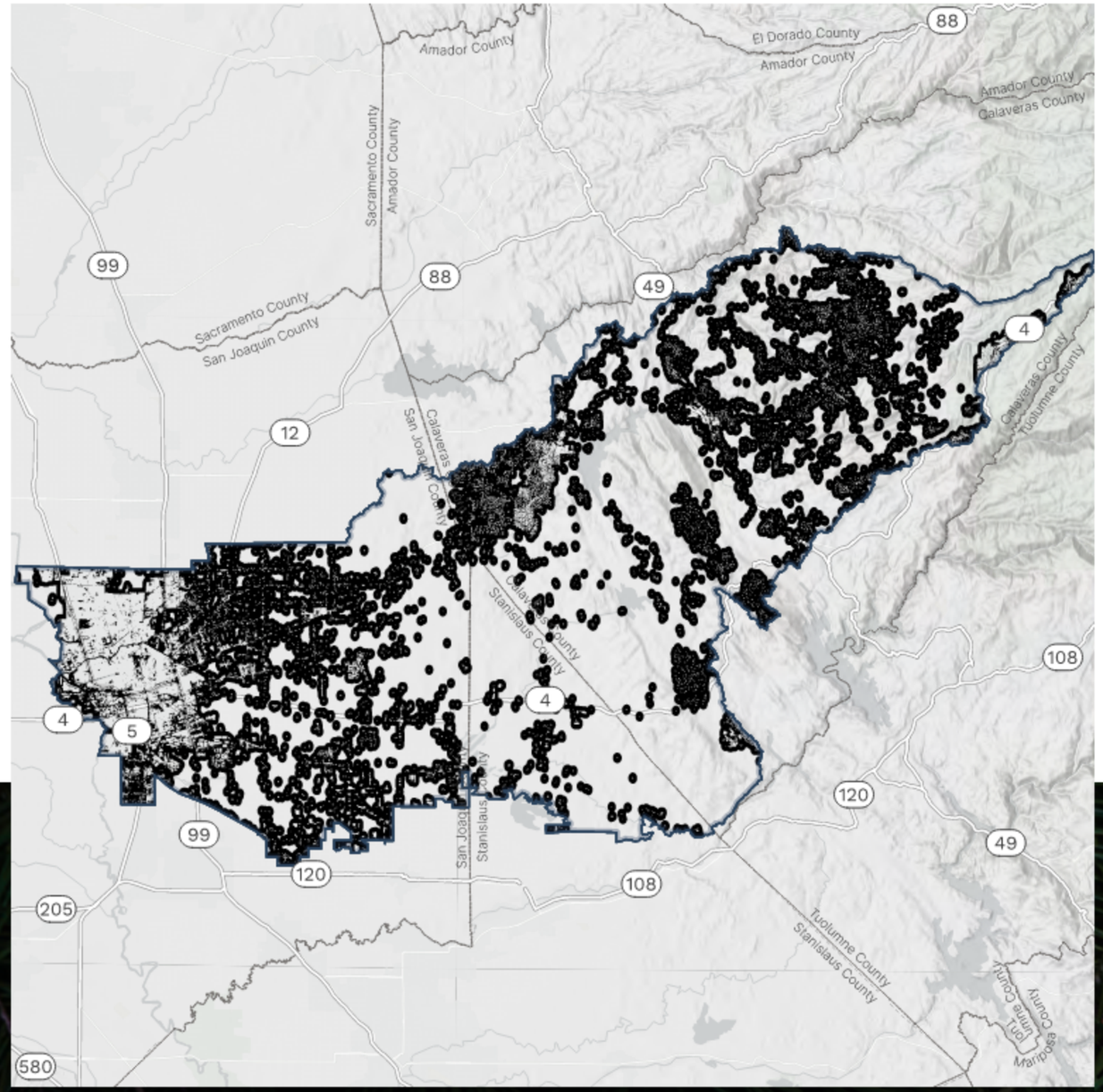
The Wildland Urban Interface (WUI) is the transition zone between human development and undeveloped lands where structures or other human development intermingle with areas of wildland or vegetative fuels. The extent of the WUI is defined as the area starting from the boundary of structure-based HVRAs (including: Structures, Energy Facilities and Emergency Service Facilities) with their 100-foot defensible space buffers and extending away from those structures a distance of one-quarter mile. The WUI does not overlap in space with these structures or their 100-foot defensible space buffers. Within the WUI footprint is generally where suppression resources expect fuel conditions to be conducive for direct attack across all but the most extreme wildfire weather conditions.

Documentation has divided the WUI into a Defense Zone (generally 300-1,500 feet from communities) and Threat Zone (extending one and a quarter miles from the Defense Zone) (Cleveland NF citation) (H.R. 1904 - Healthy Forests Restoration Act, 2003; U.S. Forest Service, 2005). The Vibrant Planet WUI exclusively includes the Defense Zone, and assumes that it extends a quarter mile (1,320 feet) from the edge of communities. Note that a variety of other analyses - including on the Lassen National Forest, Shasta-Trinity National Forest, and Bridger-Teton National Forest - have also defined the WUI as a quarter mile from communities (U.S. Forest Service, 2010; 2015; 2019).

