

Marin County Fire Department

in collaboration with



COMMUNITY WILDFIRE PROTECTION PLAN

July 2016





Executive Summary

This Community Wildfire Protection Plan (CWPP) provides a scientifically based assessment of wildfire threat in the wildland urban interface (WUI) of Marin County, California. This CWPP was developed through a collaborative process involving Marin County fire agencies, county officials, county, state, and federal land management agencies, and community members. It meets the CWPP requirements set forth in the federal Healthy Forests Restoration Act which include:

- Stakeholder collaboration (Section 3).
- Identifying and prioritizing areas for fuel reduction activities (Sections 4 and 5).
- Addressing structural ignitability (Section 7).

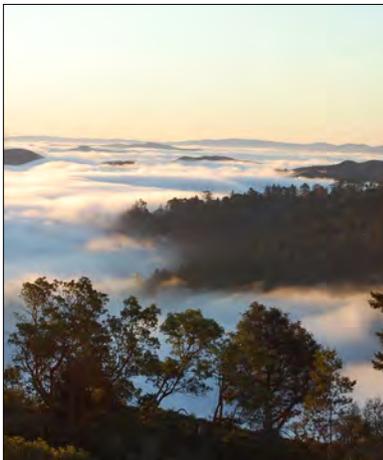
Wildfire poses the greatest risk to human life and property in Marin County's densely populated WUI, which holds an estimated 69,000 living units. Marin County is home to 23 communities listed on CAL FIRE's Communities at Risk list, with approximately 80% of the total land area in the county designated as having moderate to very high fire hazard severity ratings. The county has a long fire history with many large fires over the past decades, several of which have occurred in the WUI. To compound the issue, national fire suppression policies and practices have contributed to the continuous growth (and overgrowth) of vegetation resulting in dangerous fuel loads (see Section 1.6).



A science-based hazard, asset, risk assessment was performed using up-to-date, high resolution topography and fuels information combined with local fuel moisture and weather data. The assessment was focused on identifying areas of concern throughout the county and beginning to prioritize areas where wildfire threat is greatest. Hazard mitigation efforts can then be focused to address specific issues in the areas of greatest concern (see Sections 4 and 5).

Marin County will reduce wildland fire hazard using a collaborative and integrated approach that includes the following strategies (see Section 8):

- Pre-fire planning.
- Public education and outreach to promote and implement fire adapted community practices.
- Vegetation management and fuel reduction at the county and community levels.
- Reducing structure ignitability by promoting and enforcing building codes, ordinances, and statutes.



This document provides a framework for future collaboration that can be used to identify, prioritize, implement, and monitor hazard reduction activities throughout the county. It is intended to be a living document that will be updated periodically by FIRESafe MARIN and the Marin County Fire Department (MCFD) in collaboration with a broader group of county stakeholders. This document is also intended to support the California Fire Plan and CAL FIRE's Unit Strategic Fire Plan. While this CWPP broadly covers the entire county, this plan supports and encourages more focused plans for wildfire protection at the city, community, and neighborhood scales.



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Signatures

The Marin County Community Wildfire Protection Plan (CWPP) was developed in accordance with the Healthy Forests Restoration Act. The plan was developed collaboratively among county stakeholders including federal, state, local, and private land owners and local fire departments throughout the county. The plan includes a prioritized list of hazardous fuel reduction strategies and addresses measures that community members can take to reduce structural ignitability. The undersigned have reviewed the Marin County CWPP and accept this document as the final draft representing 2016.

/s/ Mark Heine 2/13/17
Mark Heine, Marin County Fire Chief's Association **Date**

/s/ Jason Weber 1/31/17
Jason Weber, Marin County Fire Department **Date**

/s/ Katie Rice 2/7/17
Katie Rice, Chair of FIRESafe MARIN **Date**

/s/ Christie Neill 1/31/17
Christie Neill, President of FIRESafe MARIN **Date**

/s/ Judy Arnold 3/7/17
Judy Arnold, Chair, Marin County Board of Supervisors **Date**

1. County Overview

Marin County is located in the North San Francisco Bay Area in California (**Figure 1**). The county is approximately 520 square miles (332,800 acres) with a population of approximately 261,000¹, and is largely rural. The county is bordered by Sonoma County to the northeast, the East San Francisco Bay Area to the southeast, and San Francisco County to the south, with the Pacific Ocean along its western border. Most of the county's population resides in the eastern, urban-developed region of the county along the Highway 101 corridor. The west region of the county—in and around Pt. Reyes—is a popular local tourist region covered by parklands and recreation areas, and the northwest is sparsely populated, agricultural rangeland.

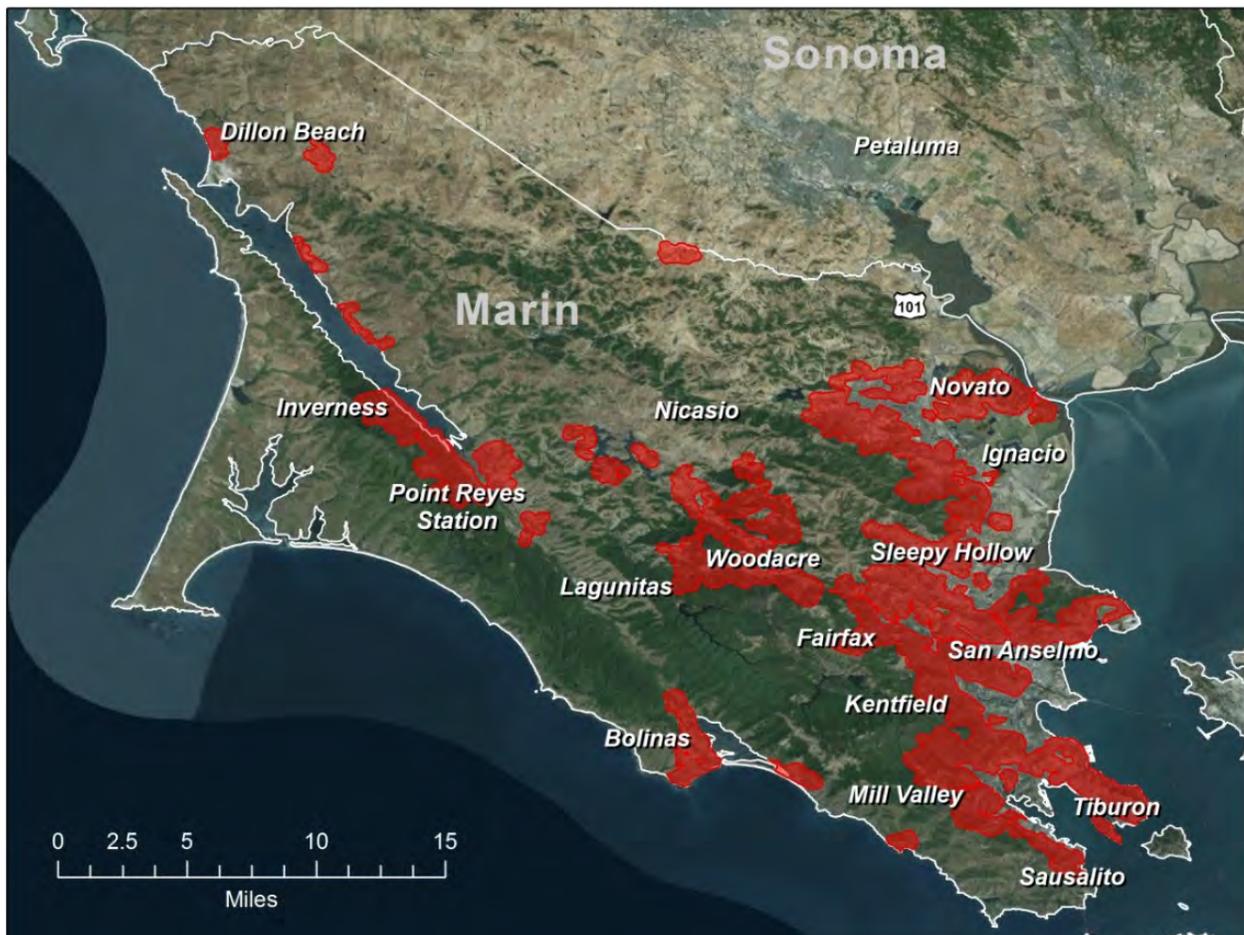


Figure 1. Map of Marin County and the wildland urban interface boundaries (red).

¹ U.S. Census Bureau Marin County population estimate for 2014, <http://quickfacts.census.gov/qfd/states/06/06041.html>, July 20, 2015

Approximately 60,000 acres—18% of the county’s land area—falls within the wildland urban interface (WUI) where residences (i.e., homes and structures) are intermixed with open space and wildland vegetation. A recent assessment by the Marin County Fire Department (MCFD) revealed that there are approximately 69,000 living units valued at \$59 billion within the WUI (Marin County Fire Department, 2015). Because of the mix and density of structure and natural fuels combined with limited access and egress routes, fire management becomes more complex in WUI environments. In Marin County specifically, many of the access roads within the WUI are narrow and winding and are often on hillsides with overgrown vegetation, making it even more difficult and costly to reduce fire hazards, fight wildfires, and protect homes and lives in these areas.

1.1 Fire Agencies, Capabilities, and Preparedness

Fire protection in California is the responsibility of either the federal, state, or local government. On federally owned land, or federal responsibility areas (FRA), fire protection is provided by the federal government, and or in partnership with local agreements. In state responsibility areas (SRA), CAL FIRE typically provides fire protection. However, in some counties CAL FIRE contracts with county fire departments to provide protection of the SRA – this is the case in Marin County, where CAL FIRE contracts with MCFD. Local responsibility areas (LRA) include incorporated cities and cultivated agriculture lands, and fire protection is typically provided by city fire departments, fire protection districts, counties, and by CAL FIRE under contract to local government.² **Figure 2** shows the FRA, SRA, and LRA in Marin County.

² http://www.fire.ca.gov/fire_prevention/fire_prevention_wildland_faqs#desig01

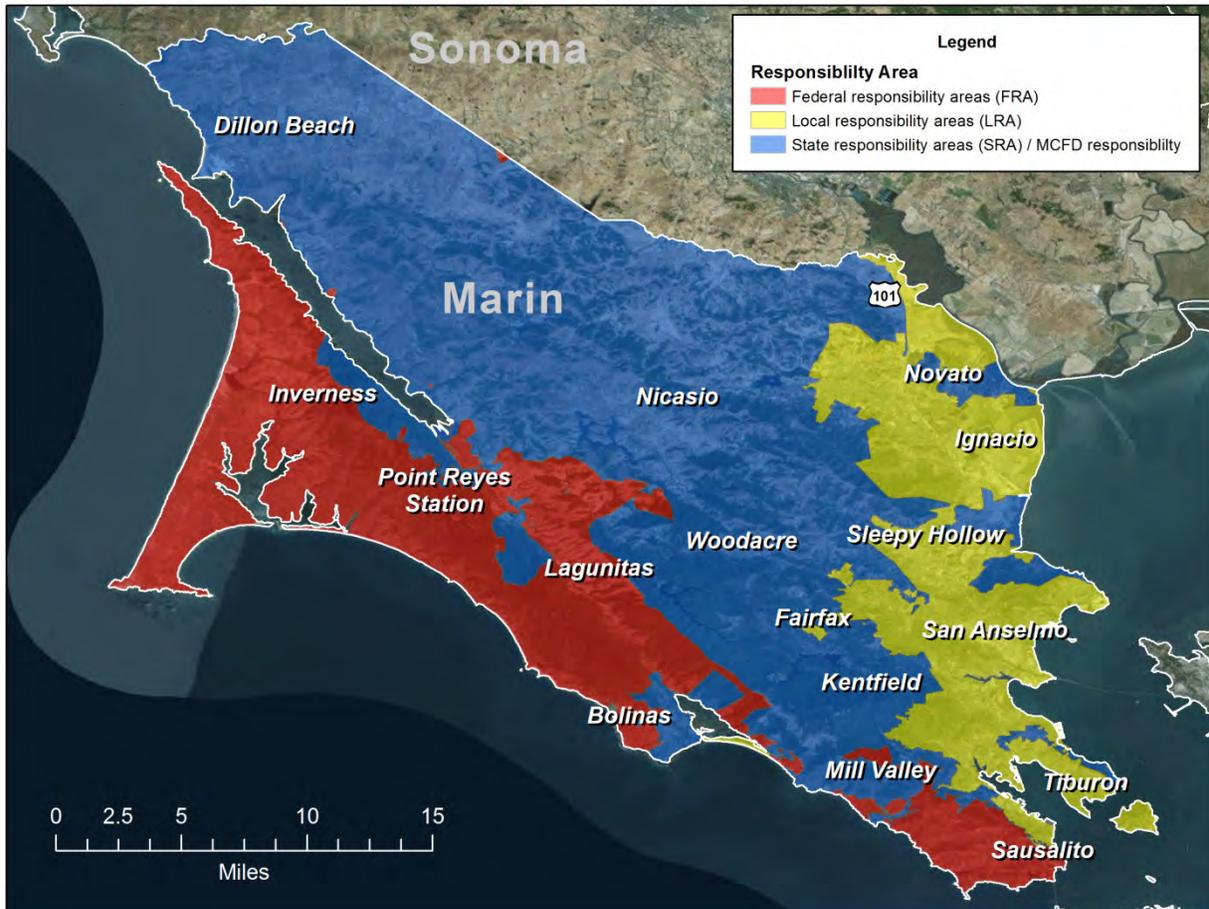


Figure 2. Map of the federal responsibility areas (red), state responsibility areas (blue), and local responsibility areas (yellow) in Marin County.

CAL FIRE contracts with MCFD to provide wildland fire protection and associated fire prevention activities for lands designated by the State Board of Forestry as SRA. Marin is one of six counties in the state who contract with CAL FIRE to protect SRA. The MCFD is responsible for the protection of approximately 200,000 acres of SRA within the county and is the primary agency that handles wildland fires. MCFD also provides similar protection services to approximately 100,000 acres of FRA in the Golden Gate National Recreation Area (GGNRA), the Muir Woods National Monument, and the Point Reyes National Seashore.

Within Marin County, there are 96,195 parcels and 106,679 living units; of these living units, an estimated 69,000 units are located in the WUI. There are 17,152 parcels and 14,560 living units located in the county's SRA; of these, 15,977 parcels are located in the WUI. Location within the WUI puts these parcels and living units at greater risk from wildfires due to surrounding vegetation and

their proximity to wildlands. **Table 2** lists the number of parcels and living units located in the SRA by fire jurisdiction.³

Table 2. Number of parcels and living units located in the SRA by fire jurisdiction.

Fire Jurisdiction	Number of Parcels	Number of Living Units
Marin County Fire Department	7,060	5,854
Southern Marin Fire Department	2,732	2,625
Novato Fire Protection District	2,040	1,706
Bolinas Fire Protection District	1,238	719
Ross Valley Fire Department	1,072	960
Kentfield Fire Protection District	818	815
Inverness Public Utilities District	752	618
Marinwood Fire Department	477	413
San Rafael Fire Department (CSA-19)	385	381
Stinson Beach Fire Protection District	328	283
Tiburon Fire Protection District	250	186
Total	17,152	14,560

MCFD staffs an Emergency Command Center (ECC) that dispatches for MCFD and local volunteer fire departments, coordinates wildland incidents within the SRA or FRA, and acts as the county’s Office of Emergency Services (OES) coordination center for fire dispatching. In addition to MCFD, there are thirteen professional fire service agencies and one volunteer department—Tomales Volunteer Fire Company (TVFC)—that provide fire services in Marin County. TVFC provides 12 firefighters to MCFD’s Tomales response zone. In addition, one private fire brigade, Skywalker Fire, is situated on the Lucas Valley Ranch. **Figure 3** shows a jurisdictional map for MCFD and the other thirteen professional fire service agencies in Marin County, and **Table 3** provides information on all of the fire service agencies in the county.

³ Parcel and living unit data are based on the 2015-16 Marin County Tax Assessor’s Roll. The next update of these data is scheduled for release in July 2016.

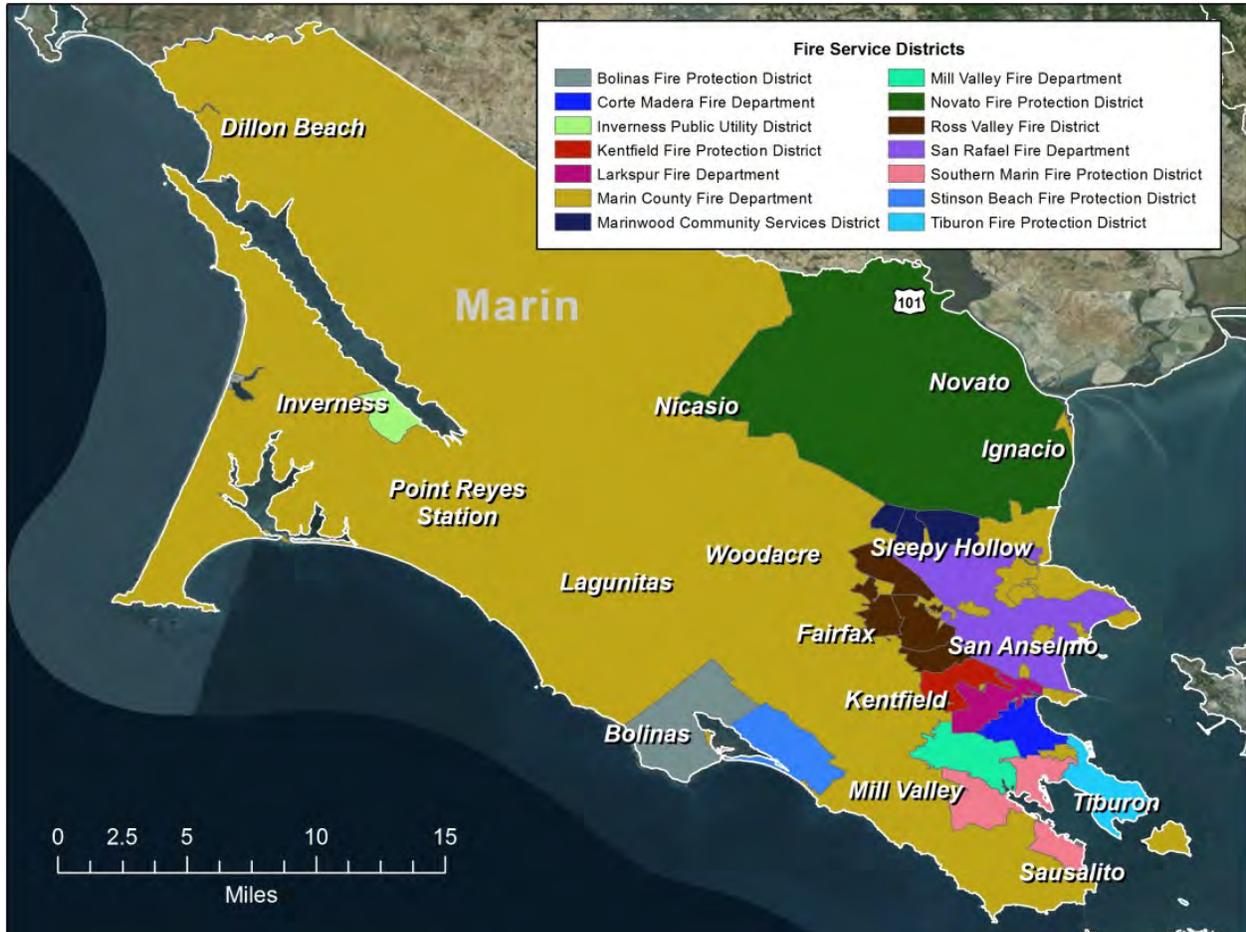


Figure 3. Map of Marin County professional fire service agency jurisdictions.

Table 3. Marin County fire service agencies.

Personnel	Fire Stations	Fire Apparatus	Additional Equipment/Services
Marin County Fire Department			
160 firefighters (full time, seasonal, volunteer), 14 person Tamalpais Fire Crew	Six	Seven Type 1 (two reserves), 12 Type 3 (5 reserves), one Type 4, one ECV, one transport/bulldozer, three water tenders, four ambulances/medic	Four Fire Detection Cameras, two Lookout Towers

Personnel	Fire Stations	Fire Apparatus	Additional Equipment/Services
Novato Fire Protection District			
76 (60 emergency response personnel, 15 administrative personnel, one fire mechanic)	Five stations, one administrative office building, one training tower	Seven Type 1 ALS (2 reserve), two Type 3 ALS, one OES Type 1, four ALS ambulances (two first out, one cross staffed and one reserve), one ALS aerial ladder truck, one water tender	Weather station, thermal imaging cameras
Kentfield Fire Protection District			
20 firefighters (full time, seasonal, volunteer)	One	Three Type 1, one ladder truck, two utility units	N/A
Bolinas Fire Protection District			
21 firefighters (full time, part time, seasonal, volunteer)	One	Two Type 1, one Type 3, one MCI trailer	N/A
Stinson Beach Fire Protection District			
5 personnel (30 volunteers)	One	Two Type 1, one Type 3, one water tender, one BLS ambulance, two command vehicles	
San Rafael Fire Department			
72 line personnel (full time), 10 administrative/prevention personnel	Seven	Nine Type 1 (two reserve), one Type 3, two ladder trucks, four medic ambulances, one hose tender, five utility units, three BC command vehicles	Eight thermal imaging cameras
Ross Valley Fire Protection District			
32 personnel (full time)	Four	Four Type 1 (three reserves), one Type 3	
Tiburon Fire Protection District			
43 personnel (full time, volunteer)	Two	Four Type 1, one Type 3, one rescue, one fireboat, one medic ambulance	Three I/R cameras

Personnel	Fire Stations	Fire Apparatus	Additional Equipment/Services
Corte Madera Fire Department			
26 personnel (full time, reserves)	Two	Three Type 1 (one reserve), two ambulances (one reserve), two command vehicles (one truck, one SUV), three utility vehicles (two trucks, one SUV)	
Mill Valley Fire Department			
35 personnel (25 full time, 10 volunteer)	Two	Three Type 1 (one reserve), one Type 3, one ALS ambulance, three command vehicles, two utility trucks	
Larkspur Fire Department			
17 personnel (full time)	Two	Three Type 1 (one reserve), one Type 3, one water tender – Type 1 tactical	
Marinwood Fire Protection District			
31 firefighters (11 full time, 20 volunteer)	One	Two Type 1, one Type 3, utility truck	
Southern Marin Fire Protection District			
53 (6 administrative, 47 emergency response)	Two	Four Type 1 (1 reserve), one Type 3, two ALS ambulances, one heavy rescue, one ladder truck, two Battalion Chief vehicles, three utility trucks, three staff vehicles	One boat, one dive tender unit, one IRB, CAL OES water rescue resources (IRB and RWC)

1.2 Agency Coordination

In addition to the CAL FIRE contract, Marin County has a well-organized local mutual aid system, based on the principles of resource sharing and cooperation with a goal of providing the public with the highest level of service that no one agency is equipped to provide. These agreements include resources from all fire agencies, law enforcement, volunteer fire departments, the OES, the National Park Service (NPS), CAL FIRE, and local landowners. **Table 4** lists the mutual aid agreements/plans and assistance-for-hire agreements. Mutual aid agreements are agreements among emergency responders to lend assistance across jurisdictional boundaries to supplement the resources of any fire agency during a period of actual or potential need.

Table 4. Mutual aid agreements/plans and assistance-for-hire agreements.

Mutual Aid Agreements and Plans
Countywide Mutual Threat Zone Plan
Marin Sonoma County Mutual Threat Zone Plan
Marin County Mutual Aid Agreement
County of Marin Urban Search and Rescue
County of Marin Office of Emergency Services
State of California Master Mutual Aid
North Bay Incident Management Team
Assistance-for-Hire Agreements
Marin Municipal Water District
Skywalker Ranch Fire Brigade
National Park Service in the areas of Point Reyes National Seashore, Golden Gate National Recreation Area, and Muir Woods National Monument

The ECC has been maintained by MCFD since the 1930s and serves as an independent dispatch center. The ECC receives, disseminates, and transmits information to field units, and has the additional responsibility to act in a supervisory role for incidents prior to the arrival of field units. The ECC also acts as the central ordering point for all state resources that are committed to SRA incidents in the county, and for Region II California Office of Emergency Services requests and OES coordination of local government fire resources entering or leaving the county operational area. The ECC processes approximately 4,500 calls annually, and is also responsible for handling all business calls received by the department. In 2015, the ECC upgraded to a new Computer Aided Dispatch (CAD) system to improve response coordination with all units.

The Communications Division of the Marin County Sheriff’s Office operates the Marin County Public Safety Communications Center, which is located in the Hall of Justice in San Rafael. The center provides service to the Sheriff’s Office, four police departments, nine fire departments, six paramedic service areas, the Marin County Department of Public Works, and many other city and county government service departments. The center is the primary 9-1-1 public safety answering point for all unincorporated areas of the county, as well as Mill Valley, Belvedere, Sausalito and Tiburon.⁴

⁴ http://marinsheriff.org/about.aspx?gi_id=5

1.3 Population and Housing

According to the most recent census data, the population of Marin County is approximately 261,000⁵, with 87% of people living in LRA, 12% living in SRA, and 1% living in FRA. **Table 5** shows the population distribution in Marin County by city or town.

Table 5. Population distribution by city or town and surrounding area.

City, Town, or Community	Population	% County Total
San Rafael	59,237	23%
Novato	55,005	21%
Mill Valley	14,403	6%
San Anselmo	12,676	5%
Larkspur	12,325	5%
Tamalpais-Homestead Valley	10,735	4%
Corte Madera	9,916	4%
Tiburon	9,224	4%
Fairfax	7,638	3%
Sausalito	7,135	3%
Kentfield	6,485	3%
Lucas Valley-Marinwood	6,094	2%
Strawberry	5,393	2%
Santa Venetia	4,292	2%
Marin City	2,666	1%
Ross	2,483	1%
Sleepy Hollow	2,384	1%
Belvedere	2,129	1%
Lagunitas-Forest Knolls	1,819	1%
Bolinas	1,620	1%
Woodacre	1,348	1%
Black Point-Green Point	1,306	1%
Inverness	1,304	1%
Point Reyes Station, Alto, Stinson Beach, San Geronimo, Muir Beach, Dillon Beach, Tomales, Nicasio	3,530	2%
Total	241,147	95%

Note: the remaining 5% of the county's population lives in rural areas outside of the cities and towns listed in this table.

⁵ Annual Estimates of the Resident Population: April 1, 2010 to July 1, 2014; Source: U.S. Census Bureau, Population Division, <http://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml>

Most of the towns and cities in Marin County are “built-out,” resulting in modest levels of new development. However, some future residential development is expected on the hillsides of the San Geronimo Valley, and in Lucas Valley, Nicasio, and Point Reyes Station. In addition, as the value of parcels increases, more lots along the Throckmorton Ridge and Panoramic Highway are being developed.

1.3.1 Population Flux

An important consideration from a fire planning and emergency response perspective is the tourist population and temporal shifts in the transient population during the summer fire season, particularly in the western coastal areas. On warm days during the summer, the transient tourist population more than doubles as people come to the county’s parks, beaches, and recreation areas. There is often heavy traffic on roadways to and from west Marin County and along Highway 1. Consideration of the tourist population flux is important for planning strategic fuels treatment projects, reducing potential ignition sources, and allocating emergency response personnel.

1.4 Land Ownership

Land owners and vegetation managers in Marin County are some of the key stakeholders in the CWPP development process. Land ownership in Marin County is quite diverse and includes federal, state, local (county), and private property owners; **Table 6** shows the distribution of land ownership in the county.

Table 6. Distribution of land ownership in Marin County.