WILDLAND URBAN INTERFACE

299,132 acres

of WUI Defense Zone



File Name: wui/main.wui.gpkg

High Value Resources & Assets

WATER - LAKES + PERENNIAL RIVERS AND STREAMS

Water HVRAs represent surface water features and flows across the landscape as well as resources or areas that can be impacted by post-disturbance erosion or sedimentation.

Lakes encompass all non-flowing, contained water bodies and includes reservoirs that perennially contain water. The Perennial Rivers and Streams HVRA represents water flow lines that are perennial in nature and does not include intermittent or ephemeral streams.

These HVRAs are a collection of vector data representing geographical locations of water bodies and flowlines both acquired from the National Hydrography Dataset (NHD) (U.S. Geological Survey, 2023) As the NHD has been deprecated by the U.S. Geological Survey as of September 2023, this dataset is currently static. Vibrant Planet has not yet accessed or implemented creation of HVRAs from the forthcoming, higher fidelity, 3DHP dataset (U.S. Geological Survey, 2023). To develop these HVRAs, the NHD is filtered for the following attributes: Lakes - where FTYPE = Lake/Pond OR Reservoir and Streams - where fcode_description = Stream/River AND Hydrographic Category = Perennial OR fcode_description = Artificial Path. For the Perennial Rivers and Stream HVRA, any overlapping features with the Lakes HVRA are erased from the dataset.

LAKES

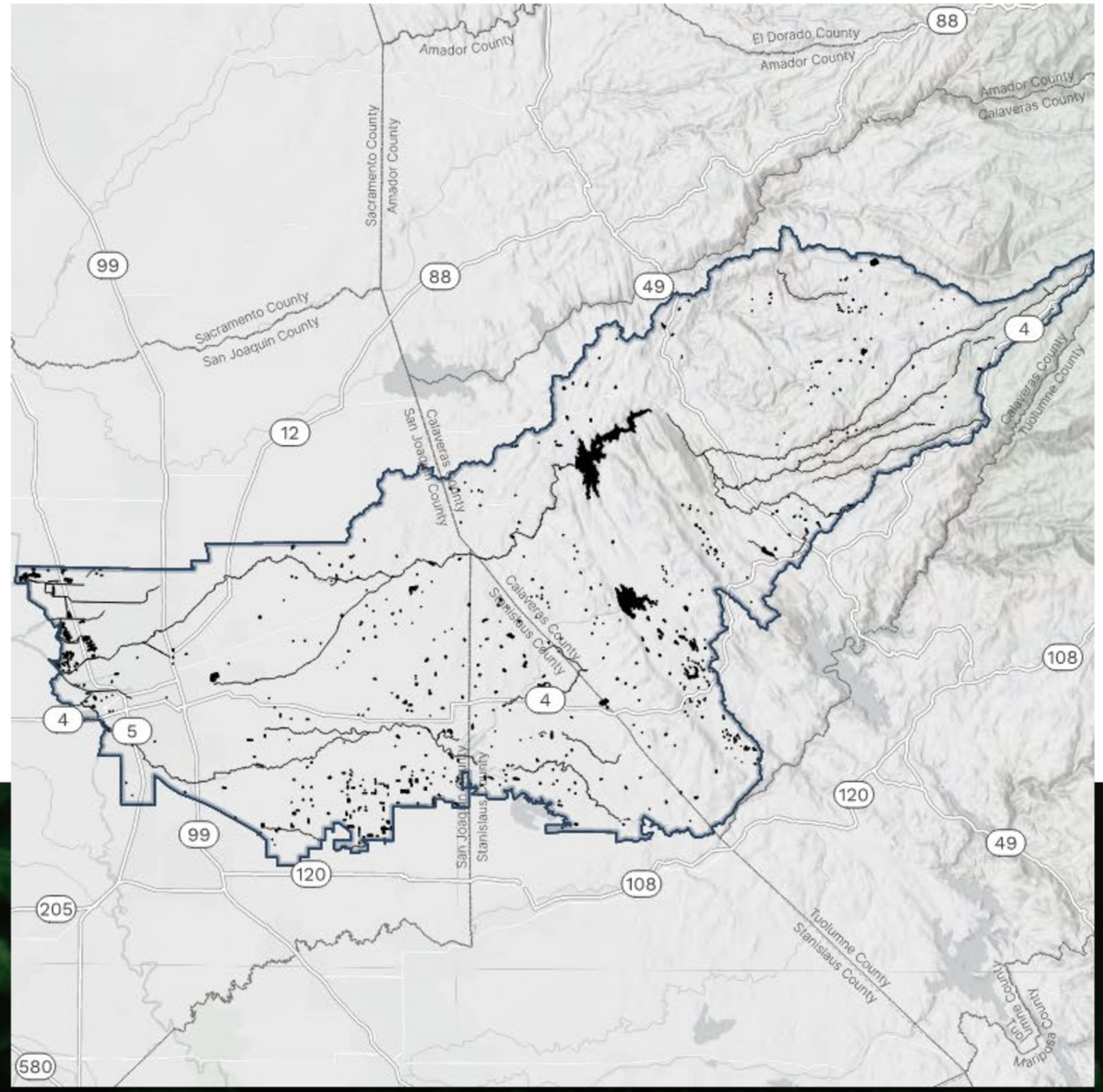
4,766 acres

of lake surface area

RIVERS + STREAMS

296.3 miles

of perennial rivers and streams



File Name: hvra_footprints/main.Lakes.gpkg

High Value Resources & Assets

WATER - PUBLIC WATER SUPPLY

Water HVRAs represent surface water features and flows across the landscape as well as resources or areas that can be impacted by post-disturbance erosion or sedimentation.

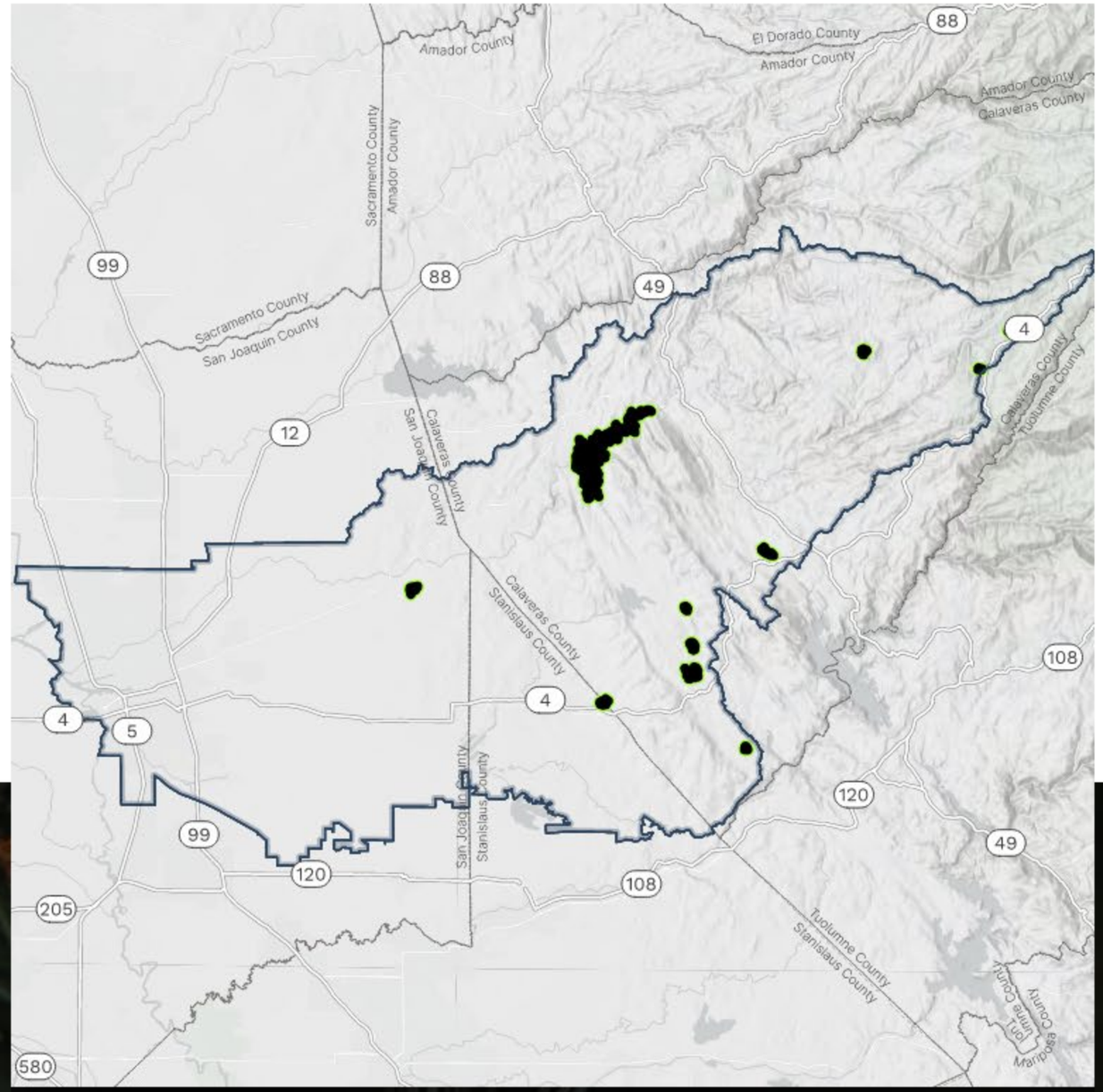
The Public Water Supply HVRA and associated Sediment Catchments for Water Supply HVRA are waterbodies identified as contributing to the public drinking water supply. Not included, are other water uses such as irrigation and public water sources not drawn from a lake/reservoir (ex: groundwater and undammed river intakes).

Public water supply waterbodies are identified as lakes and reservoirs that are collocated with National Inventory of Dams (Primary Allocation = "Public Supply") or water rights points of diversion (Primary Beneficial Use = "Public Supply"). Water rights points of diversion are further filtered to exclude groundwater pumping sites, developed springs, and other non-intake water infrastructure sites.