Land Owner	Percent Ownership
Private	56%
National Park Service	24%
Marin Municipal Water District	6%
County Open Space District	5%
State Parks	4%
Other Parks ^a	5%
Total	100%

^a Includes land controlled by municipalities and school districts, Army Corps, California Department of Agriculture, California Fish & Game, North Marin Water District, and private organizations.

1.5 Natural Resources

1.5.1 Biodiversity

Marin County has a wide variety of plants including several rare or locally endemic species. The landscape provides a range of elevations, aspects, soil types, and moisture levels that support savannas, grasslands, oak-bay woodlands, chaparral, redwood forests, and wetlands.

Rare, threatened, or endangered species (both plants and animals) are present in Marin County. Extensive information about vegetation and their habitats is included in the Marin County Parks and Open Space District's (MCOSD) Vegetation and Biodiversity Management Plan. The county has critical habitats for the following list of special-status or locally rare species—see the Vegetation and Biodiversity Management Plan (May & Associates Inc., 2015) for Latin names:

- **Wildlife (birds)** – Cooper's hawk, sharp shinned hawk, white-tailed kite, grasshopper sparrow, northern spotted owl, olive-sided flycatcher, brant, northern harrier, San Francisco common yellowthroat, California black rail, snowy egret, osprey, California clapper rail, Samuel's song sparrow, California horned lark, yellow warbler, burrowing owl, Sacramento splittail, California black rail, golden eagle, Virginia rail, San Pablo song sparrow
- **Wildlife (fish, frogs)** – coho salmon, central California coast steelhead, Chinook salmon, California red-legged frog (a threatened species)
- **Wildlife (other)** – pallid bat, American badger, salt marsh harvest mouse, land snail
- **Broadleaf herbaceous annuals and perennials** – indigo bush, coast ground cone, Tiburon buckwheat, Mt. Tamalpais jewelflower, Brewer's redmaids, Hooker's tobacco brush, silver lupine (host plant of mission blue butterfly), coast rhododendron, marsh milk vetch, Humboldt Bay owl's clover, Point Reyes bird's beak, bent-flowered fiddleneck, Mt. Tamalpais manzanita, Mt. Tamalpais lessingia, common manzanita, Brewer's claytonia, Van Houtte's columbine, serpentine reedgrass, St. Helena morning glory, Calistoga navarettia, rough leaf aster, needle-leaved yellow linanthus, coast piperia, California lace fern, bristly linanthus, Wallace spike-moss, marsh zigadenus, Oakland star tulip, Mt. Tamalpais thistle, Marin dwarf flax, Marin County navarettia, Santa Cruz microseris, coast rock crest, California bottlebrush grass, California fremontia, Durango root, bristly leptosiphon, wind poppy, San Francisco gum plant, San Francisco leafy fleabane, black sage, tufted eschscholzia, wooly headed lessingia, fragrant fritillary, Baker's navarettia, streamside daisy, featherleaf navarettia, Lobb's buttercup, Tiburon indian paintbrush, Tiburon jewelflower, California grass of Parnassus, Tiburon mariposa lily, Santa Cruz clover, pitted onion, long-rayed brodiaea, serpentine coyote mint

Challenges to Marin County's biodiversity include controlling and eliminating invasive species because they displace native plants and can change ecosystem functions. Small shrubs are particularly hard to control because they may be widely distributed spatially. In addition to displacing native species, some invasive shrubs can form a dense understory beneath forest canopies, and

could alter fire behavior and severity. Invasive trees, shrubs, plants, and grasses in Marin County include

- **Trees** – acacia, blue gum eucalyptus, Monterey cypress, Monterey pine
- **Shrubs** – cotoneaster, French broom, Himalayan blackberry, Pride of Madeira, Scotch broom, Spanish broom
- **Plants** – Bullthistle, purple starthistle, wooly distaff thistle, yellow starthistle, fennel, highway iceplant (also known as Hottentot fig), perennial pepperweed (also known as tall whitetop), puncture vine, stinkwort, thoroughwort (also known as eupatorium)
- **Perennial Grasses** – cordgrass, erect veldtgrass, Fescue, Harding grass, jubata grass/pampas grass, velvet grass
- **Annual Grasses** – barbed goatgrass, Italian wildrye, medusahead, rattlesnake grass, wild oats

1.5.2 Watersheds and Water Districts

There are more than 21,000 acres of protected watershed land on Mt. Tamalpais and in the west Marin hills, including seven reservoirs which provide 75% of the water for central and southern Marin. The Marin Municipal Water District (MMWD) was founded in 1912 and manages the watershed land in central and southern Marin, including the seven reservoirs. The MMWD watershed has 92 miles of roads, 59 miles of trails, and a network of wildfire protection fuel breaks. Access and use of the lands by the public is limited to protect the natural landscape. During extreme fire weather conditions, such as Red Flag Warnings and other emergencies, vehicle access is limited on MMWD land.⁶



Photo by David Baron⁷

The North Marin Water District (NMWD), founded in 1948, is an independent special district in the northern portion of the county and operates under the authority of Division 12 of the California Water Code. NMWD provides water service to the greater Novato area and to areas of West Marin (Point Reyes Station, Olema, Bear Valley, Inverness Park and Paradise Ranch Estates). NMWD purchases approximately 80% of its Novato water supply from the Sonoma County Water Agency, with the remaining 20% derived from the District's Stafford Lake Reservoir (located in Marin County just west of Novato) and recycled water (Bentley and Landeros, 2015).

⁶ <https://www.marinwater.org/27/About>

⁷ "Bon Tempe Lake" (<https://www.flickr.com/photos/dbaron/9388923977/>) by David Baron (<https://www.flickr.com/photos/dbaron/>) is licensed under CC BY 2.0 (<http://creativecommons.org/licenses/by/2.0/legalcode>). No changes were made to this image.

1.6 Marin County's Wildland Urban Interface

The WUI zone map used throughout this CWPP was assembled using geographic information system (GIS) data layers acquired from the Marin County GIS web portal, MarinMap.⁸ The WUI zone helps inform decisions on where to focus vegetation management and fuel reduction projects. The WUI



zone determination is also a major component of MCFD's Strategic Fire Plan (Marin County Fire Department, 2015), which in turn is part of CAL FIRE's Strategic Fire Plan.

Homes and structures located anywhere in and around the WUI are at a higher risk for exposure to wildland fire. Fire can spread rapidly throughout WUI areas through adjacent structures and/or vegetation, or by ember dispersion. Property owners in the WUI have a responsibility to prepare their property

for structure defense by providing adequate defensible space and complying with WUI building codes and ordinances (see Section 7).⁹ The WUI boundaries for Marin County were determined based on areas with high structure density and proximity to areas with a high density of burnable fuels.

⁸ <http://www.marinmap.org/Html5Viewer/Index.html?viewer=mmdataviewer&Run=WUILayerON&ServiceId=13&LayerName=Urban%20Wildland%20Interface&extent=5950502.26733493,2207544.30421775,5994476.00578578,2244189.08626013>

⁹ <http://www.leginfo.ca.gov/cgi-bin/displaycode?section=prc&group=04001-05000&file=4291-4299>

Figure 4 shows Marin County's WUI boundaries overlaid with population density; as shown in the figure, much of the county's population resides in or near the WUI.

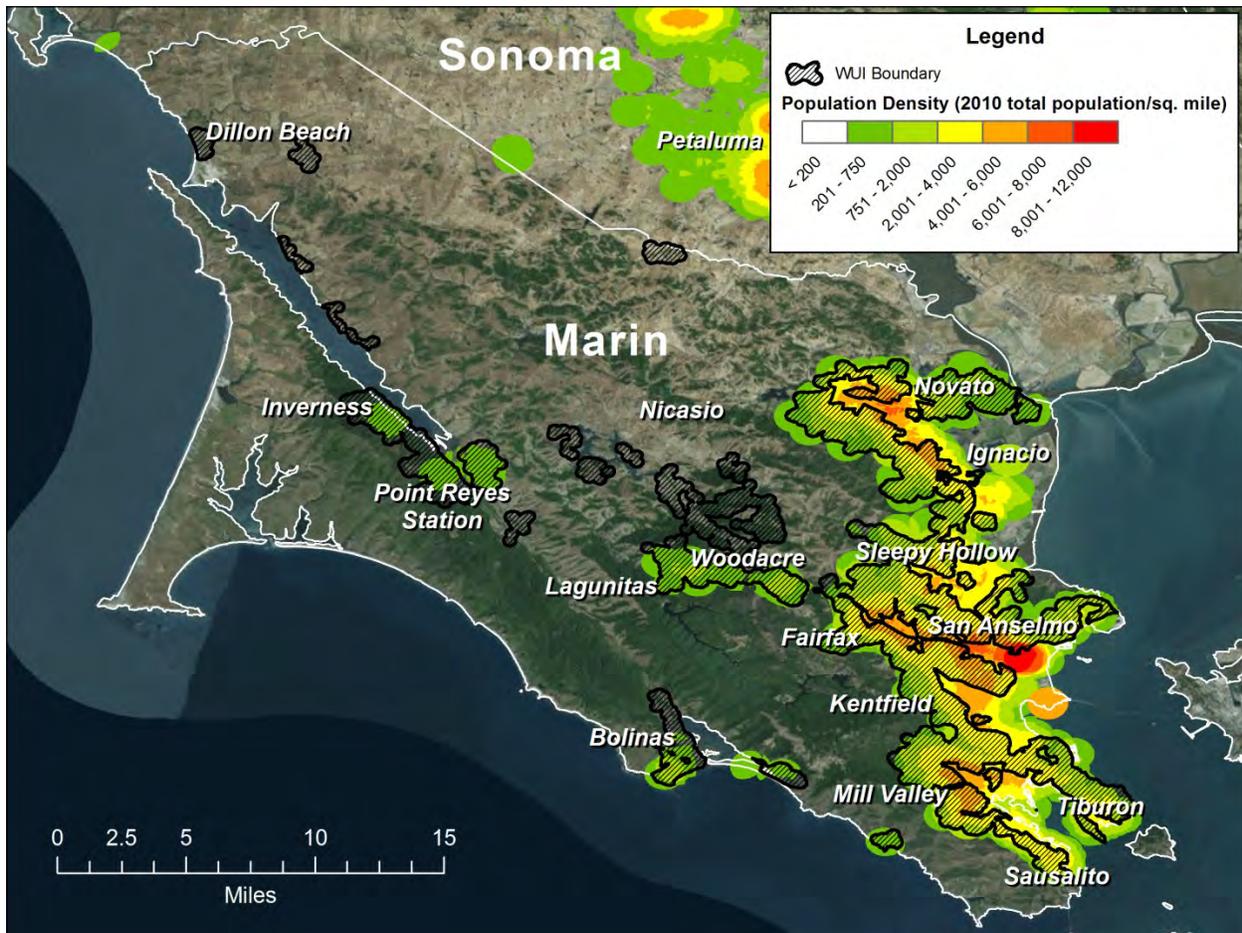


Figure 4. Population density in and around Marin County's WUI.

Unincorporated rural areas within the county include the coastal communities of Muir Beach, Stinson Beach, and Bolinas; communities near Tomales Bay including Olema, Point Reyes Station, Inverness,



Inverness Park, Marshall, Tomales, and Dillon Beach; and rural areas in the interior valleys including Nicasio, Lagunitas, Forest Knolls, San Geronimo, and Woodacre. These communities are primarily situated within or adjacent to the WUI, with moderate to dense concentrations of structures. Marin County has approximately 60,000 acres of WUI adjacent to 200,000 acres of watershed. Response times in these communities present significant challenges to keeping fires from directly impacting the communities and sub-

divisions (especially those within the SRA) as emergency fire access and evacuation egress is limited by narrow, winding roads lined with dense vegetation.

1.7 Roads and Streets

In Marin County, cul-de-sacs generally service new housing developments and most of the smaller canyons, valleys, and hillsides. Some planned unit developments are served by privately-maintained roads, which create access issues (i.e., narrow paved widths and limited on-street parking). According to California Fire Code specifications, roadways that are considered hazardous in terms of fire access and protection are those with

- less than 20 feet of unobstructed paved surface and 13.6 vertical feet;
- dead-ends longer than 800 feet, and;
- cul-de-sac diameter less than 68 feet.



Driveways that are less than 16 feet wide or that do not have adequate turnaround space are also considered hazardous. A large number of roadways and driveways in many of Marin County's communities fall into one or more of the above categories.

2. Fire Environment

The mix of weather, diverse vegetation and fuel characteristics, complex topography, and land use and development patterns in Marin County are important contributors to the fire environment. The MCFD Woodacre ECC currently manages the data from four Remote Automated Weather Stations (RAWS) for predicting fire danger utilizing the National Fire Danger Rating System (NFDRS) during the fire season. The RAWS are located in Woodacre, Middle Peak, Barnabe, Big Rock and a new station will be coming online in Novato.

2.1 Weather

Marin County is bounded by the cool waters of the Pacific Ocean to the west, the San Francisco and Richardson Bays to the southeast, the San Pablo Bay to the east, and Sonoma County agricultural lands to the north. The combination of these large bodies of water, location in the mid-latitudes, and the persistent high pressure over the eastern Pacific Ocean results in several micro-climates. Weather in the county consists of warm, dry summers and cool, wet winters. The climate in early fall and late spring is generally similar to the summer, and late fall is similar to winter. Spring is generally cool, but not as wet as the winter. While these general weather conditions are fairly representative of the typical Marin County weather, complex topography, annual variability of weather patterns, and less frequent and transient weather patterns are important to fire conditions.



Summer Weather Conditions

In the late spring through early fall, the combination of frequent and strong high-pressure systems (known as the Pacific High) over California combined with the cool waters of the ocean/bays results in persistent fog and low clouds along the coast (including over southern Marin County near the San Francisco Bay). The fog often penetrates into the inland valleys of northern and central Marin County, especially during overnight hours. At the coastline, mist from fog can keep the land surfaces modestly moist while inland land surfaces above the fog or inversion are often very dry.

The Pacific High that persists from late spring through early fall over the eastern Pacific, combined with a thermal low pressure over the Central Valley of California, results in an almost continuous sea breeze. These winds usher in cool and moist air and can be strong (15 to 25 mph), especially over the ridge tops and through northwest to southeast lying valleys, including San Geronimo/Ross, Hicks, and Lucas Valleys. These westerly winds are usually highest in the afternoon, decrease in the evening, and are light overnight before increasing again in the late morning/early afternoon.

Extreme Summer Weather Conditions

Occasionally in the summer and more often in the fall, the Pacific High moves inland and centers over Oregon and Idaho, while low pressure moves from the Central Valley of California to southern California and Arizona. The resulting north-to-south pressure gradient can be strong enough to retard the typical sea breeze and can even result in winds blowing from the land to the ocean (offshore winds). As the offshore winds move air from the Great Basin to the coastal areas of California, the air descends and compresses, which greatly warms and dries the air. Under these “Diablo” wind conditions, temperatures in Marin County can reach 100°F in the inland areas and even



80°F at the coast, and relative humidity can be very low. In addition, wind speeds can be high (20 to 40 mph) and gusty, and are often much faster over the mountains and ridge tops such as Mt. Tamalpais, Loma Alta, and Mt. Burdell compared to low-lying areas. Wind speeds can be high over the ridges and mountains at all times of day under this “offshore” wind pattern, and are often much slower or even calm at night in low-lying areas because nighttime cooling decouples the aloft winds from the surface winds. It is during these Diablo wind events that there is a high potential for large,

wind-driven fires should there be an ignition. Historically, the largest and most destructive fires have occurred during these offshore (also known as Foehn) wind events including the Angel Island and the Vision fires.

A few times per year in the summer and early fall, monsoonal flow from Mexico brings in moist and unstable air over central and northern California, which can result in thunderstorms with or without precipitation. With the otherwise dry summer conditions, the lightning can ignite fires. These monsoonal flow patterns are usually only one to two day events.

Winter Weather Conditions

Beginning in late November and lasting through the end of March, the Pacific High moves south and weakens, allowing storms that originate in the Gulf of Alaska to move over California. These storms bring precipitation and, at times, strong winds out of the south. Each storm usually results in one-fourth inch to several inches of rain over a day or so. Near Mt. Tamalpais, rainfall amounts are enhanced by orographic lifting, resulting in higher rain amounts in the Kentfield and Fairfax areas compared to the rest of the county. Typically, after the first rain in November, the cool weather and occasional storm keeps the ground wet through late Spring. However, in some years, significant rain does not occur until later in the year (e.g., early-to-late December) and there can be several weeks without any storms and rain. During storms, temperatures are usually mild.

When there are no storms over California, a land-breeze typically forms (i.e., winds blowing from the Central Valley to the Pacific Ocean). These winds can reach 30 mph, and travel through the southeast to northwest lying valleys, over low-lying ridges such as the Marin Headlands, and through the Golden Gate. These winds are usually highest in the mid-morning hours and decrease in the afternoon as the Central Valley warms during the day. The winds are associated with cold and modestly moist air.

Spring Transitional Conditions

In late February/early March through late April, the Pacific High strengthens and moves north, and storms impacting the county become less frequent. During this time of year there is often a low pressure area over the desert in southwest California. The combination of the Pacific High to the north and low-pressure to the southwest results in strong winds blowing from the northwest to the southeast. Like the sea breeze, these winds bring in cool, moist air and are usually highest in the afternoon hours. Because of winter and spring rains, the land is wet and there is little danger of wildland fire despite the high winds and only occasional precipitation. There is often little coastal fog this time of year.

2.2 Vegetation and Fuels Characteristics

Vegetation, which is also known as fuel, plays a major role in fire behavior and potential fire hazards. A fuel's composition, including moisture level, chemical make-up, and density, determines its degree of flammability. Of these, fuel moisture level is the most important



consideration. Generally, live trees contain a great deal of moisture while dead logs contain very little. The moisture content and distribution of fuels define how quickly a fire can spread and how intense or hot it may become. High moisture content will slow the burning process since heat from the fire must first eliminate moisture.

In addition to moisture, a fuel's chemical makeup determines how readily it will burn. Some plants, shrubs, and trees such as chamise and eucalyptus (both present in Marin County) contain oils or resins that promote combustion, causing them to burn more easily, quickly, and intensely. Finally, the density of a fuel influences its flammability; when fuels are close together but not too dense, they will ignite each other, causing the fuel to spread readily. However, if fuels are so close that air cannot circulate easily, the fuel will not burn freely.¹⁰

Marin County has extensive topographic diversity that supports a variety of vegetation types. Environmental factors, such as temperature, precipitation, soil type, aspect, slope, and land use history, all help determine the existing vegetation at any given location. In the central and eastern parts of the county, north facing slopes are usually densely wooded from lower elevations to ridge peaks with a mixture of mostly hardwood tree species such as coast live oak, California bay, Pacific madrone, and other oak species. Marshlands are also present throughout the county; once ignited, marsh fires can be difficult to contain and extinguish.

Grasslands with a mixture of native and nonnative annual and perennial plant species occur most often in the northern and western parts of the county due to a combination of soil type, lower rainfall, and a long history of ranching.



The southern and western facing slopes tend to have a higher percentage of grasslands, which in turn have the potential to experience higher rates of fire spread. Grassland fires are dangerous even without extreme fire weather scenarios due to the rapid rate of fire spread; in some cases, fires spread so quickly that large areas can burn before response resources are able to arrive.

In the west portion of the county closer to the coast, where precipitation is higher and marine influence is greater, most

areas are densely forested with conifer species (i.e., Bishop pine, Douglas-fir, and coast redwood) and associated hardwood species. Chaparral vegetation also occurs in parts of the county, especially on steeper south and west facing slopes. This mix of densely forested areas mixed with chaparral results in higher fuel loads and potentially higher fire intensity. Expansion of the residential community into areas of heavier vegetation has resulted in homes existing in close proximity to dense natural foliage;

¹⁰ <http://www.nps.gov/fire/wildland-fire/learning-center/fire-in-depth/fire-behavior.cfm>

these homes are often completely surrounded by highly combustible or tall vegetation, increasing the potential that wildland fires could impact them.

As part of the development of this CWPP, an updated vegetation map layer was created using the most recent vegetation information available from a variety of state and local data sources. Vegetation distribution in Marin County is characterized by approximately 20 different types of vegetation which have been classified into 15 fire behavior fuel models. [Table 7](#) lists the fuel model types for Marin County, while [Figure 5](#) shows a fuel model map; the data shown were developed to support this CWPP and represent the most up-to-date and highest-resolution vegetation coverage information for the county. The methods used to develop the data set are described in [Appendix A](#).

Table 7. Fuel model types for Marin County.

Scott & Burgan Fuel Model Description and Number	Acres	Percent of County Total
Moderate load, dry climate grass (104)	79,727	24%
Short, sparse, dry climate grass (101)	62,050	18%
Very high load broadleaf litter (189)	51,227	15%
Low load, humid climate timber-shrub (144)	29,637	9%
Very high load, dry climate timber-shrub (165)	29,120	9%
High load, dry climate shrub (145)	24,186	7%
Urban/developed (91)	18,714	6%
Low load compact conifer litter (181)	7,008	2%
Moderate load dry climate shrub (142)	6,308	2%
Low load, very coarse, humid climate grass (103)	6,147	2%
Very high load, dry climate shrub (147)	5,572	2%
Open water (98)	5,514	2%
Moderate load, humid climate timber-grass-shrub (163)	2,324	1%
Bare ground (99)	2,169	1%
Other	6,412	2%
Total	336,116	100%

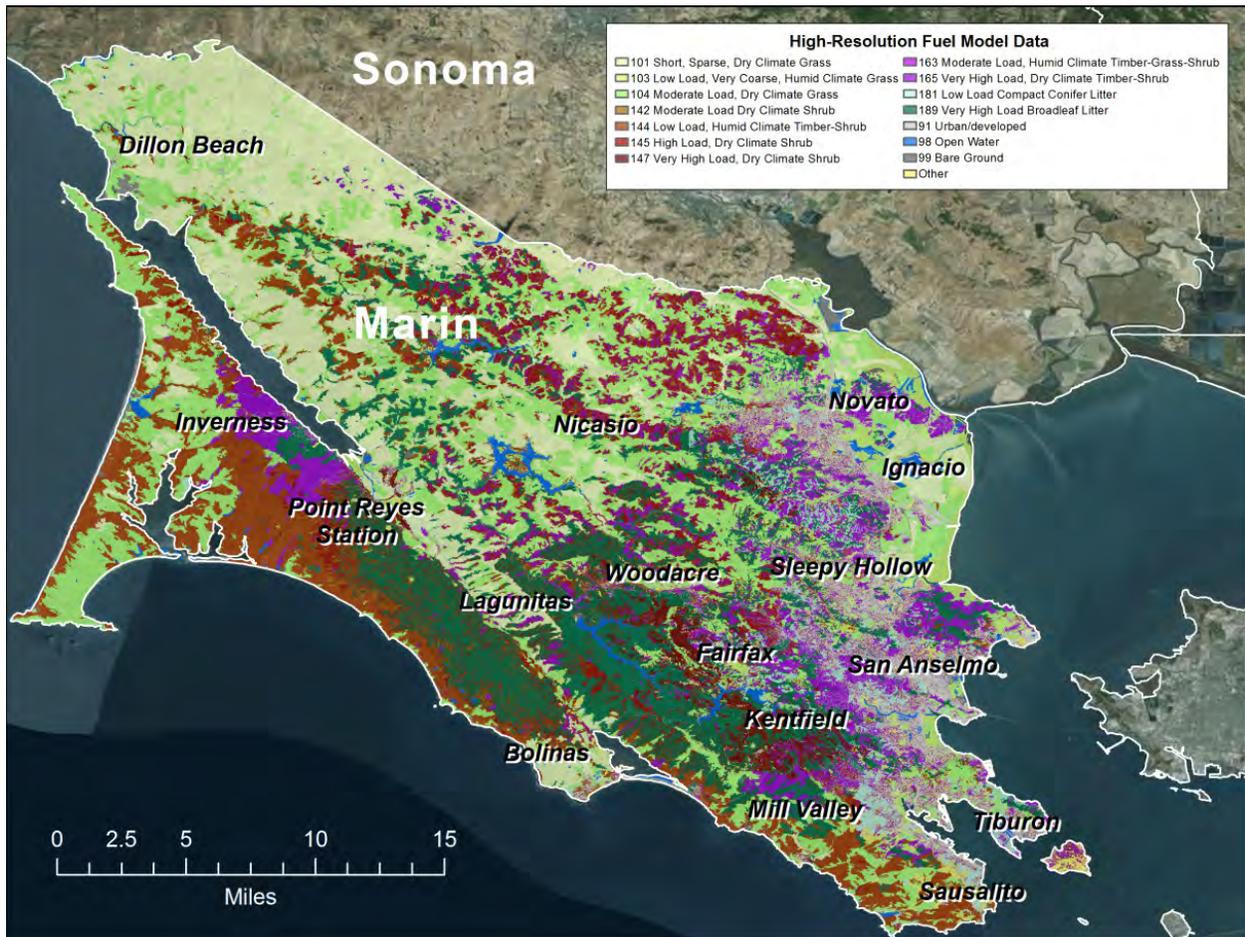


Figure 5. Updated high-resolution (5 x 5 meter) fuel model map for Marin County.

2.2.1 Vegetation Diseases and Infestations

Insect infestations and plant diseases, such as California oak mortality syndrome (sudden oak death), are increasing and threaten to change the structure and overall health of native plant communities in Marin County (May & Associates Inc., 2015). Sudden oak death has no known cure and is the biggest concern; this syndrome is caused by the fungus-like *Phytophthora ramorum*, which has led to widespread mortality of several tree species in California since the mid-1990s; the tanoak (*Lithocarpus densiflorus*) in particular appears to have little or no resistance to the disease. Sudden oak death has resulted in stands of essentially dead trees with very low fuel moistures. Studies examining the impacts of sudden oak death on fire behavior indicate that while predicted surface fire behavior in sudden oak death stands seems to conform to a common fuel model already in use for

hardwood stands, the very low moisture content of dead tanoak leaves may lead to crown ignitions more often during fires of “normal” intensity (Lee, 2009).

Two other plant diseases prevalent in Marin County are pitch canker (which affects conifers such as Bishop pine and other pine species), and madrone twig dieback (which affects Pacific madrones). Pitch canker is caused by the fungus *Fusarium circinatum* (F.



subglutinans, F. sp. pini), which enters the tree through wounds caused by insects. While some trees do recover, most infected trees are eventually killed by the fungus. Management of this disease largely focuses on containment to reduce the fungus spreading to other trees. Pitch canker is a particular issue in the NPS lands of Pt. Reyes National Seashore, where many acres of young Bishop pines that were seeded on the Inverness Ridge by the Mount Vision Fire of 1995 have been infected. These dead and dying trees have created large swaths of land with dense and dry fuel loads. Madrone twig dieback is caused by the native fungus *Botryosphaeria dothidea*, and appears to be getting worse throughout the county due to drought effects on Pacific madrones.

Three additional threats to trees common to Marin County include:

- Bark and ambrosia beetles (*Monarthrum dentiger* and *monarthrum scutellare*), which target oak and tanoak trees. Sudden oak death may be exacerbating the effects of beetle infestations which prey on trees already weakened by this disease.
- Root rot, caused by oak root fungus (*Armillaria mellea*), is primarily associated with oaks and other hardwoods but also attacks conifers. These fungal infestations cause canopy thinning and branch dieback and can kill mature trees. As with the beetle infestations, sudden oak death may be exacerbating the effects of root rot fungus in the county forests.
- Velvet-top fungus (*Phaeolus schweinitzii*) is a root rot fungus affecting Douglas-fir and other conifers, with the infection typically occurring through a wound.

¹¹ “Dead Coast Live Oak in Marin.Steve Swain[1]” (<https://www.flickr.com/photos/usfsregion5/5812704230/>) by the USFS Region 5 (<https://www.flickr.com/photos/usfsregion5/>) is licensed under CC BY 2.0 (creativecommons.org/licenses/by/2.0/legalcode). No changes were made to this image.

2.3 Topography

Topography characterizes the land surface features of an area in terms of elevation, aspect, and slope. Aspect is the compass direction that a slope faces, which can have a strong influence on surface temperature, and more importantly on fuel moistures. Both elevation and aspect play an important role in the type of vegetation present, the length of the growing season, and the amount of sunlight absorbed by vegetation. Generally, southern aspects receive more solar radiation than northern aspects; the result is that soil and vegetation on southern aspects is warmer and dryer than soil and vegetation on northern aspects. Slope is a measure of land steepness and can significantly influence fire behavior as fire tends to spread more rapidly on steeper slopes. For example, as slope increases from 20 – 40%, flame heights can double and rates of fire spread can increase fourfold; from 40 – 60%, flame heights can become three times higher and rates of spread can increase eightfold.¹²



Marin County is topographically diverse, with rolling hills, valleys and ridges that trend from northwest to southeast. Elevation throughout the county varies considerably, with Mt. Tamalpais' peak resting at 2,574 feet above sea level and many communities at or near sea level. Correspondingly, there is considerable diversity in slope percentages. The San Geronimo Valley slopes run from level (in the valley itself) to near 70%. Mt. Barnabe has slopes that run from 20 to 70%, and Throckmorton ridge has slopes that range in steepness from 40 – 100%. These slope changes can make fighting fires extremely difficult.

2.4 Fire History

In the time before the county was settled, fire was a natural part of the ecosystem. Much of the vegetation in what is now the wildlands of Marin County depended on fire to renew itself by removing old, dead fuel in order to make room for healthy new vegetation and promote the growth of native plant species. Once the land was settled, businessmen, landowners, and homeowners had an interest in protecting the natural assets of Marin County and their own investments. Uncontrolled fires had already burned large tracts in the past and valuable lumber, structures, and field crops had

¹² Adapted from the S-290 Intermediate Wildland Fire Behavior course material (National Wildfire Coordinating Group, <http://training.nwcg.gov/courses/s290.html>)



been destroyed. A series of fires that occurred in the late 1800s prompted the organization of the first fire departments in Marin County around the turn of the century.¹³

Since then, national fire suppression policies and practices (among other factors) have contributed to the continuous growth (and overgrowth) of vegetation resulting in dangerous fuel density, or fuel loads. Combined with this fuel accumulation, the public have been

building homes closer and closer to wildlands, which is creating the WUI fire issues that are now present in many parts of Marin County and the country.

Throughout its history, Marin County has experienced many wildland fires. **Figure 6** shows a map of large fires that have occurred in Marin's WUI.

¹³ Adapted from <http://www.marincounty.org/depts/fr/divisions/administration/history/1910>

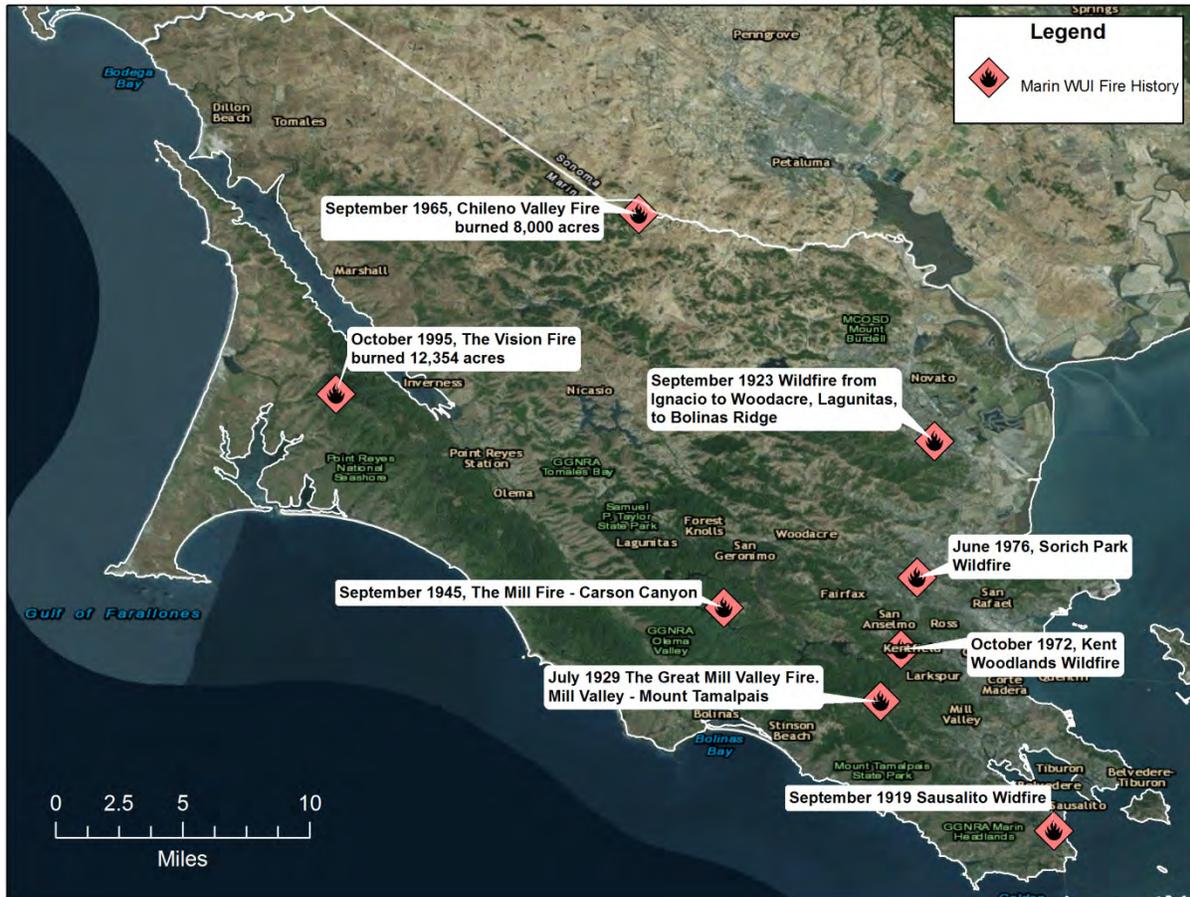


Figure 6. Map of large fires that have occurred in Marin County’s WUI.

The most recent Marin County fire that resulted in significant structure loss was the Vision Fire in 1995, which destroyed 48 structures in the community of Inverness. In 1929, the base of Mt. Tamalpais—specifically the community of Mill Valley—experienced a significant fire known as the Great Mill Valley Fire. That fire’s footprint is now developed with more than 1,100 homes (valued at \$1.3 billion) which have significantly altered the natural vegetation through urban and suburban development.

2.5 Ignition History

Ignition data for all authorities having jurisdiction (AHJ) were acquired and analyzed for 2002 through 2011 to evaluate ignition trends within the county. Table 8 presents the ignition history for all AHJs classified by ignition category. Figure 7 shows a map of the ignition history for all AHJs classified by ignition category.

Table 8. Ignition statistics for all Marin County AHJs from 2002 through 2011.

Ignition Category	Number	Percentage
Structure	3019	49.5%
Mobile Property	25	0.4%
Vehicles	901	14.8%
Natural Vegetation	1359	22.3%
Outside Rubbish	357	5.9%
Special Outside	171	2.8%
Cultivated Vegetation/Crop	14	0.2%
Other	248	4.1%

The 9-year ignition history identifies the majority of ignition sources as structure, natural vegetation, and vehicles.

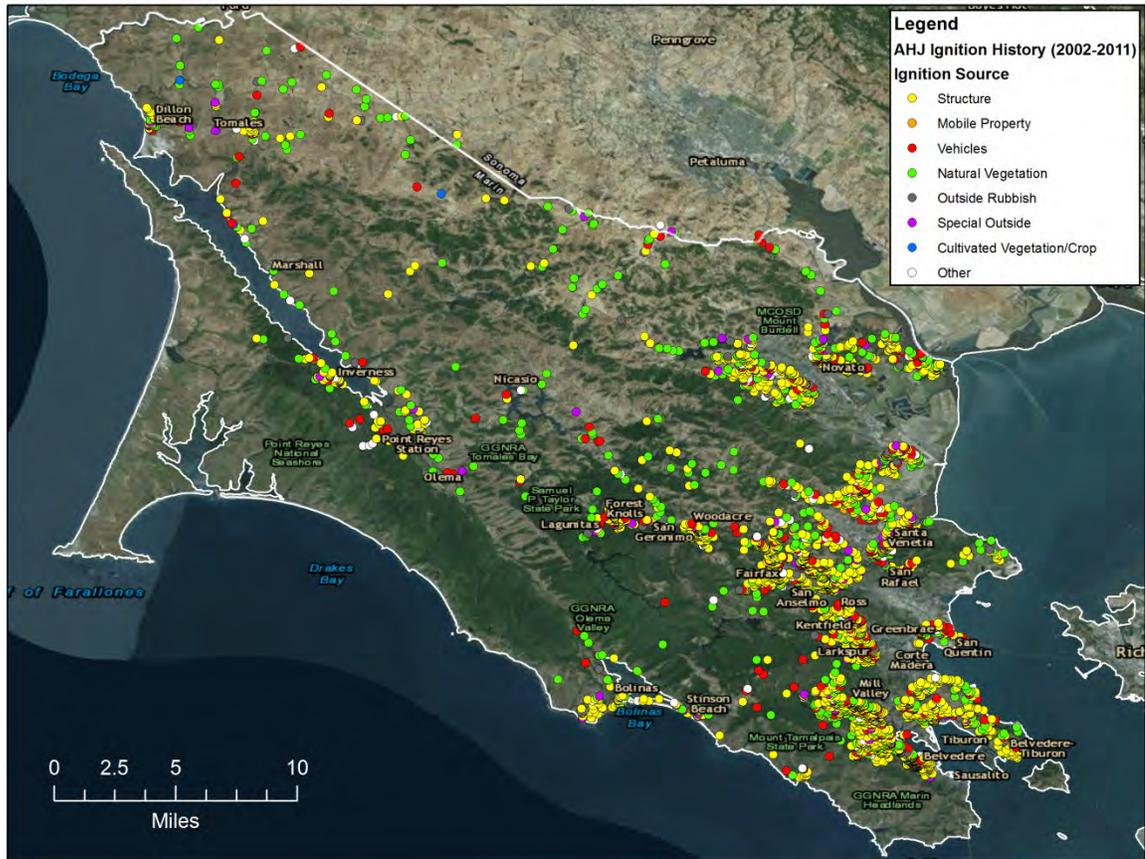


Figure 7. Map of ignition history data for all authorities having jurisdiction (AHJs) in Marin County from 2002 through 2011.

3. Collaboration

A key requirement when developing a CWPP is stakeholder and community involvement and collaboration. A CWPP provides a mechanism for obtaining community input and identifying high risk areas, possible fire hazards, and potential projects intended to mitigate areas of concern and fire hazard. This Plan integrated this community-focused approach through a number of public and stakeholder meetings and is intended to provide the community a forum for identifying assets and communities at risk from wildfire.

Stakeholder input and review was actively sought throughout the development of this CWPP. The information contained in this plan is a reflection of county stakeholders and the public working together to develop a living document that can be used over the next 5 to 10 years to implement the recommended action plan described in Section 8. In addition to feedback from elected officials and public citizens throughout Marin County’s cities and towns, **Table 9** lists the stakeholders comprised of fire agencies, land management agencies, utility operators, homeowners associations, FIREsafe MARIN, and other private and public entities that participated in this CWPP process.

Table 9. Participants in this CWPP process.

Public, Private, and Volunteer Fire Agencies and Associations			
Marin County Fire Department	Ross Valley Fire Department	San Rafael Fire Department	Southern Marin Fire Protection District
Tiburon Fire Protection District	Corte Madera Fire Department	Larkspur Fire Department	Marinwood Fire Department
Mill Valley Fire Department	Novato Fire Protection District	Bolinas Fire Protection District	Stinson Beach Fire Protection District
Inverness Public Utilities District	Nicasio Volunteer Fire Department	CAL FIRE	Skywalker Ranch Fire Brigade
Muir Beach Volunteer Fire Department	Kentfield Fire Protection District	Tomales Volunteer Fire Department	Marin County Fire Chiefs Association (Mark Heine, Pres.)
Land Management Agencies			
National Park Service	Marin Municipal Water District	Marin County Parks and Open Space District	California State Parks
Private Groups and Foundations			
Pacific Gas and Electric		North Bay Conservation Corps	
Homeowners Associations			
Homeowners Associations throughout Marin County		West Marin ranch and agricultural landowners	Large private landowners

3.1 FIRESafe MARIN

FIRESafe MARIN (FSM), Marin County's Fire Safe Council, promotes public and private partnerships to enhance wildfire safety and build Firewise Communities.¹⁴ FSM is a nonprofit organization with the dual mission of reducing wildland fire hazards and improving fire-safety awareness in Marin County. FSM receives significant investments through CAL FIRE SRA Grants, PG&E Grants, other state and federal entities, and private donations. This CWPP work was funded through a CAL FIRE SRA grant to FSM.

3.2 Fire Agencies

To engage local fire departments and agencies in the CWPP process, a stakeholder meeting was held specifically for fire chiefs representing all fire departments in the county. The meeting was held on August 20, 2015, from 9:00-11:30 a.m. at the Novato Fire District administrative office. Meeting attendance included at least one representative from each department or district in Marin County. The format of the meeting included a brief presentation by the CWPP team followed by a question and answer session. During this meeting, the fire chiefs were asked to identify the areas of concern and hazard mitigation projects within their jurisdictions (see **Figure 8** in Section 4.1.1). This information was processed for use in developing this CWPP.

3.3 Land Management Agencies

To engage Marin's land management agencies, three stakeholder meetings were held. The format of the meetings included a brief CWPP project update followed by a question and answer session. Each land management agency was asked to provide information regarding areas of concern and hazard mitigation projects within their jurisdictions. This information was processed for use in developing this CWPP.

The cities within Marin County, along with land management agencies, work to reduce fire hazards as directed by their management and planning documents. Planning is driven by the goals of protecting natural habitat and special species while managing the growth of invasive species. Management strategies can be challenging and require interagency cooperation and collaboration in fuel break and fuel reduction areas. Emphasis during fuel treatment planning will need to consider how to minimize the introduction, spread, and removal of invasive species. Agencies within Marin County include:

¹⁴ The National Fire Protection Association (NFPA) established the Firewise Communities Program to encourage local fire safety solutions by involving homeowners to take individual responsibility for preparing their homes for the risks of wildfires. The Firewise program uses their website (<http://www.firewise.org/>) to provide information and promotes ways to keep homes from igniting.

- **National Park Service** – works under the guidance of a Fire Management Plan (FMP) which has gone through the federal environmental compliance process. The FMP’s priority is to increase the reduction of hazardous fuels in high priority areas using prescribed fire and mechanical treatments (e.g., along road corridors, around structures, and in strategic areas to create fuel breaks).
- **Marin Municipal Water District** – currently operates under the Mt. Tamalpais Area Vegetation Management Plan (VMP). The MMWD released its draft Wildfire Protection and Habitat Improvement Plan in August 2012 (Leonard Charles and Associates, 2012).
- **Marin County Parks and Open Space District** – released its draft Vegetation and Biodiversity Management Plan (VBMP) in April 2015 to direct resource management efforts on the county’s 34 preserves to maintain and increase biodiversity while reducing the risk of wildfire (May & Associates Inc., 2015). MCOSD manages nearly 16,000 acres including an extensive network of approximately 249 miles of roads and trails. A significant portion of MCOSD’s preserves are adjacent to private homes, structures, and evacuation routes; consequently, a great deal of effort is involved in working with neighbors and other local agencies to resolve disputes over responsibility for fuel reduction and defensible space.
- **CA State Parks** – reviews all proposed fuel breaks and vegetation modification zones for environmental impacts. The impacts of greatest concern are the spread and proliferation of invasive species and the cost of invasive management in the fuel reduction zones, fragmentation of suitable habitat for native species, impacts to listed and special status species, and sediment issues associated with an increase in bare soil. In lieu of installing fuel breaks, the State Parks work with MCFD on vegetation modification zones to reduce fire hazards. Vegetation modification areas were completed to State Parks specifications to meet the goals of fuel reduction while minimizing environmental impacts. State Parks treat many fuel modification zones due to increases in invasive plant infestations in the locations where vegetation modification has been employed.
- **Marin Audubon Society** – established in 1956 as part of the effort to prevent development of houses on Richardson Bay tidelands. The Marin Audubon Society (MAS) was one of the founders of Audubon Canyon Ranch, and was instrumental in protecting Bothin Marsh in Mill Valley and the Marin Islands National Wildlife Refuge in San Rafael, which supports the largest heron rookery in San Francisco Bay. MAS restores wetlands on its properties and then donates many of them to the California Department of Fish and Game and the Marin County Open Space District.¹⁵

3.4 Community Stakeholders

To capture the issues and concerns of private land and homeowners, neighborhood groups, civic organizations, professional organizations, and environmental groups, a series of public meetings

¹⁵ <http://www.marinaudubon.org/about.php#mission>

were conducted in four regions of the county: Mill Valley (southern Marin County); Pt. Reyes (west Marin County); San Anselmo (central Marin County); and Novato (northern Marin County). The meetings were publicized through local fire departments and agencies, the FSM website, county websites, and print media, and email invitations were sent to several hundred individuals and groups. **Table 10** lists the public meeting dates, times, and locations.

Table 10. Marin County CWPP public meeting dates, time, and locations.

Date and time	Location
October 12, 2015, 6:00-7:30 p.m.	Mill Valley Community Center, Mountain View Room
October 13, 2015, 6:00-7:30 p.m.	Pt. Reyes Bear Valley Visitors Center, Red Barn Room
October 14, 2015, 6:00-7:30 p.m.	San Anselmo, City Council Chambers
October 15, 2015, 6:00-7:30 p.m.	Novato, City Hall

The meeting format consisted of a brief presentation (approximately 20 minutes) conducted by various members of the CWPP team and included an overview of the purpose of preparing a CWPP, the CWPP process, and Marin’s fire history. The remaining 60-70 minutes included a question and answer session managed by the CWPP team to ensure that participants had an opportunity to voice their concerns. The concerns and ideas expressed during the public meetings were captured in meeting notes. Public concerns regarding fire hazards were fairly consistent throughout the county, and **Table 11** includes a summary of these concerns.



Table 11. Summary of the public’s concerns regarding fire hazards throughout Marin County.

Concerns	Suggestions
Evacuation routes	<ul style="list-style-type: none"> - Prioritize evacuation routes for fuel reduction programs - Develop traffic congestion controls along evacuation routes - Implement stronger parking enforcement along evacuation routes - Continue to maintain foot trail network in Mill Valley - Implement maintenance program for foot trail network in Fairfax - Encourage community-level drills for evacuation preparedness - Consider if additional vegetation reduction are required from roadways that are key evacuation routes into or out of a particular neighborhood
Defensible space	<ul style="list-style-type: none"> - Increase the number of annual inspections - Increase enforcement - Consider providing defensible space financial assistance for seniors - Increase chipper programs
Cooperation with large land managers/owners	<ul style="list-style-type: none"> - Provide a collaboration mechanism between private property owners (and Home Owners Associations) and large land owners (i.e., MCOSSD, MMWD, NPS) - Consider the creation of transition zones (areas between developed residential areas and open space areas) where additional defensible space or additional vegetation clearance is needed
Absentee property owners	<ul style="list-style-type: none"> - Better enforce defensible space compliance with absentee property owners - Develop a program to address fuel reduction on vacant properties
Fuel reduction	<ul style="list-style-type: none"> - Consider grazing as a fuel reduction strategy
Increased use of technology for fire protection	<ul style="list-style-type: none"> - Develop an App for Marin County evacuation routes - Consider ways to improve the coverage of the fire detection cameras - Consider ways to use drone technology for fire protection
Public Education/Outreach	<ul style="list-style-type: none"> - Develop and distribute more information about fire resistant landscaping - Create a fire blog
Tree removal	<ul style="list-style-type: none"> - Consider how to make the tree removal process less cumbersome and less expensive

4. Hazard, Asset, Risk Assessment Approach

Wildfire threat can be defined as the result of an analysis of potential fire behavior and the likelihood of fire to occur relative to the assets (or communities) at risk. CAL FIRE is required by law to map areas of significant fire hazards based on fuels, terrain, weather, and other relevant factors. These zones, referred to as Fire Hazard Severity Zones (FHSZ), influence how people construct buildings and protect property to reduce risk associated with wildland fires. The maps were last updated in the mid-1980s and early 1990s, and are currently being updated by CAL FIRE to incorporate improved fire science, data, and mapping techniques (California Department of Forestry and Fire Protection, 2007).

While the CAL FIRE FHSZ maps are useful in examining potential fire hazard severity at the state-level, the underlying data and methods used to develop the FHSZ maps can be improved upon by using local (and more recent) fuel characteristics and improved fire modeling methods. The CAL FIRE FHSZ maps also do not take into account local perspectives and priorities regarding communities at risk and areas of concern.

To improve upon the currently available state-level fire hazard assessment information, an independent hazard, asset, risk assessment was performed to help identify and prioritize areas within the county that are potentially at a high threat from wildfire based on more recent fuels data, advanced modeling techniques, and local input. The assessment was performed by modeling potential fire behavior and the probability or likelihood that an area will burn given an ignition. Next, the fire modeling output was combined with areas of concern and assets at risk. Composite maps were generated indicating relative potential fire hazards throughout the county.

4.1 Assets at Risk

Assets at risk are defined as structures and resources that can be damaged or destroyed by wildland fire. Assets in Marin County include real estate (homes and businesses), emergency communication facilities, transportation and utility infrastructure, watersheds, protected wildlands, tourist and recreation areas, and agricultural lands. In addition to providing a framework for protecting citizens and providing for firefighter safety, the California Fire Plan identifies the following assets warranting consideration in pre-fire planning: watersheds and water; wildlife; habitat; special status plants and animals; scenic, cultural and historic areas; recreation; rangeland; structures; infrastructure; and air quality.



Photo by Miquel Vieira¹⁶

There are approximately 111,000 living units in Marin County with a median home value of approximately \$1 million (Mara, 2015). As many homes in the county are located in the WUI, if a major wildland fire were to result in the loss of many homes, it could have a short-term negative impact on Marin County’s property tax base.

The Mt. Tamalpais watershed supplies central and southern Marin County with 75% of their fresh water. Given the area’s seasonal rainfall, any

major wildfire impacting the heavily forested watershed will result in major silting and subsequent degradation of water quantity and quality in the watershed. This watershed—as well as the lands managed by MCOSSD, state parks, and NPS—are largely contiguous. They harbor several endangered, threatened, and special-status species, including the coho salmon and northern spotted owl. The area is also part of a major migrating bird flyway and nesting area.

Marin County is also a major tourist destination. Major parks within Marin County include California State Parks (Mt. Tamalpais, Samuel P. Taylor, and China Camp), NPS’s GGNRA, Muir Woods National Monument, and Point Reyes National Seashore. The Point Reyes National Seashore and Muir Woods National Monument together attract 3.5 million visitors annually. The GGNRA, a majority of which resides within Marin County, attracts an additional 14.9 million visitors per year and contributes an estimated \$365.2 million annually to the economy (Prado, 2016). A major wildfire affecting any of these parks could have negative impacts on the local economy for years after the event.

Finally, Marin County’s agricultural land base includes nearly 137,000 acres of privately owned agriculturally zoned land and 32,000 acres of federally-owned land that is leased to agricultural operators. Agricultural operations include livestock and livestock products; aquaculture; field crops; and fruit, vegetable, and nursery crops. The gross value of all agricultural production was approximately \$101 million in 2014 (Marin County Department of Agriculture, 2014).



To help protect people and property from potential catastrophic wildfire, the National Fire Plan identifies communities that are at high risk of damage from wildfire. These high risk communities identified within the WUI were published in the Federal Register in 2001. In California, CAL FIRE has the responsibility for managing the list.¹⁷ With

¹⁶ “Mt Tamalpais Watershed from Mt Tamalpais summit”

(<https://www.flickr.com/photos/miguelvieira/2440494686/in/photostream/>) by Miquel Vieira

(<https://www.flickr.com/photos/miguelvieira/>) is licensed under CC BY 2.0 (creativecommons.org/licenses/by/2.0/legalcode). No changes were made to this image.

¹⁷ National Fire Plan Communities at Risk List, http://osfm.fire.ca.gov/fireplan/fireplanning_communities_at_risk (last accessed February 3, 2016)

California's extensive WUI situation, the list of communities extends beyond just those adjacent to Federal lands; there are 1,329 communities currently on the California Communities at Risk List. Marin County has 23 of these at risk communities, as shown in **Table 12**. A countywide assessment of the wildland fire threat undertaken by CAL FIRE revealed that nearly 313,000 acres (approximately 82% of the total land area of the county) are ranked as having moderate to very high fire hazard severity zone ratings.

Table 12. Marin County communities at risk and fire district jurisdiction.

Community	Fire Department/District
Bolinas	Bolinas Fire Protection District
Corte Madera	Corte Madera Fire Department
Fairfax	Ross Valley Fire Department
Inverness	Inverness Fire Department
Inverness Park	Inverness Fire Department
Kentfield	Kentfield Fire Protection District
Lagunitas-Forest Knolls	Marin County Fire Department
Larkspur	Larkspur Fire Department
Lucas Valley-Marinwood	Marinwood Fire Department
Marin City	Marin County Fire Department
Mill Valley	Mill Valley Fire Department
Novato	Novato Fire Protection District
Olema	Marin County Fire Department
Ross	Ross Valley Fire Department
San Anselmo	Ross Valley Fire Department
San Rafael	San Rafael Fire Department
Santa Venetia	San Rafael Fire Department
Sausalito	Southern Marin Fire Protection District
Stinson Beach	Stinson Beach Fire Protection District
Strawberry	Southern Marin Fire Protection District
Tamalpais-Homestead Valley	Southern Marin Fire Protection District
Tiburon	Tiburon Fire Protection District
Woodacre	Marin County Fire Department

4.1.1 Areas of Concern

One of the objectives in developing this CWPP was to compile and begin to prioritize a list of hazard reduction strategies and projects throughout the county. As part of the CWPP process, fire departments, land management agencies, and other stakeholders were asked to identify and provide information about the areas they are most concerned about within their jurisdictions. Not surprisingly, almost all of the areas identified by stakeholders fall within Marin’s WUI boundary.

Figure 8 shows a map of the areas of concern identified by stakeholder agencies.