PUBLIC WATER SUPPLY

11

waterbodies used for public drinking water



File Name: hvra_footprints/main.Public Water Supply.gpkg

High Value Resources & Assets

WATER - SEDIMENT CATCHMENTS FOR WATER SUPPLY

SEDIMENT CATCHMENTS

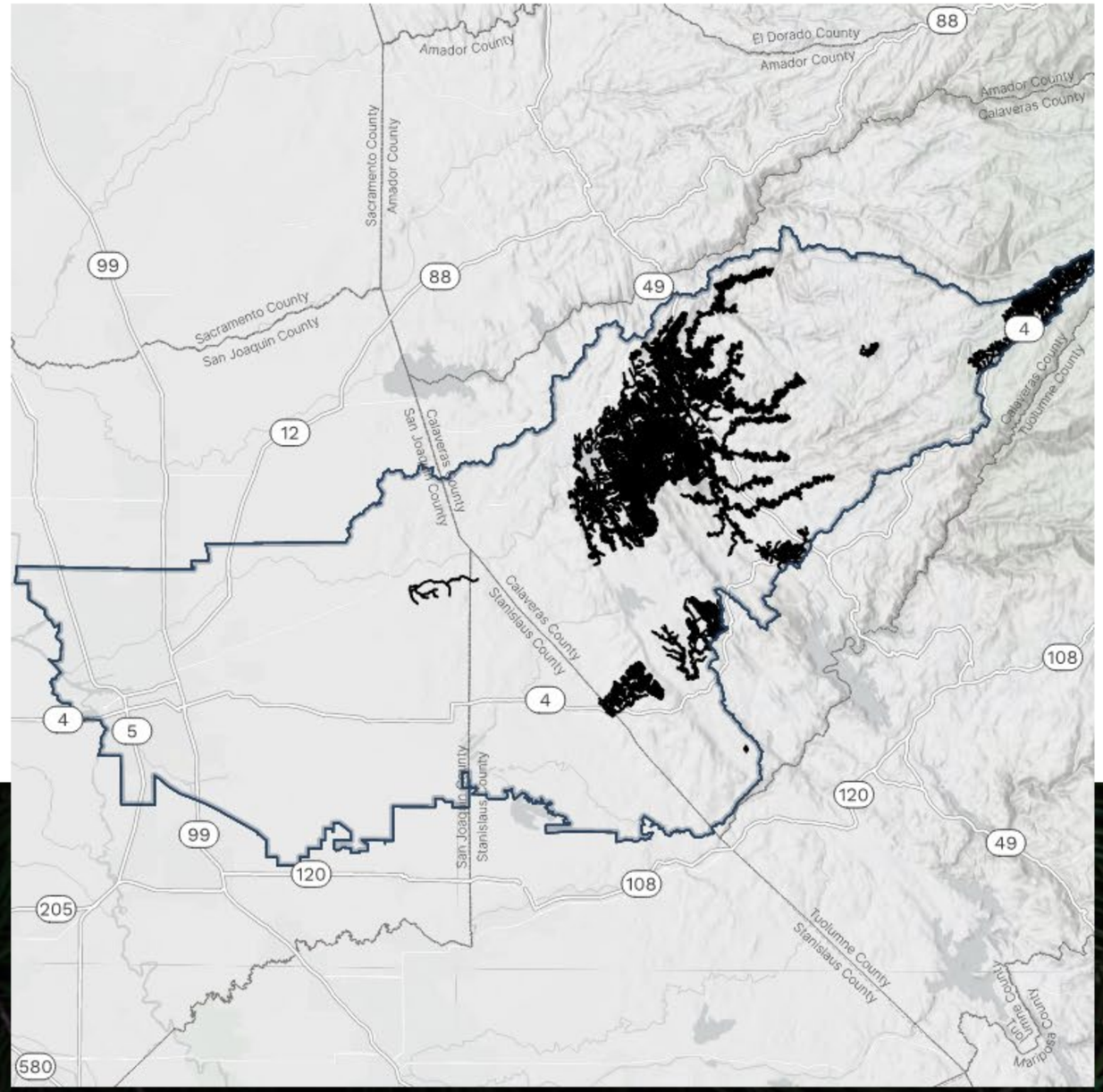
48,437 acres

of catchments to drinking water supply

Water HVRAs represent surface water features and flows across the landscape as well as resources or areas that can be impacted by post-disturbance erosion or sedimentation.

Sediment Catchments for Waterbodies represent areas of a landscape that could contribute sedimentation to the footprint of specific waterbodies. The footprint of this HVRA is comprehensive of both the Public Water Supply HVRA and the sediment contributing areas. The sediment-contributing area is based on the contributing tributary network as defined by sediment transport ability and vulnerable highly-erodible areas of the combined catchment likely to directly contribute sediment to the tributary network after a disturbance.

The Sediment Catchments for Waterbodies HVRA is the product of geomorphic, hydraulic, and hydrologic models applied to a waterbody that is selected based on its function (ex: public supply, habitat, etc.). The modeling process identifies areas that are likely to have a regular and persistent impact on the waterbody through erosion and sedimentation. For additional information see the Vibrant Planet Knowledge Center.



File Name: hvra_footprints/main.Sediment Catchments for Water Supplies.gpkg

High Value Resources & Assets

WILDLANDS HEALTH - RIPARIAN AREAS

Plant associations or other HVRAs that represent wildland health, function or resilience fall into the Wildlands Health objective.