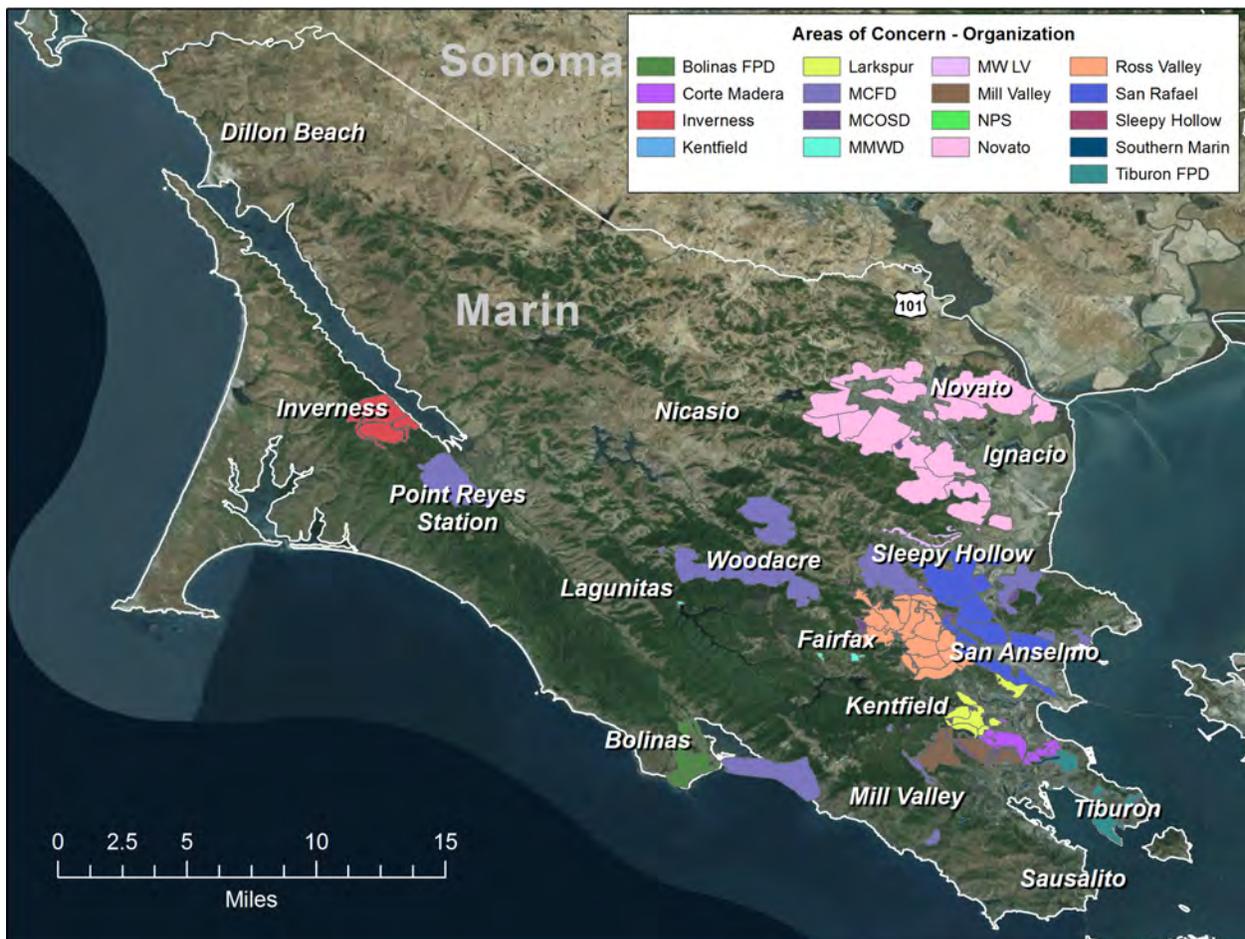


Figure 8. Map of the areas of concern identified by stakeholder agencies in Marin County.

4.1.2 Fire Road and Fuelbreak Networks

Historically, fuel reduction efforts have focused on maintaining Marin’s main fire road and fuel break networks that extend from the shore of the San Francisco Bay in Sausalito to Lagunitas. This network of fire roads and fuel breaks generally follows ridge top emergency access roads and incorporates

natural (existing grassland) or human-made features (e.g., golf course). In addition, there are lateral fuel breaks that extend from the primary fuel break to the east, and specific fuel breaks and projects (i.e., prescribed burns, fuel removal projects) implemented to protect specific communities. Maintaining fire roads and fuelbreaks that provide access for firefighting equipment and personnel to undeveloped areas is important.

In addition to the areas of concern and fuel break information, agencies provided information about fuel reduction projects and/or hazard mitigation efforts within their jurisdictions. **Appendix B** provides a list of the areas of concern information and hazard mitigation efforts provided by the stakeholder agencies listed in alphabetical order by agency name (not in order of priority). Appendix B also includes a list of past, current, and/or planned projects from the 2015 Marin Unit Fire Plan. The lists in Appendix B are intended to provide a starting point for identifying and prioritizing a more complete, countywide list of future fuel reduction and outreach projects.

4.2 Risk Assessment Approach

To help identify and prioritize areas within the county that are potentially at a high risk of threat from wildfire, a hazard, asset, risk assessment was performed using recently updated fuels data and representative weather scenarios. **Figure 9** shows the steps used to perform the hazard, asset, risk assessment.

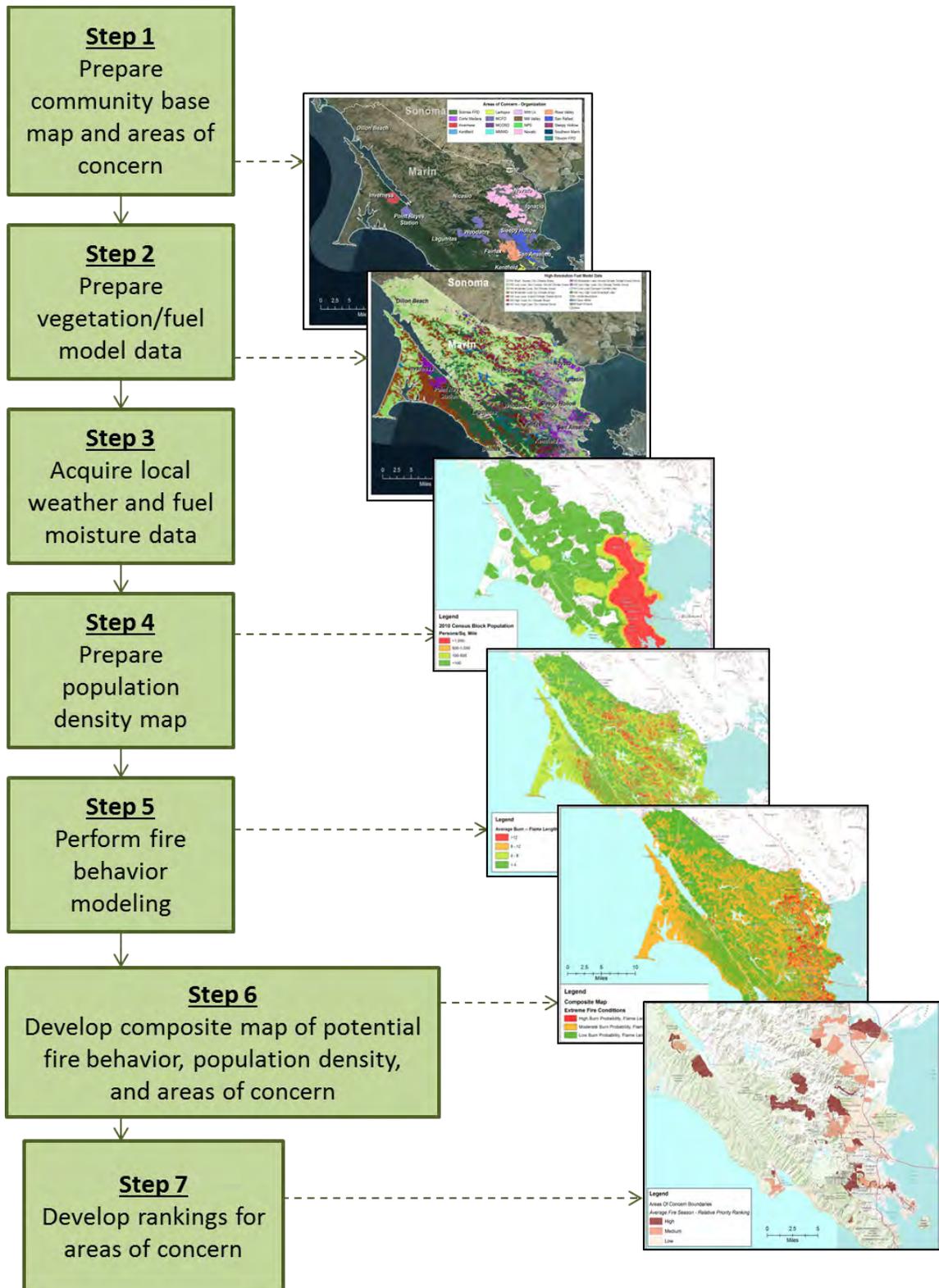


Figure 9. The steps used to perform the hazard, asset, risk assessment.

4.2.1 Step 1: Prepare Community Base Map and Areas of Concern

A base map of Marin County was assembled using GIS data layers acquired primarily from Marin County's GIS portal, marinmap.org. The base map included map layers of political boundaries, fire districts, land ownership, census data, infrastructure, building footprints, a parcel map, WUI boundaries, sensitive habitats, and areas of concern. Information regarding areas of concern was provided by each stakeholder agency and was digitized and merged into one GIS map layer (see Section 4.1.1 and Figure 8). The community base map and corresponding map layers were made available for viewing through an ESRI ArcOnline website.

4.2.2 Step 2: Prepare Vegetation and Fuel Model Data

FlamMap is a fire behavior model that can be used to predict potential fire behavior based on fuels (and fuel moisture), topography, and weather conditions. As part of the development of this CWPP, an updated, high-resolution (5 x 5 meter) gridded vegetation map was developed using a combination of vegetation data provided by local land management agencies and recently obtained LiDAR measurements (see Section 2.2 and Appendix A). The 5 x 5 meter data were used as input to FlamMap for modeling potential fire behavior.

4.2.3 Step 3: Acquire Local Weather and Fuel Moisture Data

In addition to fuel characteristics, the FlamMap fire behavior model requires information about fuel moisture and weather conditions. Two fire weather scenarios were chosen to represent annual wildfire conditions for an average fire season and a fire season under extreme fire conditions. The average fire season scenario was created by summarizing the weather and fuel moisture parameters from April through October (a typical fire season), and was used to represent the fire weather conditions during a typical summer day in Marin County. The extreme fire conditions scenario was created using the 97th percentile weather data from July through October, and represents the hottest and driest time periods during the summer months when fire behavior would be the most intense and difficult to control.

The fire weather statistics model, IFT-FireFamilyPlus, available through the Interagency Fuels Treatment Decision Support System (IFTDSS), was used to summarize fuel moisture, wind speed, and wind direction data for each fire weather scenario for four RAWS available in the Weather Information Management System (WIMS). Data were summarized by station and weather scenario for the Mt. Barnaby, Big Rock, Woodacre, and Middle Peak RAWS stations (Figure 10). Because there was little variability in the data values among the four RAWS stations for each scenario, data from the four stations were averaged to represent the county as a whole. Table 13 lists the fuel moisture and weather values for the average fire season and extreme fire conditions scenarios.

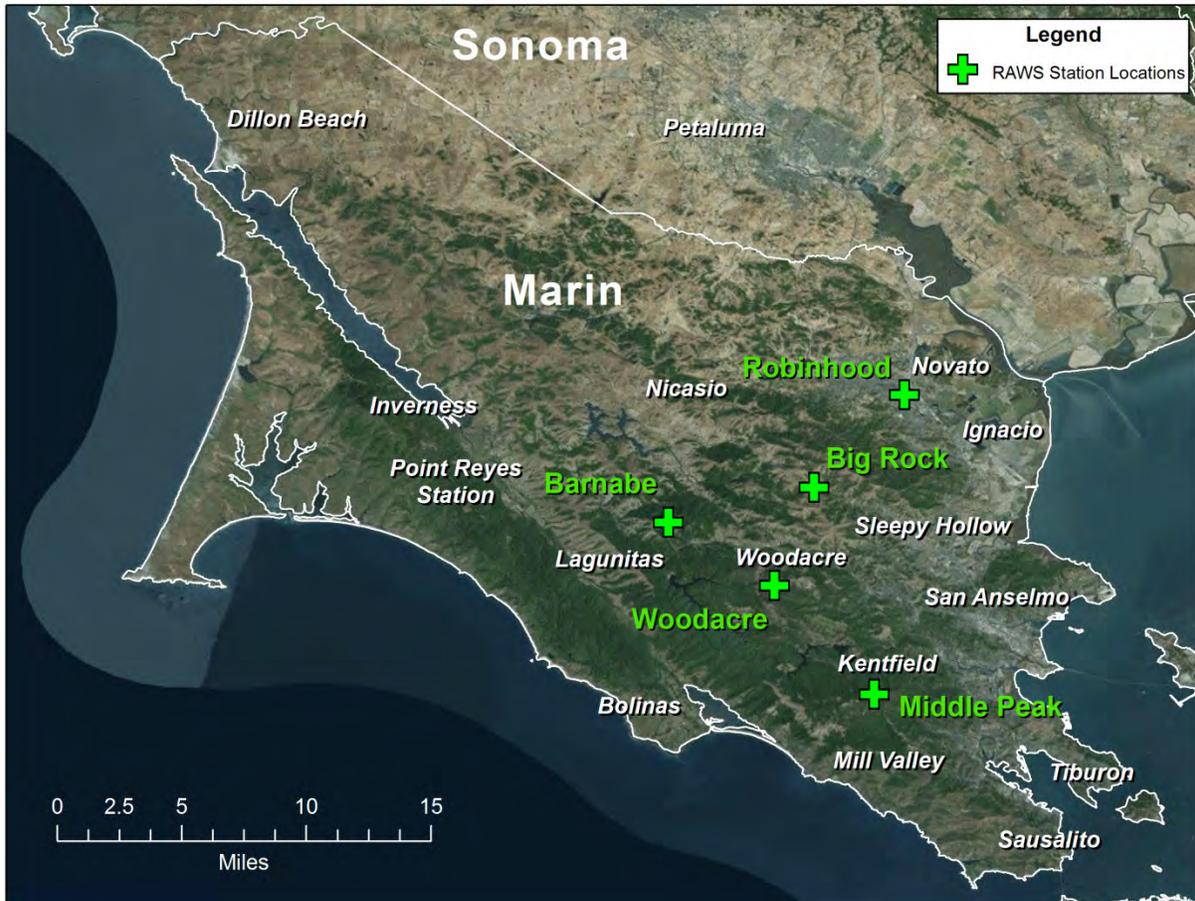


Figure 10. RAWs station locations in Marin County. Note that data from the Robinhood site in Novato were not used for this analysis as the data were not yet available.

Table 13. Fuel moisture and weather values used for the average fire season and extreme fire conditions modeling scenarios.

Parameter (units)	Average Fire Season	Extreme Fire Conditions
1-hour fuel moisture	7%	3%
10-hour fuel moisture	10%	4%
1,000-hour fuel moisture	12%	6%
Herbaceous fuel moisture	19%	4%
Live wood fuel moisture	74%	65%
Wind speed	7 miles per hour	15 miles per hour
Wind direction	206°	206°

4.2.4 Step 4: Prepare a Population Density Map

Population density data for Marin County were acquired from the U.S. Census Bureau. The data were mapped and used in the hazard, value, risk assessment to identify populated areas, which represent areas with high structure density. These data were used as a surrogate for representing areas of high asset value that are important from a fire protection perspective. **Figure 11** shows the population density map for Marin County.

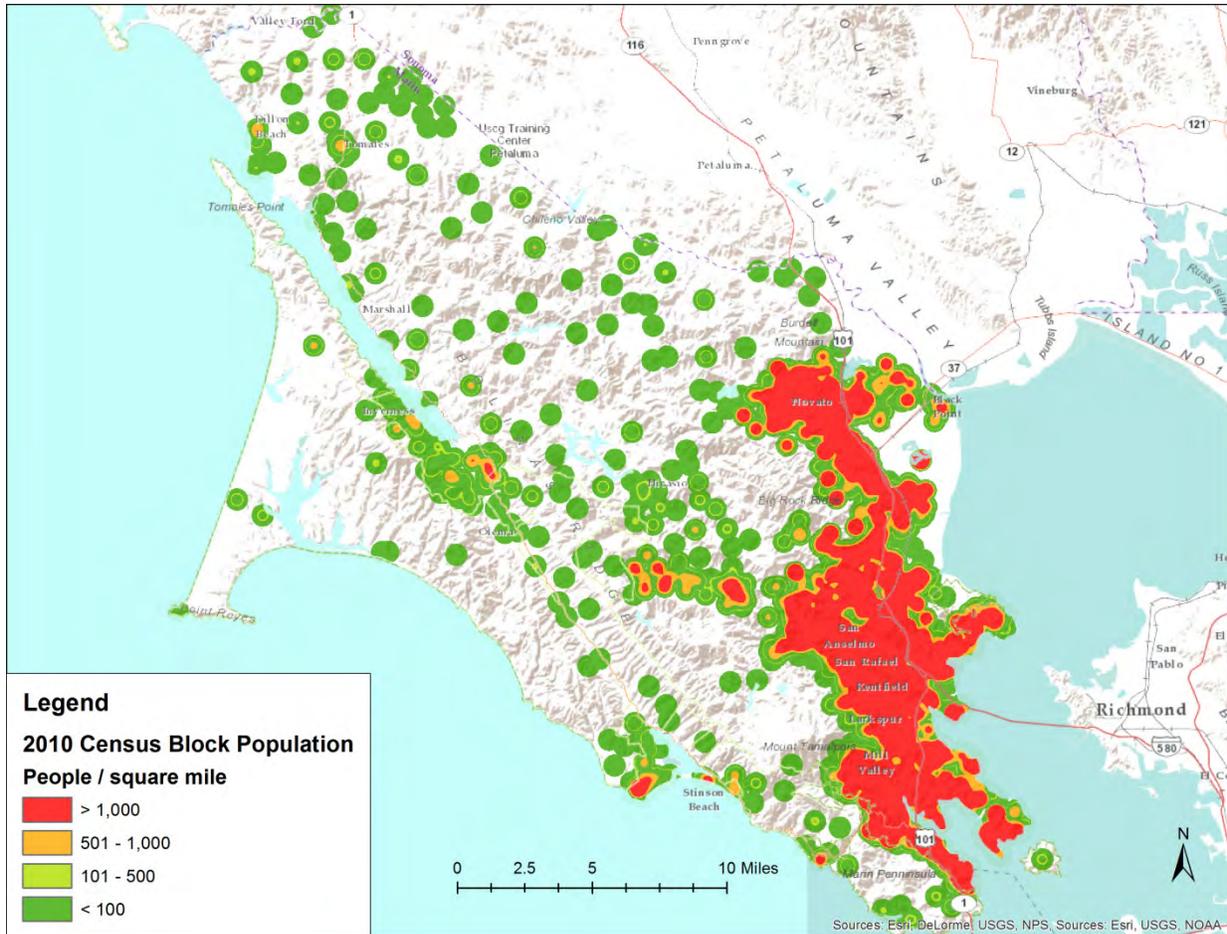


Figure 11. Population density in Marin County based on the 2010 Census.

4.2.5 Step 5: Perform Fire Behavior Modeling

Wildfire modeling attempts to predict fire behavior, such as how quickly a fire might spread, how much heat it might generate, and in which direction it might move. Most fire behavior models require three key inputs: (1) fuel model information, (2) fuel moisture, and (3) weather. Fire behavior modeling can provide an indication of how difficult a fire might be to suppress and the likelihood of

fire transition from the ground to the tree canopy, which can help identify areas where extreme fire behavior may occur.

The FlamMap fire behavior model was used to model flame length and rate of spread. Flame length is commonly used as a gauge of fire hazards because it provides an indicator of possible fire danger from a suppression perspective. **Table 14** shows the fire suppression interpretations of flame length; fires with lower flame lengths are typically easier to suppress while fires with higher flame lengths are much more difficult.

Table 14. Fire suppression interpretations of flame length and fire line intensity.

Flame Length (feet)	Fire Intensity (btu/feet/second)	Interpretations
0-4	0-100	Fires can generally be attacked at the head or flanks by persons using hand tools. Hand line should hold the fire.
4-8	100-500	Fires are too intense for direct attack on the head by persons using hand tools. Hand line cannot be relied on to hold fires. Equipment such as bulldozers, engines, and retardant aircraft can be effective.
8-11	500-1,000	Fires may present serious control problems – torching out, crowning, and spotting. Control efforts at the head of the fire will probably be ineffective.
11+	1,000+	Crowning, spotting, and major runs are common. Control efforts at the head of the fire will probably be ineffective.

Rate of spread is an indicator of how rapidly a fire might spread, and is defined as the rate of forward spread of the fire head expressed in feet per minute. FlamMap runs were performed for the two weather scenarios identified in Table 13 using the custom fuel model data developed for Marin County (see Figure 5 in Section 2.2) and topographical data (slope, aspect, and elevation).

4.2.6 Step 6: Develop Composite Maps

The population density maps and fire behavior modeling maps shown in this section are 5 x 5 meter gridded (or raster) GIS data layers.

The composite maps from the hazard, value, risk assessment were composed using a suitability modeling approach. Suitability modeling is a GIS-based method used for identifying areas based on specific criteria. For this work, suitability modeling was used to identify areas of high fire hazard (or concern) based on fire behavior potentials, population density, and proximity to areas of concern.

The Environmental Systems Research Institute (ESRI) ArcGIS software, Spatial Analyst, was used for this analysis. Spatial Analyst is a raster- or grid-based software package that provides a platform for developing and manipulating gridded data. Spatial Analyst can be used to develop suitability models that produce maps highlighting "suitable" geographic areas based on defined model criteria and weighting schemes.

4.2.7 Step 7: Develop Rankings for Areas of Concern

The area of concern map (Figure 8 in Section 4.1.1) was overlaid on the composite population, flame length, and rate of spread map (Step 5 above). Using GIS software, spatial statistics were calculated within each polygon boundary representing an area of concern. Within each polygon boundary, the underlying composite grid cell values were averaged; the sum of all grid cell values falling within a polygon boundary was divided by the number of grid cells within the boundary. The result is a relative ranking of the areas of concern across the county. The highest ranking areas indicate places that may be of highest concern in terms of both fire hazard and population. This information can be used to prioritize areas of concern and potential fuel reduction strategies.

5. Modeling Results

The approach outlined in Section 4.2 was used to perform the hazard, asset, risk assessment modeling using the population density data (Figure 11) and the weather and fuel moisture data for both the average fire season and extreme fire conditions scenarios (Table 13). The remainder of this section discusses the modeling results.

5.1 Average Fire Season Modeling Results

The average fire season modeling scenario is based on the fuel moisture and weather data shown in Table 13 in Section 4.2.3. Modeled flame length for the average fire season scenario is shown in **Figure 12**; red and orange show potential flame lengths greater than 8 feet, indicating areas that might exhibit more extreme fire behavior and/or be relatively more hazardous from a fire suppression perspective (see Table 14 in Section 4.2.5).

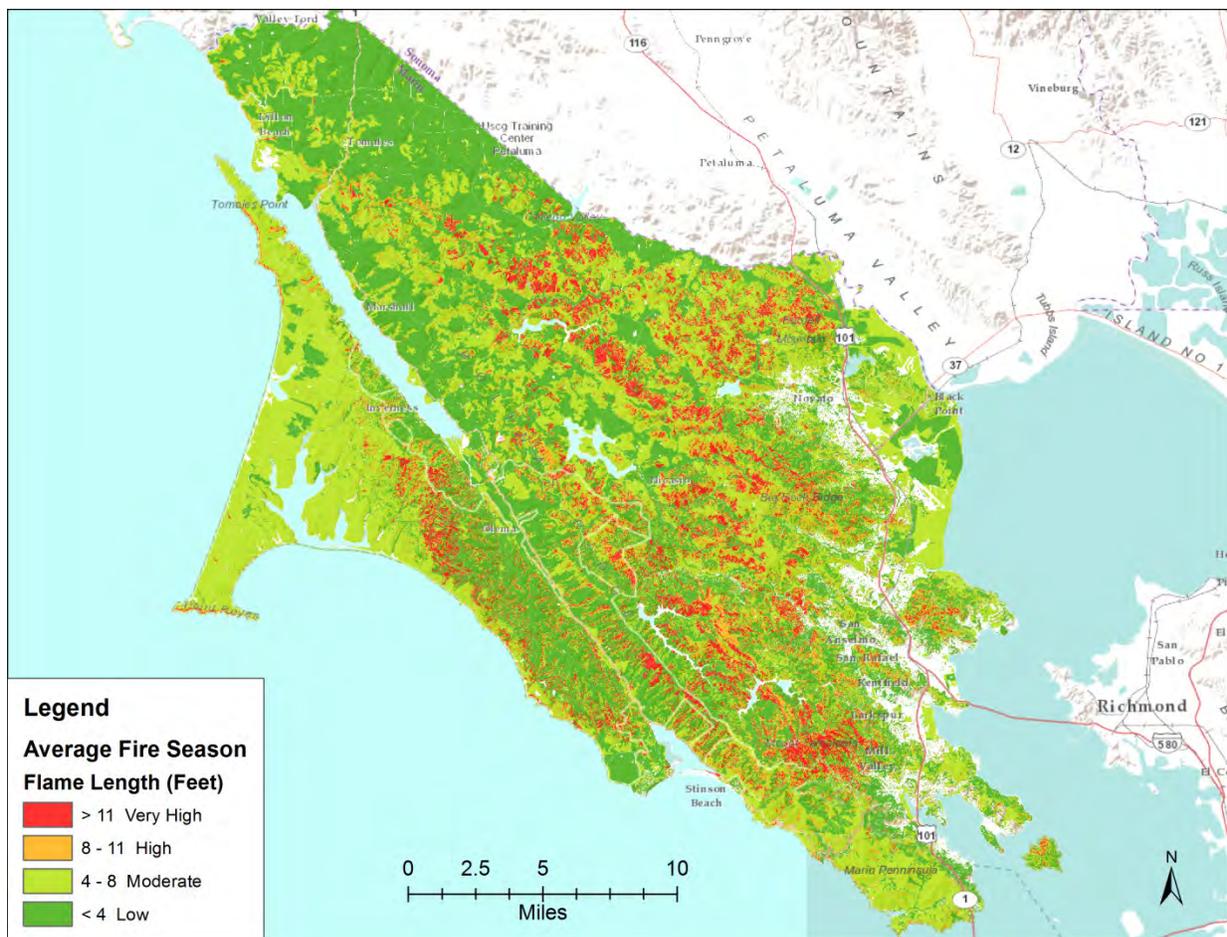


Figure 12. Potential flame length for the average fire season weather scenario.

Rate of spread is defined as the rate of forward spread of the fire head expressed in feet per minute. The higher the rate of spread, the more difficult a fire is to suppress. The rate of spread model output for the average fire season scenario is shown in **Figure 13**; orange and red show areas where more extreme fire behavior is likely given an ignition.

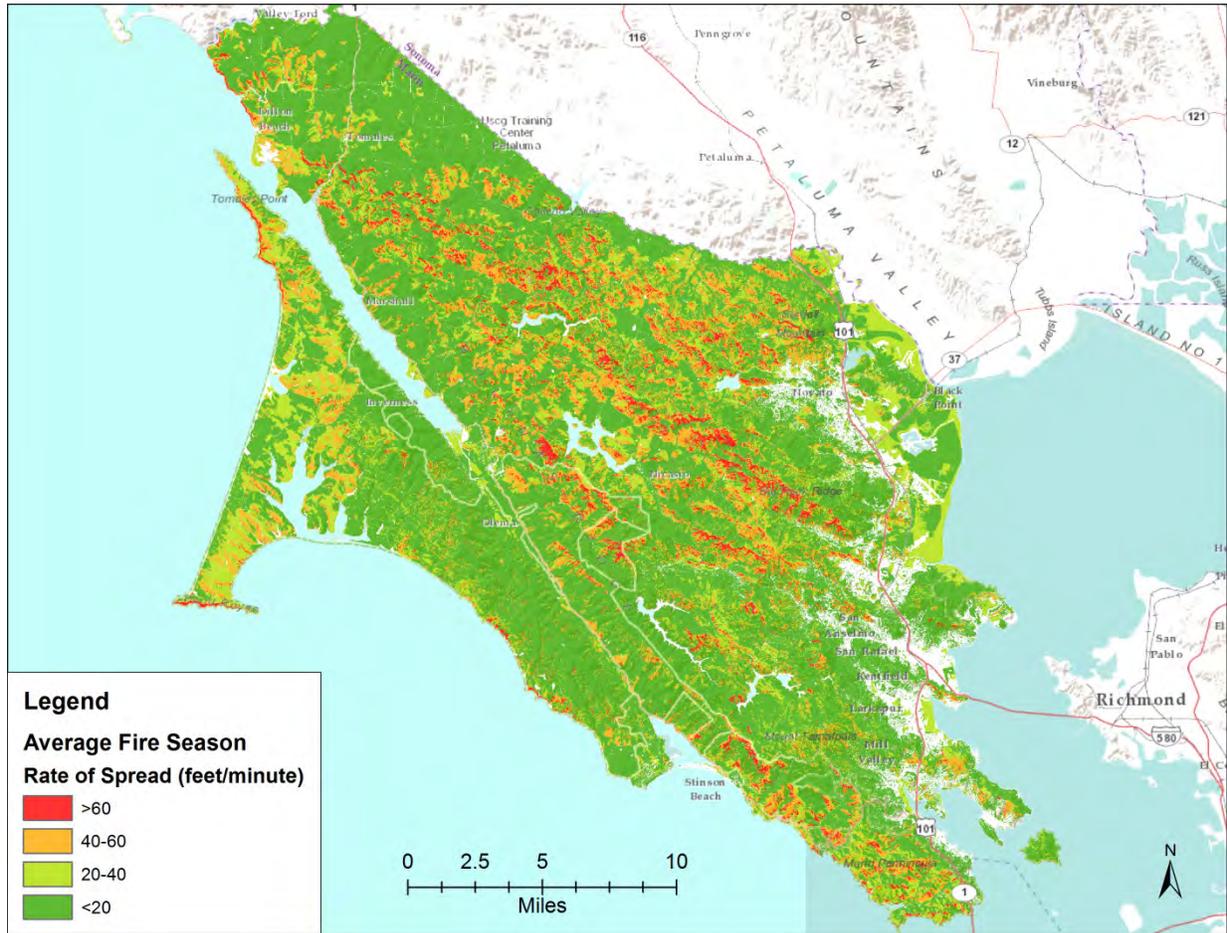


Figure 13. Predicted rate of spread for the average fire season weather scenario.

Using GIS data processing techniques (see Section 4.2.6), the population density, flame length, and rate of spread maps were merged and processed to identify areas that have very high population density, flame lengths, and rate of spread. **Figure 14** shows this composite map; red and orange show areas of very high to high population density, flame length, and rate of spread. These are areas of high asset value where fire behavior is likely to be extreme.



Figure 14. Composite map of population density, flame length, and rate of spread for the average fire season model scenario.

To help prioritize areas of the county where fuel reduction and hazard mitigation efforts might be focused, Figure 13 was overlaid with the areas of concern boundaries (Figure 8 in Section 4.1.1), and GIS processing methods were used to calculate spatial statistics within these areas of concern (see Section 4.2.7). This information was used to rank the areas of concern, shown in **Figure 15**.

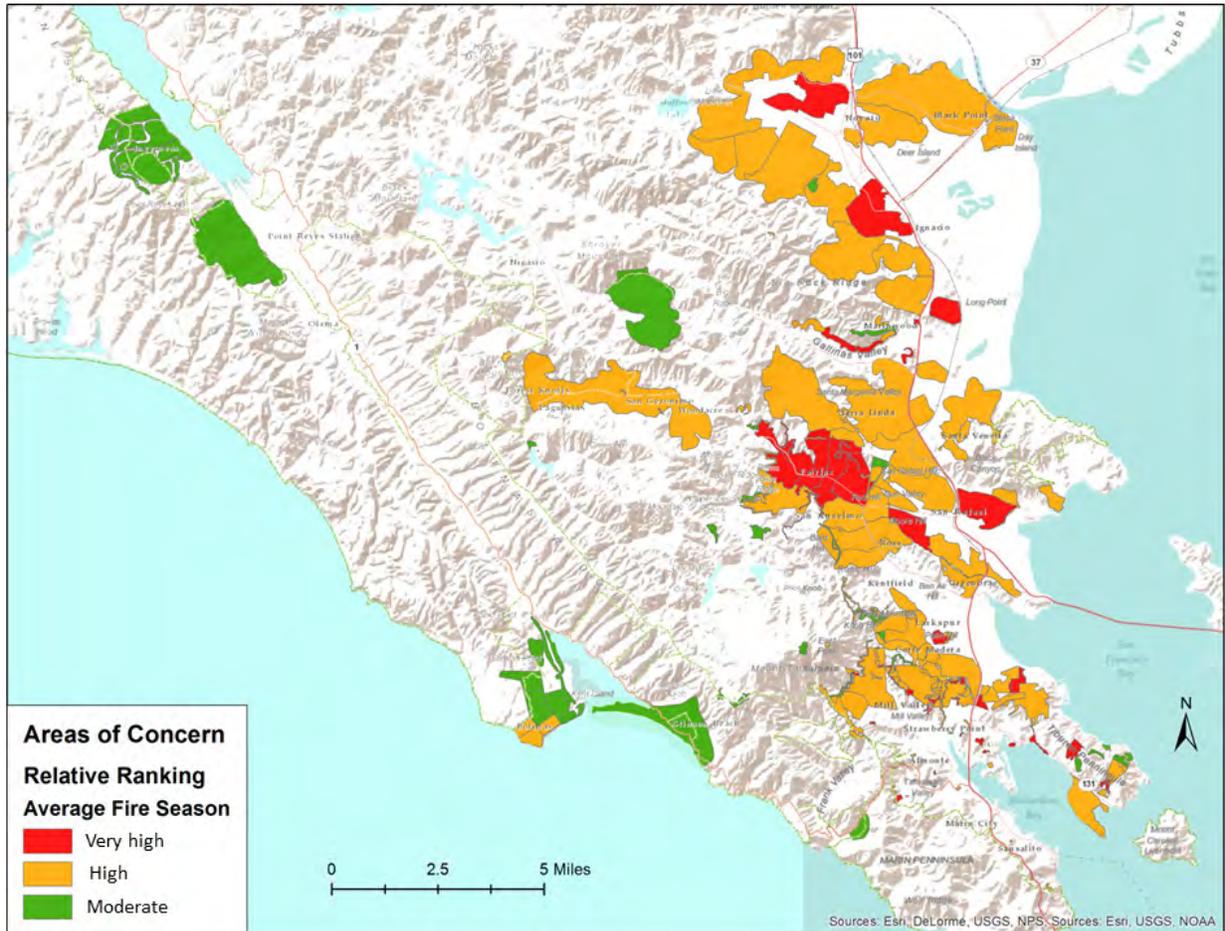


Figure 15. Areas of concern rankings in Marin County based on population density, flame length, and rate of spread for the average fire season model scenario.

The red areas in Figure 15 indicate the top 33% of the areas of concern, where population density, flame length, and rate of spread could all be potentially very high. The orange areas indicate the middle 33% (high), and the green indicate the lower 33% (moderate).

5.2 Extreme Fire Conditions Modeling Results

The extreme fire conditions modeling scenario is based on the fuel moisture and weather data shown in Table 13. Modeled flame length for the extreme fire season scenario is shown in **Figure 16**; red and orange show potential flame lengths greater than 8 feet, indicating areas that would likely exhibit more extreme fire behavior and be relatively more hazardous from a fire suppression perspective (see Table 14). Note that under the extreme fire conditions scenario, much more of the county area has flame length above 8 feet compared to the average fire season scenario shown in Figure 12.

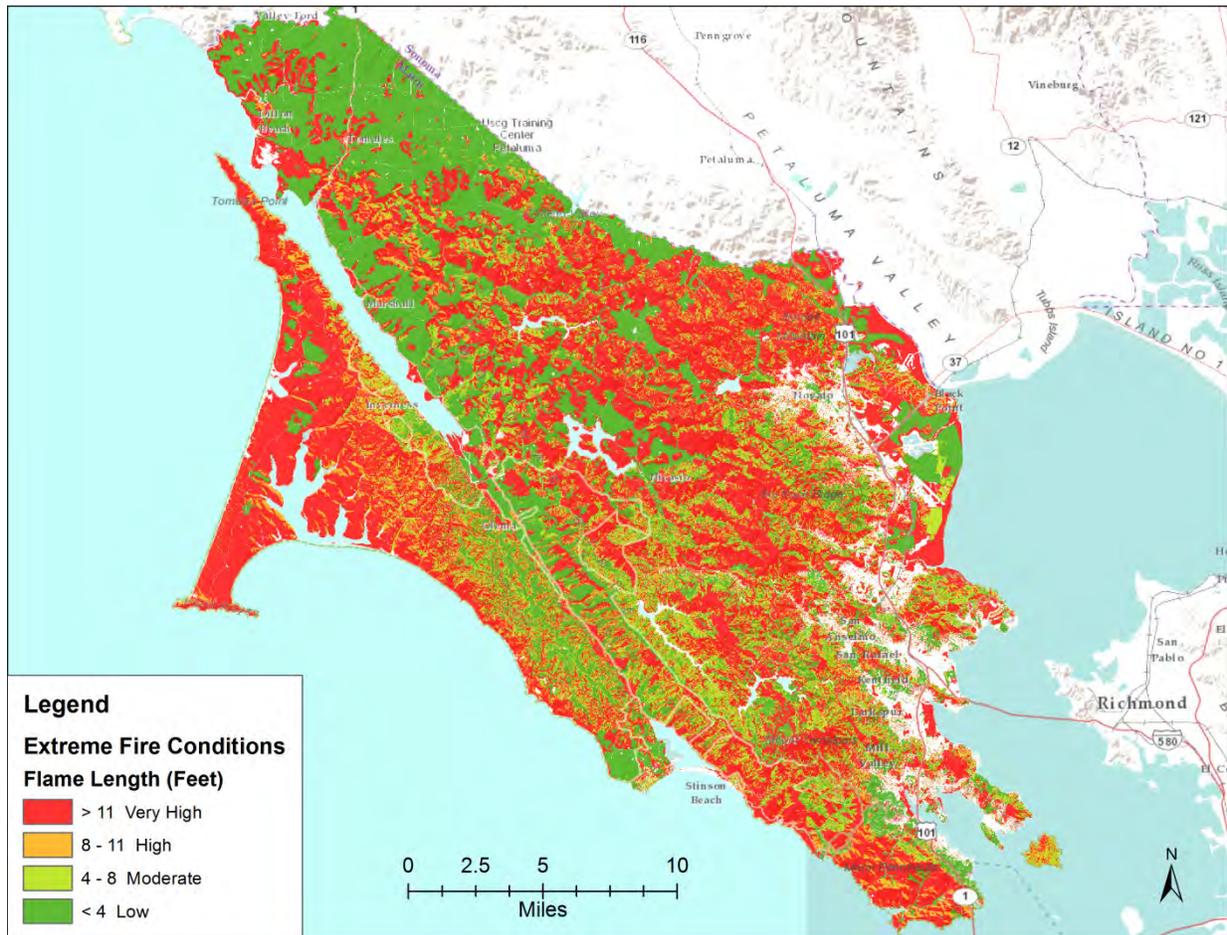


Figure 16. Potential flame length for the extreme fire conditions scenario.

The rate of spread model output for the extreme fire conditions scenario is shown in **Figure 17**; red and orange show areas that are likely to exhibit more extreme fire behavior. Under the extreme fire conditions scenario, rates of spread are greater in northwestern regions of the county.

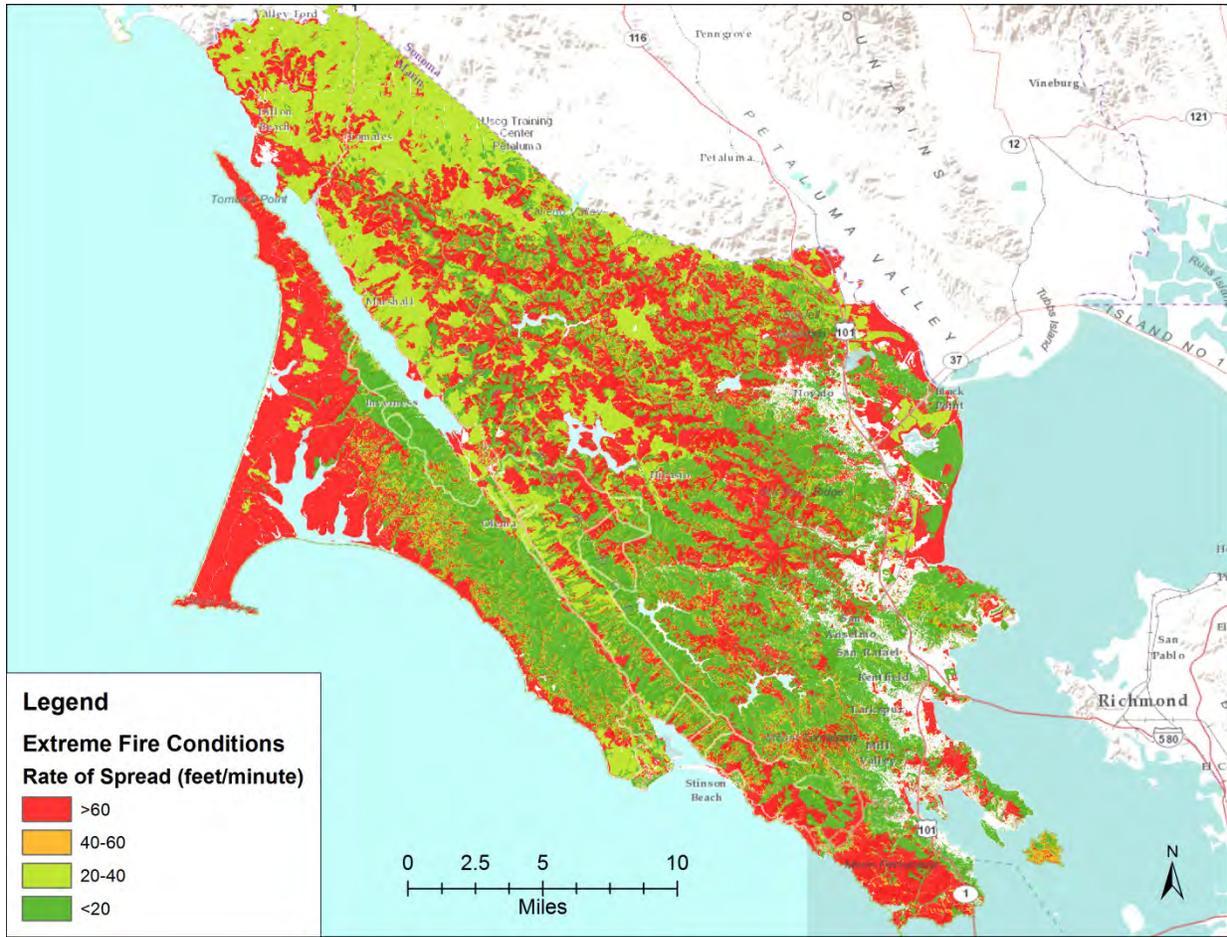


Figure 17. Predicted rate of spread for the extreme fire conditions scenario.

Using GIS data processing techniques (see Section 4.2.6), the population density, flame length, and rate of spread maps were merged to identify areas that have very high population density, flame lengths, and rate of spread. **Figure 18** shows this composite map for the extreme fire conditions scenario; red and orange show areas of very high to high population density, flame length, and rate of spread. Again, note that under the extreme fire conditions scenario, much more of the county area is located in these very high to high condition areas compared to the average fire season scenario shown in Figure 14.

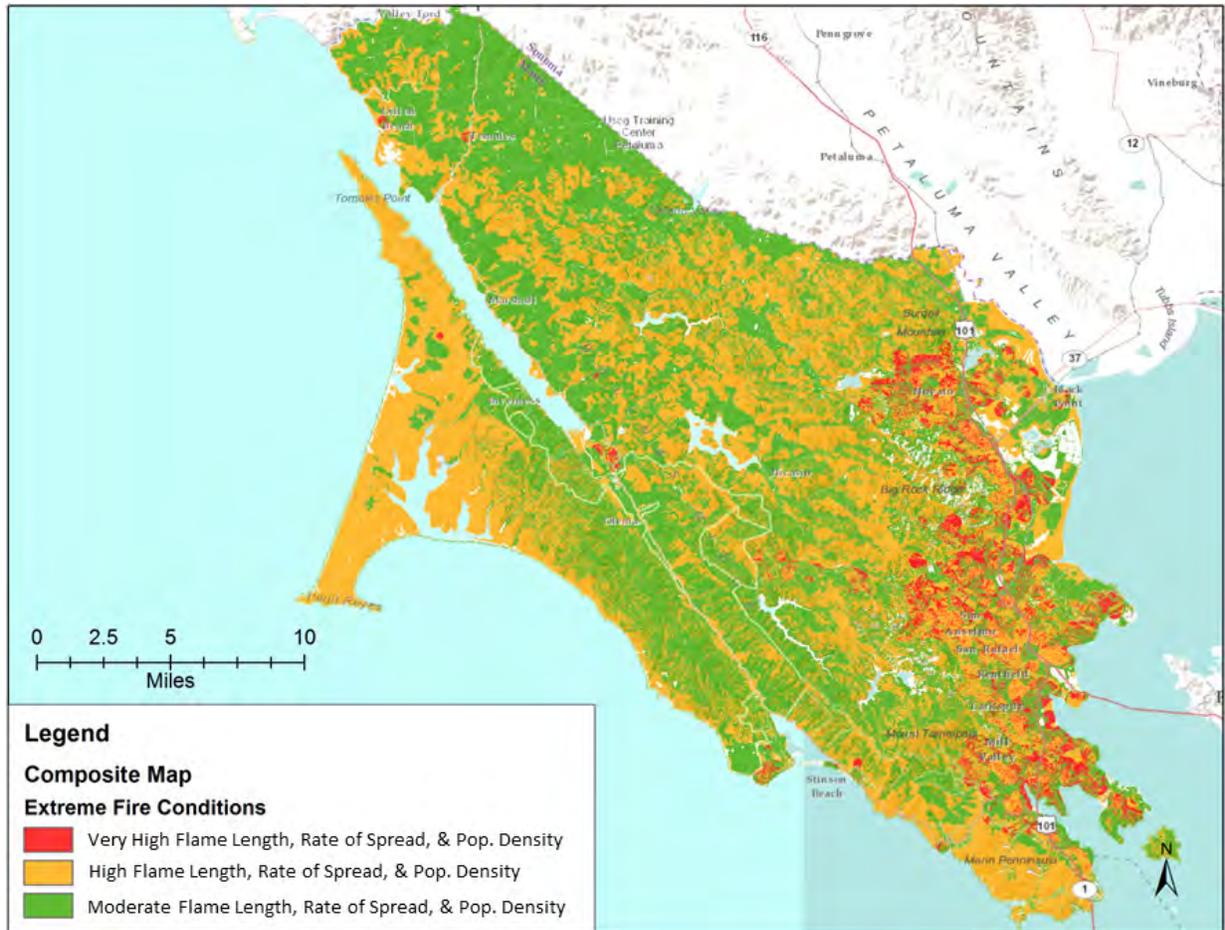


Figure 18. Composite map of population density, flame length, and rate of spread for the extreme fire conditions scenario.

To help prioritize areas of the county where fuel reduction and hazard mitigation efforts might be focused, Figure 18 was overlaid with the areas of concern boundaries (Figure 8 in Section 4.1.1), and GIS processing methods were used to calculate spatial statistics within these areas of concern (see Section 4.2.7). This information was used to rank the areas of concern, shown in **Figure 19**.

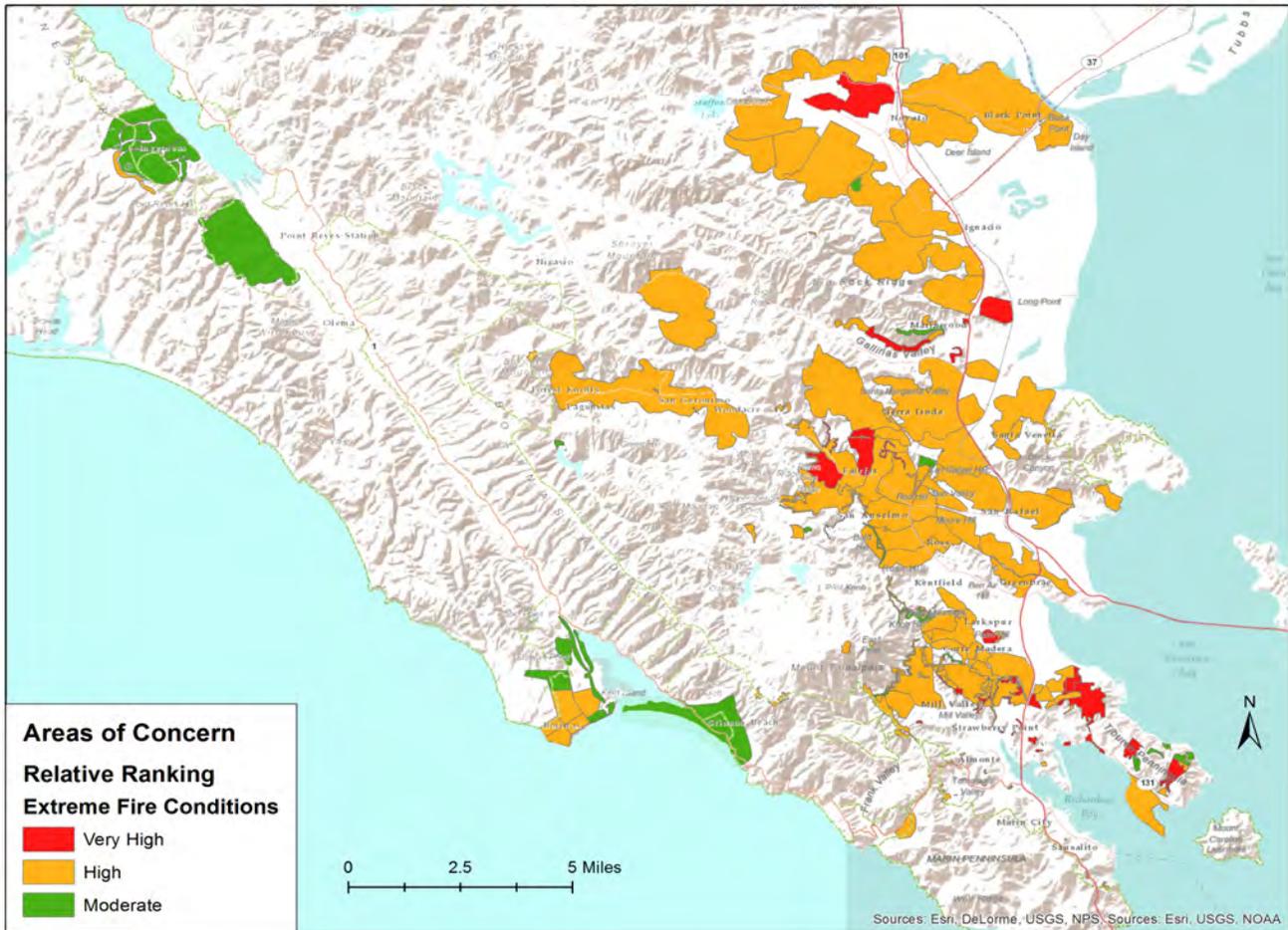


Figure 19. Areas of concern rankings in Marin County based on population density, flame length, and rate of spread for the extreme fire conditions scenario.

The red areas in Figure 19 indicate the top 33% of the areas of concern, where population density, flame length, and rate of spread could all be potentially very high. The orange areas indicate the middle 33% (high) and the green indicate the lower 33% (moderate).

5.3 Discussion of Findings

The overall results of the hazard, value, risk assessment and the relative rankings by community and area of concern are summarized in **Table 15**. Note that almost all of the areas of concern are ranked very high to high based on the asset, value, risk assessment modeling. The areas that rank moderate are located in more rural, less densely populated parts of the county, although they should be considered for hazard reduction efforts. The relative ranking information in Table 15 provides a starting point for prioritizing areas to focus fuel reduction efforts.

Table 15. Marin County communities at risk and areas of concern relative rankings, based on the results of the asset, hazard, risk modeling.

Communities at Risk and Areas of Concern	Relative Ranking
Bolinas (water system expansion/improvement)	Very High/High
Corte Madera and Larkspur (Tiburon Ridge, Ring Mountain, Palm Hill WUI)	Very High
Corte Madera (Marin Estates, Madrono-Pleasant [Town], Madera del Presidio Phase II, Chapman, Park/Meadowsweet, Christmas Tree Hill, Blithdale Ridge, Palm Hill/Blue Rock, Madera del Presidio Phase I)	High
Inverness (watershed and residential areas)	High/Moderate
Kentfield (Evergreen Fire Trail; Rancheria Road; Crown Road from 123 Crown Road to Phoenix Road and continuing on Indian Fire Road to the Blithedale Ridge/Eldridge Grade intersection; King Mountain Loop project (Larkspur) to 76 Ridgecrest Road; 12 Ridgecrest Road to 76 Ridgecrest Road, including all of BlueRidge Road southwest facing slope; the area of Goodhill Road and Crown Road, including the area of Harry Allen Trail; 351 Evergreen Road to 414 Crown Road to 12 Ridgecrest Road, south and southeast facing slope)	High
Larkspur (North Magnolia WUI; Greenbrae Hills WUI; Marina Vista Area WUI; Baltimore Canyon WUI; Marina Vista/SE Baltimore Canyon; King Mountain/NW Baltimore Canyon)	High
Mill Valley (MMWD land and open space areas)	Very High
Mill Valley (Scott Valley, Cascade, PG&E property, Summit, City property, open space, City right-of-way, private property, Warner Canyon/Scott Highlands, MMWD/private/City right-of-way)	High
Marin County Fire Department (Hill Ranch, Los Ranchitos, Summit, Bay View, San Pedro, Mount Tam Lookout, Sleepy Hollow WUI, Throckmorton /Panoramic WUI, Dickson Lookout, Woodacre/Lagunitas/Forest Knolls WUI, Mount Tam Middle Peak infrastructure, Rancho Santa Margarita WUI, Inverness WUI, Green Gulch, Stinson Beach WUI)	High

Communities at Risk and Areas of Concern	Relative Ranking
Marin County Open Space District Lands (areas in and adjacent to neighborhoods)	Very High/High
Marin Municipal Water District (Rock Spring, Pine Mountain south gate, Sky Oaks Meadow, Deer Park Road, Sky Oaks Headquarters, Peters Dam)	High/Moderate
Marinwood/Lucas Valley (Limestone Hill area, CSA 13, Horse Hill area, Berry area, Miller Creek Road Area, Valleystone Project, Lucas Valley Estates)	Very High/High
Novato (Marin Valley, Novato North, Anderson Rowe)	Very High
Novato (San Marin, Hilltop, Loma Verde, Wilson West, Cherry Hill, Pacheco Valley, Little Mountain, Indian Valley, Wildhorse Valley, Wilson East, Ignacio Valley, Atherton, Blackpoint)	High
Ross Valley (Fairfax, Hawthorne Hills, San Francisco Boulevard, Alameda, Morningside, upper San Anselmo Avenue)	Very High
Ross Valley (Ross [east/central/south], San Anselmo [downtown], Cascade Canyon, Sleepy Hollow)	High
San Rafael (San Pedro Ridge, Dominican, Glenwood, Peacock Gap, Gerstle Park and Cal Park neighborhoods)	Very High
San Rafael (Smith Ranch areas, West End from San Rafael Hill to Ridgewood Avenue Bret Harte, Los Ranchitos areas, Terra Linda neighborhoods)	High
Sleepy Hollow (Loma Alta area)	High
Southern Marin (Meda project, Milland, Ricardo open space, So. Morning Sun/Tennessee, Hawkhill, Autumn Lane)	Very High
Southern Marin (Rodeo water tank, U.S. Route 101/Wolfback Ridge, Seminary, Edwards/Marion, Lattie Lane/Highway 1, Blackfield, Laguna/Forest, Cabin Drive, Homestead Valley, Fairview Ring Mountain Area, Aqua Hotel Hill, Highway 1 to Erica/Friars)	High
Tiburon (Middle Ridge, South Knoll Playground, Blackies Pasture, Greenwood Beach)	Very High
Tiburon (Ring Mountain, Old St. Hilary's Open Space Preserve, Tiburon Marsh, Belvedere Lane and right of ways, Tom Price Park, Sugarloaf Drive to Paradise Drive, Middle Ridge open space, Romberg Tiburon Center, Paradise State Park)	High

The data in Table 15 should be viewed at a finer scale within each community listed in order to get a proper context of the areas of concern at a more local scale. It is important to note that the modeling performed in this section does not take into account factors such as sensitive habitats, plant species, practical implementation of fuel reduction projects, or reduction project costs. Fire protection and land management agencies should work collaboratively to determine which areas to focus efforts on, and what projects and prescriptions best serve specific areas.