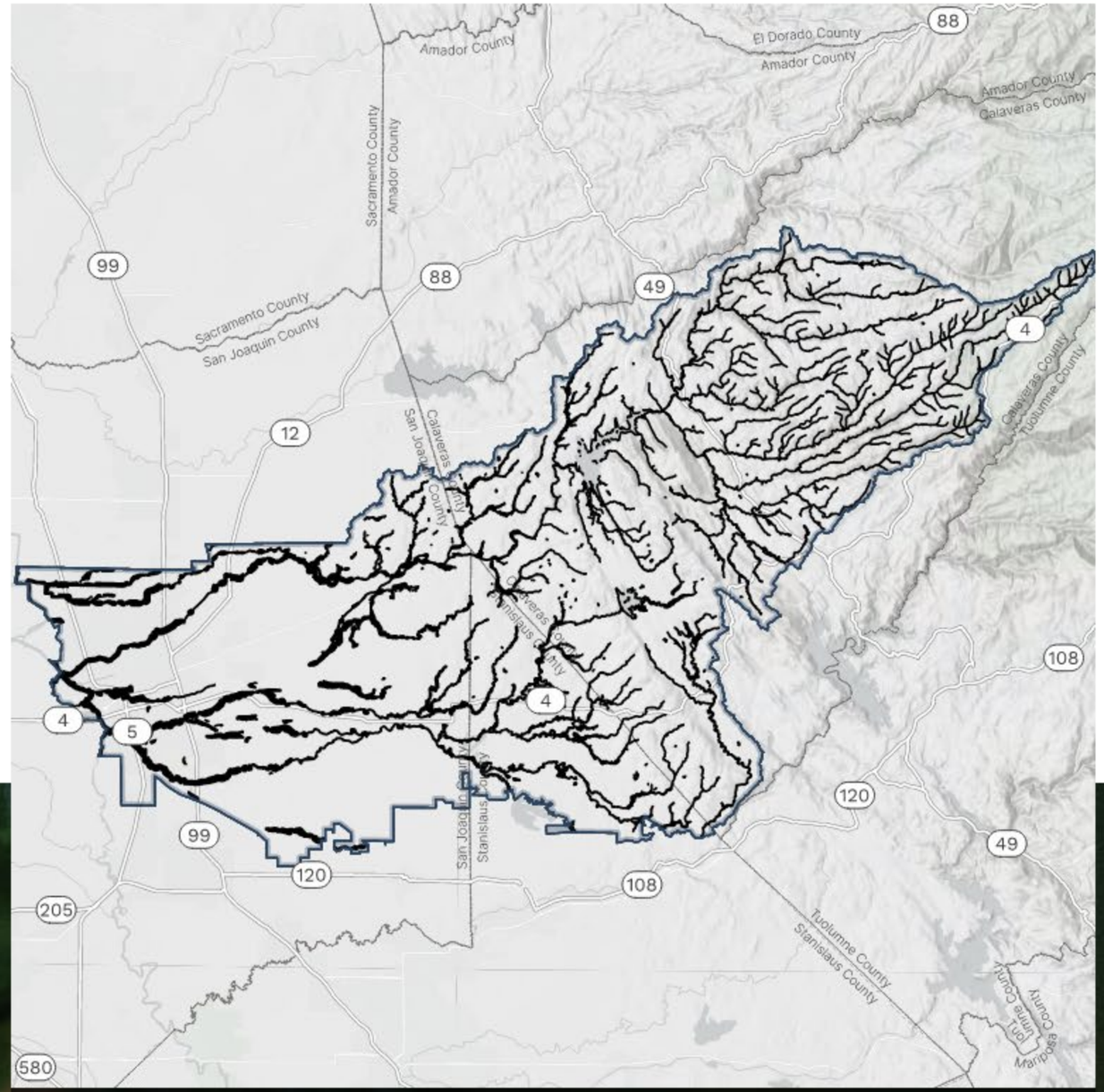
Riparian Areas include areas on the landscape adjacent to water sources where the ecosystem function is influenced by nearby aquatic ecosystems (Ilhardt, 2000).

The Vibrant Planet Riparian Areas HVRA is based on geospatial locations of riparian areas as created in the National Riparian Areas Basemap. This dataset combines the modeled 50-year flow data with the lidar-derived height above the stream channel to define riparian areas based on flooding extent during moderately high-water events. The National Riparian Areas Basemap layer is clipped to create a uniform layer performance across a range of landscape aridity conditions. The clipping extent is defined using the stream reach catchments from the NHDPlus-HR flowlines dataset where the stream reach is classified as perennial, intermittent with stream order greater than one, or ephemeral with stream order greater than two.