6. Pre-Fire Management Strategies and Tactics

The pre-fire management strategies presented in this section focus on vegetation management, hazardous fuel reduction, pre-fire planning, statutes and regulations, fire prevention, and public education and outreach.

This CWPP provides county-scale planning information but also recognizes and supports more focused fire planning efforts to address specific city, community, or neighborhood scale needs. The CWPP provides guidance for localized plans prepared to more specifically address site-specific issues, fuels treatment options, specific vegetation prescriptions, refined or redefined community and WUI boundaries, emergency preparedness, and other issues important to community wildfire safety. Localized plans have priority and authority over county-level recommendations.

Marin County fire agencies (described in Section 1.1) take a holistic approach to pre-fire and fuels management by implementing a variety of practices and programs focused around the WUI where there is the greatest wildfire threat to human life and property. Marin County's wildfire programs include

1. Building and vegetation management codes that consider building materials, as well as construction, engineering, and vegetation management standards.
2. Hazardous fuel reduction at both the county and community level. At the county level, this includes working with private landowners and county agencies to maintain and create strategic fuel reductions zones; maintain fuel breaks and fire roads; and implementing other types of fuel reduction projects. At the community level, fire agencies work with property owners and homeowners associations to create more fire safe communities (i.e., Ready, Set, Go and Firewise community programs) and to address issues related to road and property access to provide safe evacuation routes and emergency vehicle entry during a wildfire event.
3. Public outreach and building awareness of the wildfire threat in Marin County.
4. A newly installed network of fire detection cameras.

6.1 Building Codes and Standards

Coordinated pre-fire management efforts occur continuously throughout the county and across fire agencies. These activities include business and home inspection programs, land development plan reviews and construction inspections, fire alarm and suppression system plan reviews, fire investigations, inspections of hazardous and assembly occupancies, reviews of VMPs, a requirement for all new construction and substantial remodels in the WUI), and building code and standard

development. Section 8 includes more information about Marin’s building codes and standards for reducing structure ignitability.

6.2 Hazardous Fuel Reduction

Marin County fire officials work to mitigate fires in the WUI using hazardous fuel modification, which includes wide area defensible space projects and ridge top fuel breaks, many of which are constructed by the MCFD’s Tamalpais Fire Crew as well as by other local resources. The location and extent of the breaks are determined through coordination with the local land management agency and or landowner, conformance with MCFD’s CWPP, and the availability of grant and other types of funding.

At the community level, fire agencies work with individuals and homeowners associations to create more fire safe communities through programs such as Ready, Set, Go! and the Firewise community programs.¹⁸ The Ready, Set, Go! (RSG)

Program is managed by the International Association of Fire Chiefs (IAFC). Launched nationally in March 2011 at the Wildland-Urban Interface Conference (WUI Conference), the program helps fire departments teach individuals who live in high risk wildfire areas—and the wildland-urban interface—how to best prepare themselves and their properties against fire threats.¹⁹



The Firewise Communities Program is managed by the National Fire Protection Agency (NFPA) and co-sponsored by the U.S. Department of Agriculture Forest Service, the U.S. Department of the Interior, and the National Association of State Foresters. The program encourages local solutions for safety by involving homeowners in taking individual responsibility for preparing their homes from the risk of wildfire. Firewise is a key component of Fire Adapted Communities, a collaborative approach that connects all those who play a role in wildfire education, planning, and action with comprehensive resources to help reduce risk. The Firewise Communities program teaches people how to adapt to living with wildfire and encourages neighbors to work together and take action to prevent losses.²⁰

¹⁸ <http://www.marinfirechiefs.org/>

¹⁹ <http://www.wildlandfirersg.org/About/Learn-About-Ready-Set-Go>

²⁰ <http://www.firewise.org/about.aspx>

FSM is actively involved in working with local agencies to coordinate and support chipper days that involve cutting, clearing, pruning, and limbing understory vegetation around structures, fire roads, and evacuation routes.

6.3 Information and Education

The information and education programs administered throughout Marin County are coordinated efforts supported by MCFD command staff, the Fire Prevention Bureau, local fire agency personnel, and cooperators. Cooperators include the Marin County Sheriff's Office, Marin County OES, FSM, the Marin County Fire Chiefs' Association, NPS, MMWD, and MCOSD.

6.3.1 Information

During wildfire events, the public information function is covered 24 hours a day by Incident Command System qualified Public Information Officers (PIO) and by MCFD's ECC personnel. The overall goal of this function is to keep the people of Marin County informed by providing timely and accurate information. In addition, MCFD is in constant contact with CAL FIRE's Duty Chief regarding fire condition updates and ensures all local dignitaries are regularly briefed with changes or updates.

Fire agencies across Marin County regularly provide press releases and interviews to media outlets on request, and the county has retained a County PIO who is used to support fire agency public information outreach efforts. In addition, a Public Information Team (PIT), consisting of representatives from several fire agencies, meets once per month and provides a forum for each department to communicate with other departments and the public. The PIT provides a uniform message and training for county government across departments and helps prepare department-specific informational programs, including social media.



6.3.2 Education and Outreach

Annually, thousands of Marin County residents attend community events, such as fire station pancake breakfasts, community fairs where local fire departments and/or FSM sponsor exhibits, cardiopulmonary resuscitation (CPR) training classes, Community Emergency Response Teams (CERT) training classes, "Ready, Set, Go!", and "Get-Ready"²¹ classes, and school programs. Fire departments across the county also give presentations to

²¹ Training for Before, During and After a Disaster, see <http://readymarin.org/get-ready/>

the public that include disaster and wildfire event preparedness, home safety, fire safety, defensible space, and vegetation management.



MCFD, along with many cooperators and corporate sponsors, produced a defensible space and wildland fire preparedness video. The video, “Marin on Fire,” has several 5-minute chapters that cover road and property access, defensible space, making your home ignition resistant, and tips on what to do if a wildfire is approaching your house. MCFD has also released a 5-minute video about the few simple things a homeowner can do to increase their home’s

chances of survival during a wildfire event. MCFD and FSM web sites also have extensive public education links to CAL FIRE wildfire preparedness literature and to the Marin County Fire Chief’s Association “Ready-Set-Go” site. Department Fire Chiefs are also frequent contributors to the local newspaper with editorial columns on various aspects of fire safety and disaster preparedness, including winter/holiday home fire safety and wildfire preparedness.

MCFD strives to make their wildfire and defensible space safety messages consistent with those promulgated by CAL FIRE. As part of this effort, MCFD posts CAL FIRE’s defensible space flyers and handouts on their website and makes these brochures available at fire station lobbies. Prior to fire-season, MCFD annually sends out a mailer to every property owner in Marin County’s SRA. The mailer contains a check-list of MCFD’s defensible space and maintenance requirements (as per the California Public Resources Code 4291)²² that need to be completed by the property owner by the start of fire season. The mailer also includes MCFD’s modified CAL FIRE Defensible Space flyer, and offers the homeowner a free-of-charge consultation by fire personnel from their local fire station.

FSM also works with local fire agencies to support public education efforts (e.g., mailers, movie theater “trailers”, newspaper opinion pieces, public events and workshops) to raise the level of public awareness of the wildland fire threat and improve the defensible space around structures.

6.4 Fire Detection Cameras

With a grant from PG&E, FSM purchased six fire detection cameras for installation in Marin County. These cameras were installed in summer 2015 and are deployed at Mt. Tamalpais, Mt. Barnabe, Big Rock, and Point Reyes.²³ The cameras are linked to a computer system that is monitored by personnel at MCFD in Woodacre. The archive of images from the cameras is available to the public.

²² Property owners in mountainous areas, forest-covered lands or any land that is covered with flammable material must create at minimum a 100-foot defensible space (or to the property line) around their homes and other structures, as mandated by California Public Resources Code 4291.

²³ <http://www.marincounty.org/depts/fr/fire-detection-cameras>

7. Structural Ignitability

In the WUI where natural fuels and structure fuels are intermixed, fire behavior is complex and difficult to predict. Research based on modeling, observations, and case studies in the WUI indicates that structure ignitability during wildland fires depends largely on the characteristics and building materials of the home and its immediate surroundings.

The dispersion of burning embers from wildfires is the most likely cause of home ignitions. When embers land near or on a structure, they can ignite near-by vegetation or accumulated debris on the roof or in the gutter. Embers can also enter the structure through openings such as an open window or vent, and could ignite the interior of the structure or debris in the attic. Wildfire can further ignite structures through direct flame contact and/or radiant heat. For this reason, it is important that structures and property in the WUI are less prone to ignition by ember dispersion, direct flame contact, and radiant heat.

Marin County's approach to mitigating structure ignitability is based on findings from the National Institute of Standards and Technology that defensive actions by homeowners can significantly affect fire behavior and structure loss, and that effective fire prevention practices are essential in increasing structure survivability.

The California Building Code (CBC)—Chapter 7A specifically—addresses the wildland fire threat to structures by requiring that structures located in state or locally designated WUI areas be built of fire resistant materials. However, the requirements promulgated by the state only apply to new construction, and do not address existing structures and additions and remodels to existing structures.

Since most of the towns and cities in Marin County are “built-out”, most fire departments have applied the Chapter 7A standards to address home ignitability for both new and existing construction. Specifically, Marin County has extensively amended the 2003 International Urban-Wildland Interface Code. As part of these amendments, MCFD applies more stringent building standards and requires the preparation of a VMP as defined in MCFD's VMP Standard. MCFD also imposes requirements for fire apparatus and water supply access to new and remodeled structures located in the WUI.

In addition to the amendments, the county requires that alterations or remodels to structures located in the WUI use specific building elements that comply with WUI-specific standards. For example, if a window is replaced, the new window is required to be dual-paned with one pane tempered.

The county has amended the 2013 California Fire Code (CFC) Chapter 49 requirements for defensible space around existing homes (note that the 2013 CFC Chapter 49 requirements are identical to the Public Resource Code and Government Code requirements). The MCFD amendment modifies the language of PRC 4291 such that the property line no longer limits the amount of defensible space

required around structures. If the 100-foot defensible space/fuel modification zone extends from private to public lands, the defensible space stops at the property boundary. However, fuel modification/clearance may be permitted after an evaluation and issuance of approval from the public land management agency.

7.1 Opportunities to Reduce Structure Ignitability

While Marin County has been aggressive in its approach to reduce structure ignitability, there are opportunities to expand awareness of measures that property owners can take to improve and enhance structure survivability.

7.1.1 Increase Education about Structural Ignitability and Defensible Space

Fire officials can increase public education about structural ignitability and defensible space by

Reaching out to vendors/contractors who sell fire resistant materials to increase education and awareness.

It is recommended that all fire officials renew their partnerships with their local building officials in order to provide information and outreach materials to the local Marin Builders Association. It is also recommended that fire officials collaborate with local building material vendors in order to better educate vendors and contractors of the CBC Chapter 7A requirements, and to provide educational materials for consumers at the point of sale. The educational materials should be consistent and uniform in look and content and explain the rationale for using fire resistive construction materials for structures in WUI areas.

These materials could be created and funded by grants through FSM, and should include, but not be limited to:

- Easy-to-understand WUI maps to help consumers determine if they are in WUI areas.
- Examples and photos of the many types and architectural styles of construction features for roofs, exterior walls and siding, protective eaves, vents, decks, door, and windows.
- Take-home pamphlets with photos, brief explanations, and links to websites and videos for additional information.
- Links to the appropriate fire and building authority having jurisdiction, with permit information.

Using the topic of roof coverings as an example, a sample outreach material could include

There are many varieties of Class A roofing materials available on the market today. The many styles allow for flexibility in achieving the desired look of the home while providing fire resistive properties that are so important in the WUI. Typical Class A roofing products include, but are not limited to, the following types:

- *Asphalt shingles*
- *Metal/stone-coated metal*
- *Concrete (standard weight and lightweight)*
- *Clay tile*
- *Synthetic*
- *Slate*
- *Hybrid composite*

Similar information with videos, photos, or samples should be included for all exterior architectural features identified in CBC Chapter 7A, and placed at all types of general home improvement stores, such as Home Depot and Rafael Lumber, and at single-focus stores such as window retailers.²⁴

Renewing and continuing efforts to educate and partner with Marin County neighborhoods located in WUI areas with a focus on structural ignitability. This should be an annual, seasonal, multi-social media approach and include a direct mail campaign.

Fire officials should develop a program to reach out to local communities encouraging and supporting the Firewise Communities Program. The five steps of Firewise recognition are:

1. Complete a community wildfire assessment.
2. Form a board or committee, and create an action plan based on the assessment to reduce the risks.
3. Conduct a “Firewise Day” event.
4. Invest a minimum of \$2 per capita in local Firewise actions for the year.
5. Submit an application to become a Firewise Community to your state Firewise liaison.

7.1.2 Inventory Structures with Shake and Shingle Roofing

Research shows that homes with a non-combustible roof and defensible space at least 30 to 60 feet around the structure have an 85-95% change of survival in a wildfire. At a minimum, a home structure should have a Class A-rated fire-resistant roof cover or assembly, and preferably one that is self-extinguishing once a falling ember burns out. Self-extinguishing means that the firebrand will not burn through to the roof deck and flames will not spread to other parts of the roof. Without a fire-resistant roof, other approaches toward mitigation will fall short of protecting the home.²⁵

²⁴ Marin Fire and Building Officials do not endorse any specific product or material, but rather look subjectively at each product for compliance and documented testing performance when considering its use in a local application.

²⁵ Insurance Institute for Business and Home Safety, see <https://disastersafety.org/wildfire>

A complete inventory of all Shake and Shingled roofs (Non-CLASS A and B roofs) should be completed in each jurisdiction to target education efforts and identify the need for roof conversions.

7.1.3 Uniform Adoption of WUI Ordinance

All fire agencies in Marin should adopt a consistent and uniform WUI ordinance and WUI map. Equal requirements and enforcement of WUI ordinances and defensible space will have the post positive effect on structural ignitability in Marin.

7.2 Structure Ignitability Efforts Currently in Place

The following summarizes Marin County's ongoing structure ignitability efforts and programs.

Building Codes, Ordinances, Standards

- Adoption of uniform WUI codes.
- Adoption of Class A roofing ordinances.
- Designated parking program.
- Application of Marin County WUI Fire Code for new and existing construction, which includes more stringent building standards, vegetation management (requiring the preparation of a VMP), and fire apparatus access and water supply requirements to new structures and structures substantially remodeled.
- Requirement that alterations or remodels to structures located in the WUI use specific building elements that comply with WUI-specific standards. For example, if a window is replaced, the new window is required to be dual-paned with one pane tempered.

Fuel and Vegetation Management

- Fire departments develop lists of fire prone vegetation subject to removal or management.
- Partnering with HOAs and FSM on residential chipper programs.
- Increasing dedicated staffing for vegetation management programs.
- Hazard assessment program (created to reverse homeowner fire insurance cancellations).
- Annual weed abatement program.
- Vegetation Management Program (voter approved Municipal Service Tax).
- Establish and maintain fuel breaks (shaded, wide area, ridge top).
- Eucalyptus and Pine tree removal program.
- Paved and unpaved road fuel reduction.

- Evacuation route fuel reduction.
- Fuel reduction on city properties.
- Creating shaded fuel breaks in transition zones between developed residential areas and open space areas.

Defensible Space Enforcement and Public Education

- Annual public education course on defensible space.
- Partnering with HOAs to become Firewise Communities.
- Defensible space mobile phone App.
- Defensible space videos.
- Implementation of the 2013 CFC Chapter 49 requirements for defensible space around existing homes (these requirements are identical to the Public Resource Code and Government Code requirements).
- Modification of the language of PRC 4291 such that the property line no longer limits the amount of defensible space required around structures. If the 100 foot defensible space/fuel modification zone intersects from private to public lands, fuel modification/clearance may be permitted after evaluation and issuance of a permit from the public land management agency.
- Development of the defensible space mailers, which provides a checklist of defensible space requirements to be completed by the property owner by the start of the annual fire season.
- Perform a defensible space blitz, in which departments assign seasonal firefighters in conjunction with on-duty/full-time personnel to go door-to-door in each station's response zone's target hazard areas.
- Hire dedicated defensible space inspectors to perform inspections in priority communities.

8. Recommendations and Action Plan

8.1 Plan Recommendations

This CWPP is intended to provide a foundation for—and to facilitate—continued multi-agency collaboration and cooperation for fire protection planning efforts in Marin County. This is considered a living document which will be reviewed and revised periodically as needed. The following recommendations were developed based on the goals and objectives of Marin’s fire agencies for reducing wildland fire hazard and stakeholder input. The recommendations set forth are aimed at achieving five key goals:

1. **Continue to identify and evaluate wildland fire hazards** and recognize life, property, and natural resource assets at risk, including watershed, wildlife habitat, and other values of functioning ecosystems.
2. **Articulate and promote the concept of land use planning related to fire risk** and individual landowner objectives and responsibilities.
3. **Support and continue to participate in the collaborative development and implementation of wildland fire protection plans** and other local, county, and regional plans that address fire protection and landowner objectives.
4. **Increase awareness, knowledge, and actions implemented by individuals and communities to reduce human loss and property damage from wildland fires**, such as defensible space and fuels reduction activities, and fire prevention through fire safe building standards.
5. **Integrate fire and fuels management practices** with landowner priorities and multiple jurisdictional efforts within local, state, and federal responsibility areas.

The following actions are recommended to move toward achieving these five goals.

8.1.1 Continue to identify and evaluate wildland fire hazards

- Continue to collect, analyze, and maintain multi-agency hazard and resource GIS data.
- Maintain an accessible online GIS portal to store and share the multi-agency maps and data developed throughout this CWPP process.
- Utilize the GIS information and modeling results presented in Section 5 of this CWPP for pre-fire planning, and to collaboratively develop priorities for projects throughout the county.
- Develop an inventory of structures with shake and shingle roofing material in each jurisdiction to identify and target education efforts and the need for roof conversions.

- Consider ways to improve the coverage of the fire detection cameras.
- Consider ways to use drone technology for fire protection.

8.1.2 Articulate and Promote the Concept of Land Use Planning Related to Fire Risk

- Continue to promote the concept of land use planning as it relates to fire risk and landowner responsibilities; identify the key minimum elements necessary to achieve a fire safe community and incorporate these elements into community outreach materials and programs.
- Continue to implement the structural ignitability activities outlined in Section 7.2.
- Develop outreach materials outlined in Section 7.1.1.
- Coordinate with county and local government staff to integrate Firewise approaches into planning documents and ordinances.
- Identify approaches to increase the number of WUI properties inspected each year.
- Continue to support community chipper programs to encourage compliance with defensible space and vegetation management requirements.
- Continue the structure ignitability efforts currently in place (see Section 7.2).
- Consider how to make the tree removal process less cumbersome and less expensive.

8.1.3 Support and continue to participate in the collaborative development and implementation of wildland fire protection plans

- Work collaboratively with county, local, and regional agencies and landowners to develop fuel reduction priorities and strategies based on this CWPP, local CWPPs, and/or other regional plans.
- Support the development and implementation of local-scale CWPPs.
- Provide a collaboration mechanism between private property owners (and Home Owners Associations) and large land owners (i.e., MCOCD, MMWD, NPS)
- Consider the creation of transition zones (areas between developed residential areas and open space areas) where additional defensible space or additional vegetation clearance is needed.

8.1.4 Increase awareness, knowledge, and actions implemented by individuals and communities to reduce human loss and property damage from wildland fires

- Continue to implement the defensible space and outreach activities outlined in Section 7.2.
- Develop outreach materials outlined in Section 7.1.1.
- Continue inter-agency coordination with Marin’s fire service community and other partners to maintain a community presence and to develop and distribute public information regarding fuel reduction efforts throughout the county.
- Educate landowners, residents, and business owners about the risks and personal responsibilities of living in the wildlands, including applicable regulations and prevention measures and preplanning activities.
- Continue efforts to partner with neighborhoods located in WUI areas to educate them on becoming fire adapted or Firewise communities.
- Continue to educate and prepare communities through an emphasis on the Ready, Set, Go! and the Firewise community programs, and create and support venues in which individual community members can be actively involved in local fire safe councils, community emergency response teams, and other community-based efforts in order to develop readiness plans and educate landowners to mitigate the risks and effects of wildland fire.
- Continue to increase education and awareness about structural ignitability and defensible space; develop and distribute educational materials to vendors and contractors who sell or install fire resistant materials, and make these materials available at local home improvement stores.
- Increase the number of annual defensible space inspections and increase enforcement.
- Consider providing defensible space financial assistance for senior citizens.
- Better enforce defensible space compliance with absentee property owners.
- Develop and distribute more information about fire resistant landscaping.
- Create a fire blog.
- Develop an App for evacuation route information.

8.1.5 Integrate fire and fuels management practices

- Continue to implement the vegetation management and fuel reduction activities outlined in Section 7.2.
- Continue implementation of the countywide fuel break and fire plan implementation.

- Continue to implement and maintain vegetation management projects along highly-traveled roadways and access points into all public lands in order to minimize ignitions.
- Prioritize evacuation routes for fuel reduction programs
- Develop traffic congestion controls along evacuation routes
- Implement stronger parking enforcement along evacuation routes
- Continue to maintain foot trail network in Mill Valley
- Implement maintenance program for foot trail network in Fairfax
- Encourage community-level drills for evacuation preparedness
- Develop a program to address fuel reduction on vacant properties.
- Consider grazing as a fuel reduction strategy.
- Consider if additional vegetation reduction are required from roadways that are key evacuation routes into or out of a particular neighborhood
- Create extended or enhanced vegetation fuels management along all identified evacuation routes from developed residential and open space areas.
- Create transition zones to extend shaded fuel breaks between developed residential areas and open space areas.
- Identify and implement vegetation management projects in priority WUI communities throughout the county.
- Work to reduce regulatory barriers that limit hazardous fuels reduction activities (e.g., tree removal process).
- Use the published science on fire ecology to assess the costs, benefits, and best implementation tools for different fuels reduction and vegetation management strategies that are intended to reduce fire risk to lives and property.
- Continue to develop strategic partnerships and funding opportunities with local industries to support fuel reduction projects.

8.2 Action Plan

Appendix D contains a list of action items based on the key goals and recommendations outlined in Section 8.1. Each year, FSM and the Marin County Fire Chief's Association (MCFCA) will request that stakeholders select and prioritize the action items (from Section 8.1 and Appendix D) that they will work on. By November 1 of each year, stakeholders will provide a status report of the action items that were worked on and accomplishments. The action plan in Appendix D will be updated and presented at the MCFCA annual planning meeting and in the FSM annual report.

8.2.1 Environmental Review and Permitting

This CWPP is an advisory document prepared by FSM in collaboration with stakeholder agencies pursuant to the HFRA. The CWPP development team was comprised of stakeholders (or their representatives) and the contents of this CWPP are opinions of these stakeholders. Because this CWPP is an advisory document, it does not legally commit any public agency to a specific course of action or project and thus, is not subject to the California Environmental Quality Act (CEQA) or to the National Environmental Protection Act (NEPA). As such, several counties in California have signed CWPPs without considering the CWPP as a project subject to CEQA.

However, if funding is received from local, state, or federal agencies to implement a specific project, and prior to work performed, the lead agency must consider whether the proposed activity is a project under CEQA or NEPA. If the lead agency makes a determination that the proposed activity is a project subject to CEQA or NEPA, the lead agency must perform environmental review prior to obtaining permits or other entitlements by any public agencies to which CEQA or NEPA apply.

8.3 Plan Management

The fire agencies, land management agencies, and private landowners responsible for managing vegetation in Marin County are encouraged to submit project ideas that focus on reducing fire hazards in priority areas. Appendix B provides an initial list of identified areas of concern and potential projects, but should be considered a starting point for continued collaboration and coordination.

To ensure continued collaboration and the long-term success of this CWPP effort, FSM—in collaboration with the MCFCA—will lead the effort to continue to evaluate, update, and maintain this CWPP as needed. The contents of the CWPP will be reviewed and evaluated every three years and the action plan will be reviewed and updated annually. This plan will be updated with input from the community and local fire and land management agencies as necessary. Updates to the plan will be documented as plan amendments as shown in Table 1.

9. References

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Appendix A: Updated Fuel Map Generation

This appendix provides the methods used to develop the data set for the fuel model types described in Section 2.2.

A.1 Processing Overview

Fire behavior modeling requires a spatially-explicit fire behavior fuel model map as input, among other datasets. As part of the development of this CWPP, 5-meter and 30-meter resolution fire behavior fuel model maps covering Marin County were developed. The maps were derived from available LiDAR and aerial imagery as well as datasets reflecting vegetation types and the presence of structures, roads, and waterbodies. These maps provide a critical tool for fire hazard mitigation planning for Marin County and were used to conduct analyses of fire risk and fire hazard reduction projects described elsewhere in this document.

A.2 Input Datasets

LiDAR data in LAS point cloud format was obtained via the USGS EarthExplorer website²⁶. The data provides complete coverage of Marin County at 2 meter nominal pulse spacing or better, and was collected in 2010 by the ARRA Golden Gate LiDAR Project²⁷. The data is in tile format, with 776 tiles making up the dataset. National Agriculture Imagery Program (NAIP) JPEG2000 orthorectified imagery collected over Marin County from June 8 through June 13, 2014 was also downloaded from the USGS Earth Explorer website.

Three available vegetation data sets were used to provide information about vegetation types for portions of Marin County. The datasets used included (1) the 2008 Marin County Open Space District (MCOSD) vegetation dataset obtained from the California Department of Fish and Wildlife (CDFW) Global Information System (GIS) Clearinghouse; (2) the 2009 Marin Municipal Water District (MMWD) vegetation dataset obtained from the CDFW GIS Clearinghouse, and; (3) the Existing Vegetation Classification and Assessment with LANDSAT of Visible Ecological Groupings (CALVEG) dataset, which was mostly based on 2007 imagery published by the U.S. Department of Agriculture Forest Service Pacific Southwest Region Remote Sensing Lab.

²⁶ <http://earthexplorer.usgs.gov/>

²⁷ http://online.sfsu.edu/ehines/arra_golden_gate_lidar_project.htm

In order to refine vegetation information for Marin County, vector data that reflected building footprints, waterbodies, and road networks were obtained from MarinMap²⁸ and were used to refine vegetation information for Marin County. The building footprint dataset was produced using 2004 orthoimagery stereopairs. The waterbody and road datasets were derived from U.S. Census TIGER files, and the road dataset was refined using 2004 orthoimagery.

A.3 Image Processing

LiDAR and NAIP imagery for Marin County were combined to provide information about vegetation cover and topography across the county. All rasters produced for use in this project were aligned to the datasets derived from raw LiDAR point clouds, projected to UTM zone 10N using the NAD83 datum with a cell size of 5 meters.