RIPARIAN AREAS

39,106 acres

of riparian areas



File Name: hvra_footprints/main.Riparian Areas.gpkg

Appendix D - Data Descriptions

Data Descriptions

DATA DICTIONARY

TITLE	FILE NAME	FILE TYPE	UNITS	SUMMARY	LEGEND DESCRIPTION
Burn Probability - Annual	burn_probability_1_year.tif	Raster	Fractional 0-1 (%)	Burn probability (BP) shows the probability of an area burning at any time during a single calendar year. A higher BP means wildfire is more likely to occur in an area.	Standard, logarithmic (breaks: 0, 0.0001, 0.0022, 0.0046, 0.01, 0.215, 0.046, 0.1, 0.215, 0.464, 1)
Average Efficiency of Water Use	mean_euw.tif	Raster	Inches of water/tons of carbon/year	Efficiency of water use shows the average annual productivity (tons of carbon) divided by the amount of water used (inches of water) per acre. This metric is intended as a balanced measure of ecosystem health and resilience that weighs reducing total water use against ecosystem growth.	Classify, stretch, clipped to the 99.9th percentile, calculated in a GIS.
Increase in Soil Erosion - No Action Scenario	soil_loss_increase_no_action.tif	Raster	Tons/acre/year	The change in expected erosion rate following a fire with no prior intervention relative to current conditions. Erosion rate is predicted using a gridded implementation of the Revised Universal Soil Loss Equation with current and expected post-fire difference driven by changes in soil cover.	Natural jenks, ten classes, calcluated in a GIS.
Project Sequencing	proposal-all projects.shp	Vector	n/a	Projects are sequenced, or ranked from 1-100 with Project 1 being the most impactful for risk reduction based wildfire hazard and objective emphasis.	Projects ranked from 1-100, with Project 1 being the most impactful at reducing wildfire risk.
Top Ten Project Review	proposal.shp	Vector	n/a	Projects are ranked from 1-10, with Project 1 being the most impactful at reducing wildfire risk. These projects, representing a potential initial body of potential work were further assessed for their specific impact on risk reduction to communities and water resources. A project by project breakdown is also provided in the appendices.	Projects ranked from 1-10, with Project 1 being the most impactful at reducing wildfire risk.
Recommended Management	proposal.shp	Vector	n/a	Management methods described in this document are intended to describe the recommended method that may be applied to any particular management unit, however the treatment prescription and intensity may vary depending on vegetation density and other factors. It is recommended that on-site ground verification occurs prior to implementation.	Categorical, representing Vibrant Planet recommended management action based on project goals and emphasis.
Change in Structure Exposure	proposal.shp, proposal.shp	Vector	n/a	The Structure Exposure Score (SES) dataset is an index of risk to structures, measuring wildfire hazard exposure specifically to structures, that incorporates fire intensity, ember load, and annual burn probability. These maps depict the change in Structure Exposure Score classes as a result of management action.	Categorical classes based on a geometric-interval scale, where each class is an order of 1.5 times higher than the previous class.
Change in Hazard	proposal.shp, proposal.shp	Vector	n/a	Hazard is classified into categorical classes using a logarithmic scale, where each class is an order of magnitude higher in hazard than the previous class. Going from very low to low, for instance, is a much smaller change in hazard than going from low to moderate.	Categorical classes based on a logarithmic scale, where each class is an order of magnitude higher in hazard than the previous class.
Change in Erosion Rate	proposal.shp, proposal.shp	Vector	Tons/acre/year	The change in expected erosion rate following a fire, both under no action and post action conditions, with no prior intervention relative to current conditions. Erosion rate is predicted using a gridded implementation of the Revised Universal Soil Loss Equation with current and expected post-fire difference driven by changes in soil cover.	Geometric interval, 10 classes, calculated in a GIS. Both maps are symbolized on the no action range of values.
Mean Characteristic Flame Length	mean_flame_length.tif	Raster	Feet	Characteristic Flame Length represents the mean weighted flame length expressed in feet. Flame lengths represent fire intensity, bucketed into six classes.	Standard, categorical (>0-2ft, >2-4ft, >4-6ft, >6-8ft, >8-12ft, >12ft).
95th Percentile Flame Length	95th_percentile_flame_length.tif	Raster	Feet	95th percentile flame length represents the average of the 95th percentile through the maximum flame lengths, weighted by weather probability occurrence. This metric can inform fire behavior potential for the near-worst weather conditions.	Standard, categorical (>0-2ft, >2-4ft, >4-6ft, >6-8ft, >8-12ft, >12ft).
Wildfire Exposure Score	wildfire_exposure_score.tif	Raster	Relative score	The Wildfire Exposure Score (WES) dataset provides an index of wildfire exposure to structures. It combines wildfire likelihood with potential damage to homes—including ember exposure from nearby fuel—and is calculated for all parts of the landscape.	A standard geometric-interval classification, where each class break is 1.5 times larger than the previous break (breaks: 0, 50, 75, 113, 169, 253, 380, 570, 854, 1500).
Ember Load + Production Indexes	ember_production_index.tif, ember_load_index.tif	Raster	Relative score		Custom logarithmic scale (breaks: 0, 31.62, 56.62, 100, 177.8, 316.2, 1000, 1778, 9999).

Data Descriptions

DATA DICTIONARY CONTINUED

TITLE	FILE NAME	FILE TYPE	UNITS	SUMMARY	LEGEND DESCRIPTION
Land Resume	land_resume.gpkg	Vector	Categorical	The Land Resume categorizes and partitions the landscape by land ownership (federal, state, local, or other).	Categorical, dynamic, based on specific owner/ manager across the AOI.
Fire History	fire_history.gpkg	Vector	Years	Fire history is a record of fire at a given location, including both wildfires and prescribed burns.	Categorical (<2015, 2015-2020, 2021-2022, 2023, 2024).
Vegetation Type	fuel_vegetation_type.tif	Raster	Categorical	Fuel Vegetation Type (FVT) describes current vegetation conditions, informs surface fuel types, fuelscapes, and ultimately informs wildfire intensity across the landscape.	LANDFIRE standard symbology, for more information on Fuel Vegetation Type codes see https://landfire.gov/fuel/fvt.
Surface Fuel Type	surface_fuel_model_class.tif	Raster	Categorical	Surface fuels are the live and dead vegetation lying on or immediately adjacent to the ground, such as woody debris, grasses, and shrubs. Even when shrubs or grasses are the tallest fuels, they are still considered surface fuels.	LANDFIRE standard symbology, for more information on Surface Fuel codes see https://landfire.gov/fuel/fbfm40.
Ignition Frequency Density Grid	ignition_frequi_density.tif	Raster	Number of fires/sq km/yr	Fire ignition frequency density is the number of fire ignitions per unit time per unit area (ignitions per year per sq km). Wildfire ignition probability data provides spatially explicit estimates of the likelihood that a wildfire will start in a given location, and can include either human or natural ignitions or both. This layer indicates if an area has a history of human caused ignitions.	Natural jenks, calculated in a GIS.
HVRA Current Value	hvra_current_value/{hvra_name}_current_value.tif	Raster	Relative score	Relative potential socio-ecological score, created using an objective, qualitative scoring framework. Values may vary spatially for each HVRA depending on a number of spatial characteristics. For HVRAs that are discrete vectors (ex: structures), value may be higher in overlapping "defense zone" buffers around features. For HVRAs that are derived from continuous raster data (ex: biomass), the score varies based on the magnitude of value of the metric corresponding to the HVRA: for example, areas that have more biomass would have a higher maximum relative value than areas that have less biomass.	No associated map pages.
HVRA Conditional Net Value Change (cNVC)	hvra_post_fire_value_change/{hvra_name}_post_fire_value_change.tif	Raster	Relative score	The conditional net value change (cNVC) is a measure of relative change in value to an HVRA, given its value (HVRA Current Value), its response to wildfire at different intensity classes (response function), and the probability of each fire intensity class (flame length probability). This metric does not account for probability of wildfire (burn probability); instead, see HVRA Expected Net Value Change (eNVC). Where cNVC is positive, the HVRA has value "gain" due to wildfire. Where cNVC is negative, the HVRA has value "loss" due to wildfire.	No associated map pages.
HVRA Cumulative Conditional Net Value Change (cNVC)	cumulative_post_fire_value_change.tif	Raster	Relative score	The HVRA Cumulative Conditional Net Value Change (cNVC) is computed as the sum of cNVC for all HVRAs. Where cumulative cNVC is positive, there is a net "gain" in value to HVRAs due to wildfire. Where cumulative cNVC is negative, there is a net value "loss" of HVRAs due to wildfire.	No associated map pages.
Soil Erosion Rates - No Action Scenario	soil_loss_fire_tons_ac.tif	Raster	Tons/acre/year	The expected erosion rate following a fire with no prior intervention predicted using a gridded implementation of the Revised Universal Soil Loss Equation. Erosion rate is affected by the current vegetation cover, soil properties, slope, landscape position, climatological rainfall patterns, and predicted fire intensity.	No associated map pages.
Soil Erosion Rates - Current Conditions	soil_loss_current_tons_ac.tif	Raster	Tons/acre/year	The expected erosion rate under current conditions predicted using a gridded implementation of the Revised Universal Soil Loss Equation. Erosion rate is affected by the current vegetation cover, soil properties, slope, landscape position, climatological rainfall patterns, and predicted fire intensity.	No associated map pages.

Data Descriptions

HVRA DATA DICTIONARY

TITLE	FILE NAME	FILE TYPE	UNITS	SUMMARY	LEGEND DESCRIPTION
Assets - Energy Facilities	hvra_footprints/main.Energy Facilities.gpkg	Vector	n/a	Asset HVRAs represent anthropogenic property and resources including structures and other infrastructure. More information about individual HVRAs can be found at the Vibrant Planet Knowledge Center.	Point features.
Assets - Structures	hvra_footprints/main.Structures.gpkg	Vector	n/a	Asset HVRAs represent anthropogenic property and resources including structures and other infrastructure.	Polygon features representing structures larger than 430 sq ft.
Assets - Transmission Lines	hvra_footprints/main.Transmission Lines.gpkg	Vector	n/a	Asset HVRAs represent anthropogenic property and resources including structures and other infrastructure.	Line features.
Safety - Emergency Service Facilities	hvra_footprints/main.Emergency Service Facilities.gpkg	Vector	n/a	Aspects of the landscape/built environment that provide critical safety features during a wildfire or other disturbance are represented as HVRAs in the Safety objective.	Point features.
Safety - Structure Transmission Zone	structure_transmission_zone.tif	Raster	Estimated number of structures per 100 square miles per year	Aspects of the landscape/built environment that provide critical safety features during a wildfire or other disturbance are represented as HVRAs in the Safety objective.	Quantiles, dynamic, calculated in a GIS.
Safety - Wildland Urban Interface (Defense Zone)	wui/main.wui.gpkg	Vector	n/a	Aspects of the landscape/built environment that provide critical safety features during a wildfire or other disturbance are represented as HVRAs in the Safety objective.	Polygon features.
Water - Lakes + Perennial Rivers and Streams	hvra_footprints/main.Lakes.gpkg, hvra_footprints/main.Perennial Rivers and Streams.gpkg	Vector	n/a	Water HVRAs represent surface water features and flows across the landscape as well as resources or areas that can be impacted by post-disturbance erosion or sedimentation.	Line (streams) and polygon features (lakes).
Water - Public Water Supply	hvra_footprints/main.Public Water Supply.gpkg	Vector	n/a	Water HVRAs represent surface water features and flows across the landscape as well as resources or areas that can be impacted by post-disturbance erosion or sedimentation.	Polygon features.
Water - Sediment Catchments for Water Supply	hvra_footprints/main.Sediment Catchments for Water Supplies.gpkg	Vector	n/a	Water HVRAs represent surface water features and flows across the landscape as well as resources or areas that can be impacted by post-disturbance erosion or sedimentation.	Polygon features.
Wildlands Health - Riparian Areas	hvra_footprints/main.Riparian Areas.gpkg	Vector	n/a	Plant associations or other HVRAs that represent wildland health, function or resilience fall into the Wildlands Health objective.	Polygon features.