LiDAR tiles were combined and processed using standard ArcGIS geoprocessing tools to derive bare earth elevation, slope, aspect, vegetation height, and vegetation percent cover. Vegetation height and vegetation cover on the 5 m grid were calculated using the internal point classification, which groups vegetation and building returns together. To differentiate between buildings and vegetation, Normalized Difference Vegetation Index (NDVI) values derived from NAIP imagery were used to mask locations, with $NDVI < 0$ representing non-vegetation. To exclude shrubs and other low-lying vegetation from the percent canopy cover calculation, all pixels in the percent canopy cover that had a canopy height of less than 3 meters were assigned a percent canopy cover value of 0%.

The vegetation and topographic information derived from these datasets were used as inputs to produce fuel model information for Marin County.

A.4 Fuel Model Crosswalk

To obtain the fuel information required for fire behavior modeling, the LiDAR- and NAIP-derived datasets were integrated with the vector information reflecting vegetation type, building footprints, waterbodies, and roads. The result of this analysis was a 5-meter resolution dataset providing 40 Scott and Burgan fire behavior fuel model assignments for all of Marin County (Scott and Burgan, 2005).

The three sources of vegetation type information were then combined. The CALVEG dataset provided county-wide vegetation type information, while the MMWD and MCOSD vegetation datasets provided only partial coverage. However, visual inspection revealed the MMWD and MCOSD datasets were more accurate than the CALVEG dataset at identifying the correct vegetation types, so the vegetation types identified by the CALVEG dataset were replaced with the MMWD and MCOSD classifications where valid data were available.

²⁸ <http://www.marinmap.org>

To assign fuel models, aspect, vegetation height, percent vegetation cover, and vegetation type datasets were used in a crosswalk. A crosswalk assigns a fuel model to each pixel based upon the information from the datasets. A modified version of a CAL FIRE furnished crosswalk was used and was modified to address vegetation types assigned to locations within Marin County that were not addressed by the original crosswalk, based on knowledge of local vegetation and from feedback from vegetation and fuels managers at Marin County Fire Department.

None of the vegetation datasets provided vegetation type information for Angel Island. A simple fuel model crosswalk was created for Angel Island based upon the canopy height and canopy cover values, and by visually examining aerial imagery. The Angel Island fuel model information was appended to the fuel model dataset covering the rest of the county.

A.5 Fuel Model Adjustments

The fuel model map described above was modified to better account for the location of roads, structures, and waterbodies. All locations falling within a waterbody were modified to an unburnable fuel model. In addition, a series of filtering steps were applied to reflect the presence of flammable vegetation in urban/developed areas. To account for the flammable vegetation that was initially classified as unburnable, canopy cover and canopy height were used to reassign all urban/developed fuel model areas with an NDVI greater than 0 to a flammable vegetation class.

Next, the road location information was used to assign pixels to the unburnable urban/developed fuel model or to a timber litter fuel type model based upon the presence of canopy cover. Large roads (freeways and highways) were buffered to 10 meters, while small roads (local roads) were buffered to 5 meters; the percent canopy cover of each pixel falling within the buffered roads was obtained. Roads with greater than 30% canopy cover were classified as burnable because fuel overhanging the road may allow fire to spread over that road. Roads with less than 30% cover were classified as unburnable.

A similar approach was used to address vegetation overhanging buildings. The building footprints and percent canopy cover data were used to assign a fuel model to all building locations. Buildings with 20-40% canopy cover were classified as a timber litter fuel type model, and buildings with greater than 40% canopy cover were assigned a timber-understory fuel type model. Buildings with less than 20% canopy cover were classified as unburnable.

A.6 Landscape File Creation

A landscape file (.lcp) is required by commonly used fire behavior models such as FlamMap to simulate fire behavior. A landscape file consists of eight layers of vegetation and geophysical information. The geophysical layers include elevation, slope, and aspect, while the vegetation layers

include fuel model, vegetation height, percent vegetation cover, canopy bulk density, and canopy base height.

The development of all layers has been described above, with the exception of the canopy bulk density and canopy base height layers. The canopy base height layer was assigned a universal value of 3' for all pixels assigned either a timber-understory or a timber litter fuel type model, based on our knowledge of local vegetation. In lieu of actual field measurements of canopy fuels in Marin County, canopy bulk density was estimated for pixels with a timber-understory or a timber litter fuel type model using plot data collected for ponderosa pine/Douglas-fir and Sierra Nevada Mixed Conifer forest types in the Interior West (Scott and Reinhardt, 2005). For each fuel model and canopy cover bin, a canopy bulk density value was assigned.

ArcFuels²⁹ was used to compile the 5 m rasters of the eight data layers into a landscape file. In addition, bilinear interpolation and majority method resampling methods were used to convert the 5 m raster datasets to 30 m resolution, and a 30 m landscape file was created for fire modeling using the Interagency Fuels Treatment Decision Support System (IFTDSS).

A.7 References

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²⁹ <http://www.arcfuels.org/>

Appendix B: Areas of Concern and Marin County Fire Plan Projects

This appendix provides a complete list of the areas of concern information and hazard mitigation efforts provided by the stakeholder agencies listed in alphabetical order by agency name (not in order of priority), and also includes a list of past, current, and/or planned projects from the 2015 Marin Unit Fire Plan. These lists are intended to provide a starting point for identifying and prioritizing a more complete, countywide list of future fuel reduction and outreach projects.

Exhibit A. List of Fire Roads, Fuel Breaks, Planned Projects, and Other Treatments

Agency	Geographic Location/Description	Fuel Reduction Strategy
Bolinas FPD	Bolinas Water System	Expansion/improvement
Bolinas FPD	Bolinas Water System	Expansion/improvement
Bolinas FPD	Bolinas Water System	Expansion/improvement
Bolinas FPD	Bolinas Water System	Expansion/improvement
Bolinas FPD	Bolinas Water System	Expansion/improvement
Bolinas FPD	Bolinas Water System	Expansion/improvement
Bolinas FPD	Bolinas Water System	Expansion/improvement
Bolinas FPD	Bolinas Water System	Expansion/improvement
Bolinas FPD	Bolinas Water System	Expansion/improvement
Bolinas FPD	Bolinas Water System	Expansion/improvement
Bolinas FPD	Bolinas Water System	Expansion/improvement
Bolinas FPD	Bolinas Water System	Expansion/improvement
Corte Madera	Endeavor (Town)	Hazardous fuel reduction (HFR) (town owned)
Corte Madera	Madrono-Pleasant (Town)	Hazardous fuel reduction (HFR) (town owned)
Corte Madera	Tiburon Ridge	Hazardous fuel reduction (HFR) (Open Space)
Corte Madera	Ring Mountain	Hazardous fuel reduction (HFR) (Open Space)
Corte Madera	Madera del Presidio Phase II	Potential Firewise community, public education, veg mgt plan (VMP)
Corte Madera	Chapman Park/Meadowsweet	Potential Firewise community(ies), public education
Corte Madera	Marin Estates	Potential Firewise community, public education
Corte Madera	Blithdale Ridge	Hazardous fuel reduction (HFR) (Open Space)
Corte Madera	Christmas Tree Hill	Potential Firewise community, public education
Corte Madera	Madera del Presidio Phase I	Potential Firewise community, public education
Corte Madera	Palm Hill/Blue Rock	Potential Firewise community, public education
Inverness	Watershed	Maintain and improve fire roads in watershed
Inverness	Watershed	Maintain and improve fire roads in watershed
Inverness	Watershed	Maintain and improve Marin County fuel break
Inverness	Watershed	Maintain and improve fire roads in watershed

Agency	Geographic Location/Description	Fuel Reduction Strategy
Inverness	Residential areas	Improve access and egress on private maintained roads and reduce hazard fuels on public & private properties; public education and outreach; upgrade water mains to improve fire flow
Inverness	Residential areas	Improve access and egress on private maintained roads and reduce hazard fuels on public & private properties; public education and outreach; upgrade water mains to improve fire flow
Inverness	Residential areas	Improve access and egress on private maintained roads and reduce hazard fuels on public & private properties; public education and outreach; upgrade water mains to improve fire flow
Inverness	Residential areas	Improve access and egress on private maintained roads and reduce hazard fuels on public & private properties; public education and outreach
Kentfield	From King Mountain Loop project (Larkspur) to 76 Ridgecrest Rd.	Open Space Land. (WUI) with highly valued assets at risk. Continuing and strengthening projects from neighboring agencies. Needs Implementation
Kentfield	From 123 Crown Rd, including the area of Harry Allen Trail to area of Goodhill Rd and Crown Rd.	MMWD Land. (WUI) with highly valued assets at risk. New project. Needs Implementation
Kentfield	From 123 Crown Rd, to Phoenix Rd and continuing on the Indian Fire Rd stopping at Blithedale Ridge/Eldridge Grade intersection.	MMWD Land. (WUI) with highly valued assets at risk. Past fuel-break completed. Needs to be maintained and strengthened.
Kentfield	From 351 Evergreen Rd to 414 Crown Rd to 12 Ridgecrest Rd. South and Southeast facing slope.	Open Space Land. (WUI) with highly valued assets at risk. Proposed project. Needs Implementation
Kentfield	From 12 Ridgecrest Rd to 76 Ridgecrest Rd. Including all of BlueRidge Rd. Southwest facing slope.	Open Space Land. (WUI) with highly valued assets at risk. Past fuel-break completed. Needs to be maintained and strengthened.
Kentfield	Evergreen Fire Trail, Rancheria Rd Connection, Crown Rd Connection	Access and Egress roads. Maintenance and clearing of a project that has been completed in the past.

Agency	Geographic Location/Description	Fuel Reduction Strategy
Mill Valley	Cascade	
Mill Valley	MMWD Property	Tall grass and brush fuel reduction
Mill Valley	Open Space Property	Tall grass, broom, brush fuel reduction
Mill Valley	Open Space Property	Tall grass, broom, brush fuel reduction
Mill Valley	MMWD	Grass, brush and Acacia fuel reduction
Mill Valley	Open Space Property	100' fuel reduction - grass and brush
Mill Valley	MMWD/Private/City ROW	Tall grass, broom, brush fuel reduction on primary access fire road
Mill Valley	City Property	Tall grass, broom, brush fuel reduction on paper roads to continue ring around Mill Valley
Mill Valley	Summit	
Mill Valley	City Property	Tall grass, broom, brush fuel reduction on paper roads to continue ring around Mill Valley
Mill Valley	Open Space Property	100' fuel reduction - grass and brush
Mill Valley	Private Property	Tall grass, thick brush, pine tree fuel reduction below homes
Mill Valley	Private Property	Tall grass, thick brush, pine tree fuel reduction
Mill Valley	Open Space Property	100' fuel reduction - grass and brush
Mill Valley	Open Space Property	Tall grass, broom, brush fuel reduction on primary access fire road
Mill Valley	City Property	Grass, brush and tree fuel reduction along a designated evacuation path
Mill Valley	Scott Valley	
Mill Valley	PGE Property	Tall grass, broom, brush and pine tree fuel reduction
Mill Valley	S/B 101 on ramp from EB to No Name exit	Tall grass, thick brush, pine tree fuel reduction
Mill Valley	Warner Canyon/Scott Highlands	
Mill Valley	City Right of Way	Tall grass, broom, brush fuel reduction along roadway
Mill Valley	City Property	Tall grass, broom, brush fuel reduction
Mill Valley	Open Space	Tall grass, broom, brush fuel reduction
Mill Valley	Open Space Property	50'-100' fuel reduction - grass and brush
MMWD	SKY OAKS MEADOW	VMP Burn
MMWD	ROCK SPRING	VMP Burn
MMWD	PINE MOUNTAIN SOUTH GATE	VMP Burn

Agency	Geographic Location/Description	Fuel Reduction Strategy
MMWD	DEER PARK RD	Road Maint
MMWD	SKY OAKS HEADQUARTERS	D Space
MMWD	PETERS DAM AND DEFENSIBLE SPACE	D space
MW LV	CSA 13	Behind homes fronting open space; Mow grasses, limb trees up 10', remove dead vegetation 100' in
MW LV	Lucas Valley Estates	Behind homes fronting open space; Mow grasses, limb trees up 10', remove dead vegetation 100' in
MW LV	Horse Hill Area	Behind homes fronting open space; Mow grasses, limb trees up 10', remove dead vegetation 100' in
MW LV	Berry Area	Behind homes fronting open space; Mow grasses, limb trees up 10', remove dead vegetation 100' in
MW LV	Miller Creek Rd Area	Behind homes fronting open space; Mow grasses, limb trees up 10', remove dead vegetation 100' in
MW LV	Limestone Hill Area	Behind homes fronting open space; Mow grasses, limb trees up 10', remove dead vegetation 100' in
MW LV	Queenstone Fire Road	Fire Road; fire road clearance
MW LV	Valleystone Project	Behind homes fronting open space; Mow grasses, limb trees up 10', remove dead vegetation 100' in
Novato	<p>Wildhorse Valley Streets & Roads: Vineyard Rd., Wildhorse Valley Rd., West Brooke Ln., Palomino Rd., Pinto Rd., Rebelo Ln., Wali Trail, Woodside Ct., Meadow Ln. Fire Roads Access: Indian Tree Rd., & Wildhorse Valley Fire Rd., Deer Camp & H Ranch Rd.</p>	<p>Projects: 1. Fire Wise Community Designation 2. Remove fire prone plants in defensible space zones. 3. Community Chipper Days 4. Shaded fuel break - 100ft surrounding Wildhorse Valley neighborhood. 5. Maintain Fire Road Access- Brush out fire road 10' on both sides and provide 14' vertical clearance between Wild Horse Valley and Indian Tree Fire Road.</p>

Agency	Geographic Location/Description	Fuel Reduction Strategy
Novato	<p>Atherton</p> <p>Streets & Roads: Atherton Ave., Oak Shade Ln., Saddlewood Dr., Morningstar Ct., Trailview Ct., Dry Creek Ln., Bugeia Ln., H Ln., Bahia Dr., Topaz Dr., Laguna Vista, Cerro Crest, Ashlet Ct., Lindsey Ct., Albatross Dr., Santanna Dr., River Vista Dr. Baruna Ct., Tiki Rd., Andale Ave., Malobar Dr., Crest, School Rd., Sutton Ln., Lockton Ln., Sunset Trail, Hampton, Woodview Ln., Greenpoint Ln., Glen rd. Channel Ln., Bridge Ln. & Harbor Dr.</p> <p>Fire Road Access: Pinheiro Ridge, Rush Creek</p>	<p>Projects:</p> <ol style="list-style-type: none"> 1. Firewise Community Designation 2. Remove fire-prone plants in defensible space zones 3. Chipper day programs 4. Shaded fuel breaks-100-200' between Laguna Vista, Bahia Lane, School Road, Crest Road, Green Point Lane and Bridge Lane. 5. Evacuation Routes- Brush out emergency evacuation routes and provide signage between Albatross/Laguna Vista and Crest Road and Crest Rd to Williams and Alpine Rd. 6. Develop and implement Bahia VMP.
Novato	<p>Marin Valley</p> <p>Streets & Roads: Marin Valley Dr., Marin View, Scenic, Wild Oak Dr., Meadow View, View Ridge Dr., Sunrise Ln., Club View, Fallen Leaf Way., Panama Dr.,</p> <p>Fire Road Access: Muroc Lake Emergency Access Road</p>	<p>Projects:</p> <ol style="list-style-type: none"> 1. Fire Wise Community Designation 2. Remove all fire prone plants in defensible space zones. 3. Chipper Day Program. 4. Evacuation routes- brush out 20ft on both sides and remove pine trees along the roadway. 5. Fuel breaks - 100-200ft surrounding the mobile home park 6. Implement VMP.

Agency	Geographic Location/Description	Fuel Reduction Strategy
Novato	<p>Little Mountain Streets & Roads: Stirup Ln., Verissimo Rd., Saddle Ln., Ravine Way, Oak Valley Rd., Sanchez Way., Center Blvd., Daryl Dr., Taurus Dr., Trish Dr., Kathleen Dr., Libra & Aries Dr., Ruben Ct., Mae Ct., Stasia Dr., Stasia Ct., San Joaquin Pl., Michele Circle, Lorraine Ct. Fire Road Access: Stafford Lake & Doe Hill</p>	<p>Projects: 1. Fire Wise Designation 2. Remove fire prone plants in defensible space zones. 3. Chipper Day program. 4. Shaded fuel breaks - San Joaquin Place between PV School and Little Mountain OSD; Pleasant Valley HOA.; Kathleen Drive and Michelle Circle 5. VMP's for multi-family dwellings 6. Maintain Fire Road Access - Brush out fire road 10' on both sides and provide 14' vertical clearance.</p>
Novato	<p>San Marin Streets & Roads: San Ramon, San Andreas, Hawthorne Ter., La Merida Ct., La Placita Ct., San Domingo Wy., San Blas Ct., Andreas Ct., San Mateo Wy., Coronado Ct., Palmo Wy., Palmo Ct., Verdad Wy., San San Carlos Wy., Jacinto Wy, Sereno Wy., Sotelo Wy., Viejo Wy, Partridge Dr., Partridge Ct., Woodleaf Ct., Adobe Ct., Simmons Ln., Butterfield Dr., Fieldstone Dr., Sundance Wy, West Campus Dr., Woodhollow Dr., Meadowcrest Rd. Fire Road Access: San Andreas, San Marin Salt Lick, San Carlos, Creekside, Quarry Basalt</p>	<p>Projects: 1. Fire Wise Community Designation 2. Remove fire prone plants in defensible space zones. 3. Community Chipper Days 4. Shaded fuel break - 100-200ft along surrounding homes adjacent to wildlands. 5. Maintain Fire Road Access - brush out fire roads 10' on both sidea and 14' vertical clearance.</p>

Agency	Geographic Location/Description	Fuel Reduction Strategy
Novato	Blackpoint Streets & Roads: Harbor Rd., Havenwood Ave., Granview Ave., Beattie Ln, Phillip Terrace Ave., Manzanita Ln., Mistletoe, Murphy Leibert Ln., lolanthus ave., Holly Ave., Oak Ave., Laurel Ave., Hemlock Ave., Norton Ave., San Rafael St., Cedar Ave. Bayview Rd., Day Island Rd. Stonetree Dr., Owl ridge Ct.	Projects: 1. Firewise Community Designation 2. Remove fire-prone plants in defensible space zones 3. Community Chipper day program 4. Evacuation Routes - Provide additional egress routes between Black Point and Stone Tree; Mazanita Avenue and Phillip Terrace Ave. 5. Evaluate "area of refuge" at the end of Lolanthus and Norton Ave.
Novato	Cherry Hill Streets & Roads: Armstrong Ave., Cherry st., Cherry Ct., Cherry Hill, Chase St., Plum St., Peach St., Olive Ave., Zandra Pl., Sherwood Pl., Summers Ave., Rudnick Ave., Rebecca Wy., Rita Ct., Olive Ct., Robinhood Dr., Knight Dr., Bishop Ct., Castle Ct., Knolltop Ct., Cross Creek Wy., Upland Ln., Westridge Ln., Samrose Dr., Ming Ct., Wendy Ct., Jacob Ct., Vincent Ln., Galloway In., James ct., Rose Ct., Windwalker Wy., Bay Tree Hollow, Equestrian Ct., Churchill Ln., Kristin Marie Ct. Fire Road Access: Cherry Ridge Rd	Projects: 1. Fire Wise Community Designation 2. Remove fire prone plants in defensible space zones 3. Community Chipper Days 4. Shaded fuel breaks - 100ft between neighborhoods and wildlands. 5. Maintain Fire Road Access- brush out 10ft on both sides and provide 14' vertical clearance.

Agency	Geographic Location/Description	Fuel Reduction Strategy
Novato	<p>Indian Valley</p> <p>Streets & Roads: Indian Valley Rd., Pacheco Rd., Chamberlain Ave., Indian Trail, Old Ranch Rd., Wildwood Ln., Bloom Ln., Gage Ln, Slowdown Ct., Indian Springs, McClay Rd.,, Silva Ct., Syl Dor Ln., Knuttle Ct., Canyon Rd., Ridge Rd., Forrest Rd., Half Moon Rd., Black Oak Ln., Wilson Ave., Mill Rd., Santa Maria Dr., Blanca Dr., Roca Ct., Plata Ct. Tanglewood Ln. Syosett Ln.</p> <p>Fire Road Access: H Ranch and Indian Valley Fire Rd., Ebright Fire Rd., H Ranch, Burnt Ridge.</p>	<p>Projects:</p> <ol style="list-style-type: none"> 1. Fire Wise Community Designation 2. Remove fire –prone plants in defensible space zones. 3. Community Chipper Days 4. Shaded fuel breaks - 100’ surrounding Half Moon Rd., Canyon Rd., Forest Rd., and Tenaya Lane. 5. Evacuation Routes - Evaluate second route from Half Moon Road to Indian Valley Rd. 6. Maintain Fire Road Access –brush out 20’ on both sides of the road & 14’ vertical clearance. 7. Old Ranch Rd., brush out road 20’ on both sides and 14’ vertical clearance.
Novato	<p>Ignacio Valley</p> <p>Streets & Roads: Carnoustie HTS., Baywood Circle, Bonnie Brae Dr., Obertz Ln., Burning Tree, Caddy Court., Wentworth Ln., Nassue Ct., Thornhill Ct., Thunderbird Dr., Thunderbird Ct., Pensacola Ct., piping Rock Rd., St. Andrews Dr., Capalano Dr., Prestwick Ct., Fairway Dr., Spyglass Dr., Birdie Dr., Country Club Dr., Eagle Dr., Olympia Wy., Marin Oaks Dr., Greg Pl., Germaine Pl., Montura Wy., Ignacio Blvd.,</p> <p>Fire Roads: Montura, Eagle, Burnt Ridge & Indian Valley College.</p>	<p>Projects:</p> <ol style="list-style-type: none"> 1. Fire Wise Community Designation. 2. Remove fire prone plants in defensible space zones. 3. Chipper Programs. 4. Shaded Fuel breaks - 100ft between residences and wildlands surrounding Carnoustie Heights, Eagle Dr., Country Club Dr., & Olympia Dr. & Burning Tree Dr. 5. Maintain Fire Road Access by brushing out 10’ on both sides and 14’ vertical clearance.

Agency	Geographic Location/Description	Fuel Reduction Strategy
Novato	<p>Pacheco Valley Streets & Roads: Alameda Del Prado, Red Hawk Rd, Pelican Ln, Kingfisher, Elegant Tern, Elf Owl, Sage Grouse, Curlew WY, Pacheco Creek Way, Buckeye Ct., Raccoon Dr., Badger Ct., Acorn Ct., Oak Forest Rd., Eagle Gap Rd., Eagle Gap Ct., Hawk Ridge, Paper Mill Creek Ct., Chaparral Ct., Burdell Ct., Josefa Ct., Charmaine Ct., Duarte Ct., Clay & Grass Ct.</p> <p>Fire Roads: Heatherstone, Ponte, Little Cat, Chicken Stack & Posada Del Sol Fire</p>	<p>Projects:</p> <ol style="list-style-type: none"> 1. Fire Wise Community Designation 2. Remove Fire prone Vegetation in defensible Space Zones 3. Chipper Day Program. 4. VMP's for each HOA 5. Evacuation Route-maintain egress by brushing out 10' on both sides of roadway. 6. Maintain Fire Road Access - brush out 10' on both sides and vertical clearance 14'. 7. Evaluate alternative evacuation routes.

Agency	Geographic Location/Description	Fuel Reduction Strategy
Novato	<p>Anderson Rowe</p> <p>Streets & Roads: Silverberry Circle, Merrit Dr., Shannon Ct., Valleyview Terr., Ash Ct., Laurelwood Dr., Highland Dr., Aaron Dr., Claire Ct., Judith Ct., Karia Ct., Becky Ct., Crystal Ct., Deborah Ct., Woodfern Ct., Palmer Dr., Rowe Ranch Dr., Ranch Ct., Rowe Ranch Wy., White Oak Wy., Oak Wy., Oak Grove Dr., Elmview Wy., Owens Dr., Entrada Dr., Azelea Pl., Susan Wy, Margaret Ct., Arlene Way, Stone Dr., Arlington Circ., Oak View Ct., Woodland Ct.,</p> <p>Fire Roads: Palmer & Anderson Rowe Water Access Rds.</p>	<p>Projects:</p> <ol style="list-style-type: none"> 1. Fire Wise Designation 2. Remove fire –prone plants in defensible space zones. 3. Community Chipper Days 4. Shaded fuel breaks - 100'-200' surrounding Highland Dr., Arlington Ct., Woodland Ct., Oak View, Becky, Crystal, Aaron and Pacific Drive, Margaret Ct., Susan Way and Arlene Way. 5. Maintain Fire Road Access- brush out 10' on both sides and 14' vertical clearance. 6. VMP's for HOA's and multi-family dwellings. 7. Pine Tree Removal Susan Way and Margaret Court.
Novato	<p>Loma Verde</p> <p>Streets & Roads: Cielo Ln., Posada Del Sol, Madrid Ln, Calle Arboleda, Calle De La Selva, Via Escondida, Corte Colina, Corte Del Cerol, Corte Sur, Corte Nortel, Calle Paseo, Corte Escuela, Alameda del Loma, Calle Empinado, Pebble Beach, Winged Foot.</p> <p>Fire Roads: Escondida Rd.</p>	<p>Projects:</p> <ol style="list-style-type: none"> 1. Fire Wise Designation 2. Remove fire-prone plants in defensible space zones 3. Chipper Day Program. 4. Fuel break - 100'-200' surrounding Winged Foot Dr., and Pebble Beach Dr. 5. VMP's – multi-family dwellings (Posada Del Sol & Ceilo Lane) 6. Maintain Fire Road Access – brush out fire roads 10' on both sides and 14' vertical clearance.

Agency	Geographic Location/Description	Fuel Reduction Strategy
Novato	Presidents/IVC Streets & Roads: Creekwood Ct., Kathy Ct. Sunset PKWY., Turber Dr., Arrowhead Ln., Indian Hills Ct., Flint Ct., Garner Dr., Truman Dr., Rowland Dr., Shevlin Dr., Balara Dr., Kaden Dr., Drakewood Dr., Pierce Dr., Brown Dr.	Projects: 1. Fire Wise Designation 2. Remove fire –prone plants in defensible space zones. 3. Community Chipper Days 4. Shaded fuel breaks - 100’ surrounding homes. 5. Indian Valley College-VMP for maintenance and fire road maintenance.
Novato	Wilson West Streets & Roads: Wilson Ave., Maestro Rd., Pillsbury Ln, Hatch Rd Carbo Ridge., Vida Ct., Eldorado Ct., La Costa Ct., Oro Ct., Mockingbird Ct., Goldfinch Ct., Meadowwark Ct., Nina Dr., Bear Creek and Brooke Dr. Fire Roads: Cabro Ridge, Wildhorse Valley connection/Ryan Trail..	Projects: 1. Fire Wise Community Designation 2. Remove fire –prone plants in defensible space zones. 3. Community Chipper Days 4. Evacuation routes- of 20’ on both sides and 14’ vertical clearance for Wilson Extension and Maestro Rd. 5. Cabro Ridge Road - brush out roadsides 20’ and 14’ vertical clearance. 6. Maintain Fire Road Access - Cabro Ridge and Wilson/H Ranch Rd.
Novato	Novato North Streets & Roads: Regalia Dr., Olivia dr., Oliva Ct., Amanda Ln., Raposa Vista, Dorothy WY., Valle View WY., Benton Dr., Tara Ln., Marion Ave., Rockrose WY., Santolina, Seventh St., Somerset Dr., Escallon Dr.	Projects: 1. Fire Wise Community Designation 2. Remove fire prone plants in defensible space zones 3. Community Chipper Days 4. Shaded fuel breaks - 100’-200’ surrounding neighborhoods adjacent to wildlands. 5. VMP’s for multi-family dwellings.