Glossary

TERMS + DEFINITIONS

TERM	DEFINITION
Benefit	An increase in the value of a resource or asset (although assets generally do not benefit from fire). The benefit to a resource may partially or wholly offset loss due to resource damage. The net effect of benefit and loss is called net value change (NVC) but has also been called net loss or net benefit.
Conditional Net Value Change (cNVC)	Conditional net value change is calculated as the sum-product of flame-length probability and net value change (to one or more resources or assets) over a range of wildfire intensity classes (usually flame length classes). Burn probability is not included in cNVC. If no beneficial effects are under consideration, cNVC can simply be called conditional loss. The terms "value change", "response" and "net response" are functional synonyms for net value change; all refer to the net effects of positive and negative changes on the value of a resource or asset.
Effects	The anticipated benefits and losses to resources and assets, typically quantified primarily as a function of fire intensity.
Effects Analysis	The analysis of likely or anticipated response (benefits and losses) of resources and assets to wildfire, typically quantified as a function of fire intensity.
Expected Loss	Expected value of loss due to wildfire, calculated as the product of burn probability and conditional loss if a fire were to occur. Expected loss considers only the adverse effects of a fire, whereas expected net value change also considers any potential offsetting beneficial effects, such as improvement in wildlife habitat.
Expected Net Value Change (eNVC)	Expected net value change is calculated as the product of burn probability and conditional net value change. Expected net value change is a risk-neutral measure of the wildfire risk to resources and assets. If no beneficial effects are under consideration, expected net value change can simply be called expected loss. The terms value change, response and net response are functional synonyms for net value change; all refer to the net effects of positive and negative changes on the value of a resource or asset.
Flame Length Exceedance Probability (FLEP)	The conditional probability of observing fire intensity above (exceeding) a specified flamelength, given that a fire occurs.
Frequency Density	The number of occurrences of an event per unit time and per unit area. For example fire-ignition frequency density is the number of fire ignitions per unit time per unit area (for example, ignitions per year per million acres).

TERM	DEFINITION
Fuelscape	A raster-format geospatial characterization of ground, surface and canopy fuel across a landscape, typically consisting of one or more fuel characteristics data layers. For fire behavior modeling, a fuelscape consists of geospatial data layers representing surface fuel model, canopy base height and canopy bulk density. Fuelscape is functionally synonymous with fire modeling landscape. Other geospatial data layers required for geospatial fire modeling include topography characteristics (slope, aspect, elevation) and vegetation characteristics (forest canopy cover and height).
Hazard	A physical situation with potential for harm to persons or damage to resources and assets. Wildfire hazard can be described qualitatively as a fire environment—fuel, weather, topography, and ignitions—with potential for causing harm or damage, or quantitatively by two characteristics: (1) the probability of a fire occurring at a specific point during a specified time period, and (2) the expected distribution of intensity given that the event does occur. Wildfire hazard at a given location on the landscape is quantified as: (1) burn probability and (2) conditional wildfire intensity given that a fire does occur. Those two characteristics can be combined into a single spatially resolved measure of wildfire hazard: integrated wildfire hazard. It is important to note that since the definition of risk in the wildfire context is expanded to include beneficial as well as negative effects, the consideration of wildfire likelihood and intensity (in other words, hazard) should be expanded as well.
HVRA - High Value Resources and Assets	High Value Resources and Assets (HVRAs) are specific measurable resources that are spatially explicit, sometimes also referred to as SARAs, or Strategic Areas, Resources and Assets. They may be ecological or anthropogenic in origin. Please refer to the Vibrant Planet Knowledge Center for more information on how Vibrant Planet HVRAs are identified and developed.
Intensity	The rate of energy release of a natural phenomenon. Intensity is generally considered to be the primary effects-causing characteristic of a wildfire and other natural phenomena. Hurricane and tornado intensity is measured by wind speed. Wildfire intensity is measured as fireline intensity or flame length.
Loss	The reduction in value of a resource or asset.
Net Value Change	The net effect of both damaging and beneficial effects on the value of a resource or asset, whether it increases or decreases. Negative numbers for net value change indicate a net loss; positive numbers indicate a net benefit.
Risk	The probabilistic change in value when value is exposed to a given disturbance intensity. Risk accounts for both the disturbance hazard (intensity, probability) and how the value would respond to that hazard of a given intensity. Risk can be positive or negative, but is typically thought of as being negative (loss of value).

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