Agency	Geographic Location/Description	Fuel Reduction Strategy
Novato	Hilltop Streets & Roads: Hayden Ave., Lamont Ave., Reichert Ave., Prospect Place.	Projects: 1. Fire Wise Designation 2. Remove fire prone plants in defensible space zones. 3. Chipper Day Program 4. Shaded fuel breaks - 100' surrounding homes and multi-family dwellings. 5. VMP's for multi-family dwellings. 6. Hilltop Restaurant 200' fuel-break. 7. Update and implement Hilltop Restaurant VMP .
Ross Valley	West End	Fuel reduction/roadway clearance/Firewise community/public education
Ross Valley	Cal Park	Fuel reduction
Ross Valley	Ross (east)	Defensible Space improvement and enforcement in the WUI; fire apparatus access on roadways; egress and escape routes on roadways; egress and escape routes on steps and lanes and paths; potential shaded fuel breaks between open space and WUI; fuel reducti
Ross Valley	Fairfax Manor (West)	Defensible Space improvement and enforcement in the WUI; fire apparatus access on roadways; egress and escape routes on roadways; egress and escape routes on steps and lanes and paths; potential shaded fuel breaks between open space and WUI; fuel reducti
Ross Valley	Ross (south)	Defensible Space improvement and enforcement in the WUI; fire apparatus access on roadways; egress and escape routes on roadways; egress and escape routes on steps and lanes and paths; potential shaded fuel breaks between open space and WUI; fuel reducti
Ross Valley	Sleepy Hollow	Defensible Space improvement and enforcement in the WUI; fire apparatus access on roadways; egress and escape routes on roadways; egress and escape routes on steps and lanes and paths; potential shaded fuel breaks between open space and WUI; fuel reducti

Agency	Geographic Location/Description	Fuel Reduction Strategy
Ross Valley	Cascade Canyon	Defensible Space improvement and enforcement in the WUI; fire apparatus access on roadways; egress and escape routes on roadways; egress and escape routes on steps and lanes and paths; potential shaded fuel breaks between open space and WUI; fuel reduction
Ross Valley	Fairfax (East)	Defensible Space improvement and enforcement in the WUI; fire apparatus access on roadways; egress and escape routes on roadways; egress and escape routes on steps and lanes and paths; potential shaded fuel breaks between open space and WUI; fuel reduction
Ross Valley	Alameda, Morningside, Upper San Anselmo Ave	Defensible Space improvement and enforcement in the WUI; fire apparatus access on roadways; egress and escape routes on roadways; egress and escape routes on steps and lanes and paths; potential shaded fuel breaks between open space and WUI; fuel reduction
Ross Valley	Ross (central)	Defensible Space improvement and enforcement in the WUI; fire apparatus access on roadways; egress and escape routes on roadways; egress and escape routes on steps and lanes and paths; potential shaded fuel breaks between open space and WUI; fuel reduction
Ross Valley	San Anselmo (east)	Defensible Space improvement and enforcement in the WUI; fire apparatus access on roadways; egress and escape routes on roadways; egress and escape routes on steps and lanes and paths; potential shaded fuel breaks between open space and WUI; fuel reduction
Ross Valley	Hawthorne Hills	Defensible Space improvement and enforcement in the WUI; fire apparatus access on roadways; egress and escape routes on roadways; egress and escape routes on steps and lanes and paths; potential shaded fuel breaks between open space and WUI; fuel reduction

Agency	Geographic Location/Description	Fuel Reduction Strategy
Ross Valley	San Francisco Blvd	Defensible Space improvement and enforcement in the WUI; fire apparatus access on roadways; egress and escape routes on roadways; egress and escape routes on steps and lanes and paths; potential shaded fuel breaks between open space and WUI; fuel reduction
Ross Valley	San Anselmo Downtown	Defensible Space improvement and enforcement in the WUI; fire apparatus access on roadways; egress and escape routes on roadways; egress and escape routes on steps and lanes and paths; potential shaded fuel breaks between open space and WUI; fuel reduction
Ross Valley	Smith Ranch areas	Fuel reduction/Firewise community/public education
San Rafael	Professional Center Parkway areas	Fuel reduction/Firewise community/public education
San Rafael	San Pedro Ridge: Dominican Neighborhood, Glenwood Neighborhood, Peacock Gap areas	Fuel reduction/roadway clearance/Firewise community/public education
San Rafael	San Rafael Hill to Ridgewood Ave (end)	Fuel reduction/Firewise community/public education
San Rafael	Gerstle Park	Fuel reduction/roadway clearance/Firewise community/public education
San Rafael	Bret Harte	Fuel reduction/roadway clearance/Firewise community/public education
San Rafael	Cal Park	Fuel reduction
San Rafael	Smith Ranch areas	Fuel reduction/Firewise community/public education
San Rafael	Gerstle Park	Fuel reduction/roadway clearance/Firewise community/public education
San Rafael	Bret Harte	Fuel reduction/roadway clearance/Firewise community/public education
San Rafael	San Rafael Hill to Ridgewood Ave (end)	Fuel reduction/Firewise community/public education
San Rafael	Professional Center Parkway areas	Fuel reduction/Firewise community/public education
San Rafael	Terra Linda neighborhoods	Fuel reduction/Firewise community/public education
San Rafael	Los Ranchitos areas	Fuel reduction/roadway clearance/Firewise community/public education
San Rafael	West End	Fuel reduction/roadway clearance/Firewise community/public education

Agency	Geographic Location/Description	Fuel Reduction Strategy
San Rafael	San Pedro Ridge: Dominican Neighborhood, Glenwood Neighborhood, Peacock Gap areas	Fuel reduction/roadway clearance/Firewise community/public education
Sleepy Hollow	Loma Alta	Fuel Modification
Sleepy Hollow	Loma Alta	Fuel Modification
Sleepy Hollow	Loma Alta	Fuel Modification
Southern Marin	Ricardo Open Spc.	Goat grazing - post graze mastication
Southern Marin	Autumn Ln/Cabin	Brush removal/canopy lift/burn piles/shaded fuel break
Southern Marin	Ring Mtn. Area	100' off prop lines - def space clearing
Southern Marin	Rodeo Water Tank	Goat grazing - subsequent brush mastication
Southern Marin	Meda Project	Tree thinning/brush removal
Southern Marin	Milland	Goat grazing - post brush mastication
Southern Marin	Seminary	Pine tree removal
Southern Marin	Hawkhill	Goat raze - post brush removal
Southern Marin	Laguna/Forest	Brush removal - shaded fuel break
Southern Marin	Lattie Lane/Hwy. 1	Goat grazing - post graze mastication
Southern Marin	Hwy 1 - Erica/Friars	Eucalyptus removal
Southern Marin	So. Morning Sun/Tennessee	Chipper days (2) & roadway clearance
Southern Marin	Blackfield	Goat graze - brush removal after
Southern Marin	US 101/Wolfback	Eucalyptus removal/brush cut/shaded fuel break
Southern Marin	Edwards/Marion	Brush removal - shaded fuel break
Southern Marin	Cabin Drive	Eucalyptus removal
Southern Marin	Aqua Hotel Hill	Pompas grass removal & goat grazing - hand cut & stack brush
Southern Marin	Fairview	Road paving
Southern Marin	Homestead Valley L.T.	Eucalyptus removal/brush cut/shaded fuel break
Tiburon FPD	Ring Mountain	fuel modification, fuel reduction, access, water supply, fire roads
Tiburon FPD	Old St Hilary's Open Space	fuel modification, fuel reduction, access, water supply
Tiburon FPD	Middle Ridge Open Space	fuel modification, fuel reduction, access, water supply
Tiburon FPD	All town of Tiburon properties	fuel modification, access
Tiburon FPD	South Knoll Playground/McKegney Green	fuel reduction, access maintenance

Agency	Geographic Location/Description	Fuel Reduction Strategy
Tiburon FPD	Sugarloaf Drive to Paradise Drive	fuel modification, fuel reduction, access, water supply, fire roads
Tiburon FPD	Open Space	fuel modification, fuel reduction, access, water supply
Tiburon FPD	Middle Ridge Open Space	fuel modification, fuel reduction, access, water supply
Tiburon FPD	Greenwood Beach/Audubon	fuel reduction, access maintenance
Tiburon FPD	Blackies Pasture	fuel reduction, access maintenance
Tiburon FPD	Tiburon Marsh	seasonal grass maintenance, fuel modification
Tiburon FPD	Romberg Tiburon Center	fuel reduction, access, water supply, building maintenance, fire roads
Tiburon FPD	Belvedere Lanes and right of ways	vegetation modification, fuel reduction, public right of way clearance, westshore road access
Tiburon FPD	Tom Price Park	dead trees, high grasses, fuel modification
Tiburon FPD	Paradise State Park	fuel reduction, access, water supply, building maintenance, fire roads

Exhibit B. Project List from the 2015 Fire Plan

Agency & Project Name	SRA, Threat, LRA	Project Type	CALMAPPER ID	Work Agent	Status	Year Complete	Net Acres
TAM Community Service District	MRN	D Space	1010-2015-FRP-003	TAM CREW	P	2015	2
MMWD BILL WILLIAMS FB	MRN	Fuel Break	1010-2015-FRP-004	MMWD	M	2015	4
MMWD DEER PARK RD	MRN	Road Maint	1010-2015-FRP-005	MMWD	M	2015	9
MMWD KNOB I	MRN	Fuel Break	1010-2015-FRP-006	Contract	M	2015	48
MMWD KNOB II	MRN	Fuel Break	1010-2015-FRP-006	Contract	M	2015	28
MMWD LAGUNITAS ROCK SPRING BREAK	MRN	Fuel Break	1010-2015-FRP-007	MMWD	M	2015	12
MMWD LOWER RAILROAD GRADE	MRN	Fuel Break	1010-2015-FRP-008	Contract	P	2015	18
MMWD NATALIE COFFIN GREENE DIBBLEE	MRN	Fuel Break	1010-2015-FRP-009	Contract	M	2015	8
MMWD PETERS DAM AND DSPACE	MRN	D space	1010-2015-FRP-010	MMWD	M	2015	10
MMWD PHOENIX DAM	MRN	Fuel Break	1010-2015-FRP-011	MMWD	M	2015	2
PHOENIX LAKE ROAD FB	MRN	Fuel Break	1010-2015-FRP-012	MMWD	M	2015	3
MMWD PINE MOUNTAIN FB	MRN	Fuel Break	1010-2015-FRP-013	MMWD	M	2015	13
MMWD PINE MOUNTAIN SOUTH GATE	MRN	VMP Burn	1010-2015-VMP-002	MMWD	p	2015	30
MMWD PORTEOUS FB	MRN	Fuel Break	1010-2015-FRP-014	Contract	P	2015	19
MMWD ROCK SPRING	MRN	VMP Burn	1010-2015-VMP-002	MMWD	M	2015	37
MMWD ROSS RESERVOIR BREAK	MRN	Fuel Break	1010-2015-FRP-015	Contract	M	2015	17
MMWD SHAVER GRADE BREAK	MRN	Road Maint	1010-2015-FRP-016	MMWD	M	2015	8
MMWD SKY OAKS HEADQUARTERS	MRN	D Space	1010-2015-FRP-017	MMWD	M	2015	10
MMWD SKY OAKS MEADOW	MRN	VMP Burn	1010-2015-VMP-003	MMWD	M	2015	47
MMWD WORN SPRING MIDDLE	MRN	Fuel Break	1010-2015-FRP-018	Contract	M	2015	16
MMWD WORN SPRING NORTH	MRN	Fuel Break	1010-2015-FRP-018	Contract	M	2015	11
MMWD Middle Peak Dspace	MRN	D space	1010-2015-FRP-019	MCFD	P	2016	1
MMWD North VMP	MRN	VMP Burn	1010-2015-VMP-004	MCFD	P	2015	481
MCP CITY SAN RAF Scettrini 1&2	THRT	Fuel Break	1010-2014-VMP-008	TAM Crew	O	2016	5
MCOSD Terra Linda/Sleepy Hollow Preserve	MRN	Defensible Space		MCP	A	2016	49
MCOSD King Mountain Phase 1	MRN	FB maintenance		MCFD	P	2015	10
MCOSD King Mountain Phase 2	MRN	Fuel Break		Tam Crew	C	2015	10
MCOSD Camino Alto Phase 1-4	MRN	Fuel Break		MVFD	M	2015	50
MCOSD Camino Alto Phase 5	MRN	Fuelbreak		MVFD	P	2018	20

Agency & Project Name	SRA, Threat, LRA	Project Type	CALMAPPER ID	Work Agent	Status	Year Complete	Net Acres
MCOSD Hillside Fuel Break	MRN	Fuelbreak		MVFD	C	2015	5
MCSOD Middle Summit Fire Road	MRN	FB Maint		MVFD	M	2015	4
MCOSD Crown/Coronet	MRN	FB maint		KNTFD	P	2016	4.5
MCOSD Terra Linda Ridge	MRN	fb/ecu removal		TAM & Contract	P	2015	40
MCOSD/KNTFD Baltimore Cyn/Ridgecrest	MRN	FB maint		KNTFD Contract	P	2015	31
MCOSD/MMWD/KNTFD- BWGulch/Indian FR	MRN	Fuel Break			P	2016	TBD
MCOSD Cascade Canyon Fuel Break	MRN	Fuel Break		Contract	P	2017	41
MCOSD/MCFD King Mountain Phase 2	MRN	Fuel Break	1010-2013-VMP-009	TAM Crew	C	2015	14
MCOSD/MVFD Mill Valley Fuel Break	MRN	Fuel Break	1010-2014-VMP-006		A	2016	61
MCOSD Gary Giacomini Preserve	MRN	Defensible Space	1010-2014-VMP-002		P	2017	10
MCOSD Blithedale Ridge FB Area 1,2,3	MRN	FB maintenance	-	MVFD	M	2015	15
MCOSD Corte Madera Ridge Fuel Break	MRN	FB maintenance	-	MVFD	M	2015	6
MVFD/MCOSD Corte Madera Ridge Fuel Break	MRN	Fuel Break			A	2017	32
NVFD/MCOFD Sleepy Hollow Community Defen	MRN	D space		TAM & Contract	P	2015	0
NPS Smith Road Euc Thin	MRN	Thinning	1010-2015-FRP-030		P	2015	11
NPS Marin Drive Euc Thin	MRN	Thinning	1010-2015-FRP-029		P	2015	32
NPS Tam Valley WUI Fuel Reduction	MRN	Fuel Reduction	1010-2015-FRP-027		P	2015	27
NPS Inverness Ridge Mechanical FR	MRN	Mech fuel red	1010-2015-FRP-020		P	2015-2018	81
NPS Bolinas Ridge Thinning	MRN	Fuel Break	1010-2015-FRP-024		P	2015-2018	81
NPS Forest Wy WUI Fuel Reduction	MRN	Fuel Reduction	1010-2015-FRP-028		P	2016	5
NPS Lamintour Rx	MRN	Prescribed Fire	1010-2015-FRP-026		P	2016	128
NPS Mc Curdy Rx	MRN	Prescribed Fire	1010-2015-FRP-021		P	2016	127
NPS Strain Hill Rx	MRN	Prescribed Fire	1010-2015-FRP-022		P	2015	74
NPS Dogtown Rx	MRN	Prescribed Fire	1010-2015-FRP-023		P	2015	44
MCFD Shroyer Mtn FB	MRN	Fuel Break	1010-2012-VMP-003		O	2016	TBD
MCFD Triple C Ranch	MRN	Fuel Break	1010-2012-VMP-007		O	2016	TBD
MCFD Iron Spring Road Fuel Break	MRN	Fuel Break	-		A	2018	22
MCFD Throckmorton Fire Road	MRN	Fuel Break	1010-2011-FPL-001	MCFD	M	2015	1
MCFD/VFD Rancho Santa Margarita	MRN	Fire Rd/Dspace			P	2015	0

Agency & Project Name	SRA, Threat, LRA	Project Type	CALMAPPER ID	Work Agent	Status	Year Complete	Net Acres
MCFD 4291 Inspections Inverness	MRN	D Space	1010-2015-PRV-001	MCFD	P	2015	1
MCFD Priority Fire Road Maintenance	MRN	Fire Rd Maint.	4200-2015-FRP-002	MCFD	P	2015	TBD
MCFD 4291 Inspections Woodacres/Lagunitas/F	MRN	D space	1010-2015-PRV-002	MCFD	P	2015	0
MCFD/Novato Burnt Ridge FB, Novato	MRN	Fuel Break	1010-2012-VMP-004	TAM Crew	O	2015-2020	75
MCFD Skywalker Ranch	MRN	D Space	1010-2012-VMP-006	TAM Crew	O		
MCFD Dickson Lookout	MRN	Pile Burn	1010-2015-FRP-033	MCFD	C	2015	0.1
MCFD Green Waste Days – Nicasio	MRN	Disposal	1010-2015-FRP-031	Compost	P	2015	0
MCFD Countwide CWPP	MRN	Plan	1010-2015-FRP-032	Marin	P	2015-2016	0
MCFD Tam Lookout Dspace	MRN	D space		MCFD	P	2016	TBD
KNTFD 4291 Inspections – Kent Woodland Estat	MRN	D Space		Fire Inspector	P	2015	0
<i>Status Guide:</i>		<i>Work Agent:</i>					
<i>A= active</i>		<i>Contract, Agency (Fire Dept, crew, engine)</i>					
<i>P=planning</i>							
<i>C=complete</i>							
<i>O=ongoing</i>							
<i>m= maintenance</i>							

Appendix C: Glossary

Authority Having Jurisdiction (AHJ) – The organization, office, or individual responsible for approving equipment, materials, an installation, or a procedure (NFPA, NFPA 1144, 2002, p. 4).

Aspect – Compass direction toward which a slope faces (NFPA, NFPA 1144, 2002, p. 4).

Building – Any structure used or intended for supporting or sheltering any use or occupancy (NFPA, NFPA 1144, 2002, p. 4).

Combustible – Any material that, in the form in which it is used and under the conditions anticipated, will ignite and burn or will add appreciable heat to an ambient fire (NFPA, NFPA 1144, 2002, p. 5).

Community Wildfire Protection Plan (CWPP) – Addresses issues such as wildfire response, hazard mitigation, community preparedness, or structure protection. The process of developing a CWPP can help communities clarify and refine their priorities for the protection of life, property, and critical infrastructure in the WUI (Source: Preparing a Community Wildfire Protection Plan, March, 2004, <http://www.stateforesters.org/files/cwpphandbook.pdf>).

Condition Class – Describes fire-related risk to ecosystems and relates current expected wildfires to their historic frequency and effects. Condition class ranks are defined as the relative risk of losing key components that define an ecosystem. Higher ranked areas present greater risk to ecosystem health. Condition class is a measure of the expected response of ecosystems to fire given current vegetation type and structure that often is far different from that historically present.

Class	Departure from natural regimes	Vegetation composition, structure, fuels	Fire behavior, severity, pattern	Disturbance agents, native species, hydrologic functions	Increased smoke production
Low Condition Class 1	None, minimal	Similar	Similar	Within natural range of variation	Low
Moderate Condition Class 2	Moderate	Moderately altered	Uncharacteristic	Outside historical range of variation	Moderate
High Condition Class 3	High	Significantly different	Highly uncharacteristic	Substantially outside historical range of variation	High

(Source: [CDF FRAP 2003 Forest and Range Assessment](#), p. 98)

Defensible Space – An area as defined by the AHJ (typically a width of 30 feet or more) between an improved property and a potential wildland fire where combustible materials and vegetation have been removed or modified to reduce the potential for fire on improved property spreading to wildland fuels or to provide a safe working area for fire fighters protecting life and improved property from wildland fire (NFPA, [NFPA 1144](#), 2002, p. 5), or as defined by PRC 4291.

Disaster – Disaster is characterized by the scope of an emergency. An emergency becomes a disaster when it exceeds the capability of the local resources to manage it. Disasters often result in great damage, loss, or destruction (Greene, R.W., [Confronting Catastrophe](#), ESRI Press, 2002, p. 110).

Dry Hydrant – An arrangement of pipe permanently connected to a water source other than a piped, pressurized water supply system that provides a ready means of water supply for fire-fighting purposes and that uses the drafting (suction) capability of fire department pumps (NFPA, [NFPA 1144](#), 2002, p. 5).

Dwelling – One or more living units, each providing complete and independent living facilities for one or more persons, including permanent provisions for living, sleeping, eating, cooking, and sanitation (NFPA, [NFPA 1144](#), 2002, p. 4).

Emergency – A deviation from planned or expected behavior or course of events that endangers or adversely affects people, property, or the environment (Greene, R.W., Confronting Catastrophe, ESRI Press, 2002, p. 110).

Evacuation/Escape Route – A route away from dangerous areas on a fire; should be preplanned.

Fire Behavior – The manner in which a fire reacts to the influences of fuel, weather, and topography.

Fire Frequency – A broad measure of the rate of fire occurrence in a particular area. For historical analyses, fire frequency is often expressed using the fire return interval calculation. For modern-era analyses, where data on timing and size of fires are recorded, fire frequency is often best expressed using fire rotation (CDF FRAP 2003 Forest and Range Assessment, p. A-12).

Fire Hazard – A fuel complex, defined by volume, type condition, arrangement, and location that determine the degree of ease of ignition and of resistance to control.

Fire Lane – A means of access or other passageway designated and identified to provide access for emergency apparatus where parking is not allowed (NFPA, NFPA 1141, 1998, p. 4).

Fire Protection – All measures taken to reduce the burden of fire on the quality of life. Fire protection includes measures such as fire prevention, fire suppression, built-in fire protection systems, and planning and building codes (NFPA, NFPA 1141, 1998, p. 4).

Fire Protection System – Any fire alarm device or system or fire extinguishing device or system, or combination, that is designed and installed for detecting, controlling, or extinguishing a fire or otherwise alerting occupants, or the fire department, or both, that a fire has occurred (NFPA, NFPA 1141, 1998, p. 4).

Fire Threat – The combination of two factors: 1) fire frequency, or the likelihood of a given area burning, and 2) potential fire behavior (hazard). Components include surface fuels, topography, fire history, and weather conditions.

Fire Regime – A measure of the general pattern of fire frequency and severity typical to a particular area or type of landscape: The regime can include other metrics of the fire, including seasonality and typical fire size, as well as a measure of the pattern of variability in characteristics (CDF FRAP 2003 Forest and Range Assessment, p. A-12).

Fire Road - improved or unimproved roads, public or private, that provide access for firefighting equipment and personnel to undeveloped areas (MCFD Ordinance, Chapter 5 Section 502.1).

Fire Rotation – An area-based average estimate of fire frequency, calculated as the length of time necessary for an area equal to the total area of interest to burn. Fire rotation is often applied to regionally stratified land groupings where individual fire-return interval across the variability of the

strata (i.e., the fine scale pattern of variation in timing of fires) is unknown, but detailed information on fire size is known. Hence, fire rotation is a common estimate of fire frequency during periods of recorded fire sizes (CDF FRAP 2003 Forest and Range Assessment, p. A-12).

Fire Weather – Weather conditions that influence fire starts, fire behavior or fire suppression (FIREWISE Communities, 2009).

Firebreak – A natural or constructed barrier used to stop or check fires that may occur, or to provide a control line from which to work (FIREWISE Communities, 2009).

Fuelbreak – An area, strategically located for fighting anticipated fires, where the native vegetation has been permanently modified or replaced so that fires burning into it can be more easily controlled. Fuel breaks divide fire-prone areas into smaller areas for easier fire control and to provide access for firefighting.

Fuels – All combustible material within the wildland/urban interface or intermix, including vegetation and structures.

Fuel Loading – The volume of fuel in a given area generally expressed in tons per acre.

Fuel Models – Description of the types of vegetative combustible material:

- Light Fuels – grasses, forbs
- Medium Fuels – short light brush and small trees
- Heavy Fuels – tall dense brush, timber and hardwoods
- Slash Fuels – logs, chunks, bark, branches, stumps, and broken understory trees and brush.

Fuel Modification – Any manipulation or removal of fuels to reduce the likelihood of ignition or the resistance to fire control (FIREWISE Communities, 2009).

Geographic Information Systems (GIS) – The combination of skilled persons, spatial and descriptive data, analytic methods, and computer software and hardware – all organized to automate, manage, and deliver information through geographic presentation (i.e., maps) (Zeiler, M., Modeling Our World, ESRI Press, 1999, p. 46).

Ground Fuels – All combustible materials such as grass, duff, loose surface litter, tree or shrub roots, rotting wood, leaves, peat or sawdust that typically support combustion.

Hazard – Refers generally to physical characteristics that may cause an emergency. Earthquake faults, flood zones, and highly flammable brush fields are all examples of hazards (Greene, R.W., Confronting Catastrophe, ESRI Press, 2002, p. 110). Also see **Fire Hazard**.

Healthy Forests Restoration Act (HFRA), 2003 – This Act gives incentives for communities to engage in comprehensive forest planning and prioritization. This legislation includes statutory

incentives for the US Forest Service (USFS) and the Bureau of Land Management (BLM) to give consideration to the priorities of local communities as they develop and implement forest management and hazardous fuel reduction priorities. The Act emphasizes the need for federal agencies to work collaboratively with communities in developing hazardous fuel reduction projects, and places priority on treatment areas identified by communities themselves in a CWPP (Source: Preparing a Community Wildfire Protection Plan. March, 2004).

Improved Property – A piece of land or real estate upon which a structure has been placed, a marketable crop is growing (including timber), or other property improvement has been made (NFPA, NFPA 1144, 2002, p. 5).

Intermix – An area where improved property and wildland fuels meet with no clearly defined boundary (NFPA, NFPA 1144, 2002, p. 5).

Ladder Fuels – Fuels that provide vertical continuity allowing fire to carry from surface fuels in the crowns of trees or shrubs with relative ease (FIREWISE Communities, 2009).

Mitigation – Action that moderates the severity of a fire or risk (NFPA, NFPA 1144, 2002, p. 5).

National Fire Protection Association (NFPA) – An international nonprofit organization, established in 1896, to reduce the worldwide burden of fire and other hazards on the quality of life by providing and advocating consensus codes and standards, research, training, and education.

NFPA-1144 Standard for Protection of life and Property from Wildfire – Standard developed by the NFPA to be used to provide minimum planning, construction, maintenance, education, and management elements for the protection of life, property, and other values that could be threatened by wildland fire. The standard shall be used to provide minimum requirements to parties responsible for fire protection, land use planning, property development, property maintenance, and others responsible for or interested in improving fire and life safety in areas where wildland fire could threaten lives, property, and other values (NFPA, NFPA 1144, 2002, p. 4).

Noncombustible – Any material that, in the form in which it is used and under the conditions anticipated will not ignite and burn nor will add appreciable heat to an ambient fire (NFPA, NFPA 1144, 2002, p. 5).

Overstory – That portion of the trees in a forest that forms the upper or uppermost layer.

Risk – The potential or likelihood of an emergency to occur. For example, the risk of damage to a structure from wildfire is high if it is built upon, or adjacent to, a highly flammable brush field or other area deemed to have a high **Fire Threat** (Greene, R.W., Confronting Catastrophe, ESRI Press, 2002, p. 110).

Safe Zone – An area cleared of flammable materials used for escape in the event the line is outflanked or in case a spot fire causes fuels outside the control line to render the line unsafe. In firing operations, crews progress so as to maintain a safety zone close at hand allowing the fuels inside the control line to be consumed before going ahead. Safety zones may also be constructed as integral parts of fuelbreaks; they are greatly enlarged areas which can be used with relative safety by firefighters and their equipment in the event of blowup in the vicinity.

Slope – The variation of terrain from the horizontal; the number of feet rise or fall per 100 feet measured horizontally, expressed as a percentage. Upward or downward incline or slant (NFPA, [NFPA 1144](#), 2002, p. 5).

Turnaround – A portion of a roadway, unobstructed by parking, that allows for a safe reversal of direction for emergency equipment (NFPA, [NFPA 1144](#), 2002, p. 5).

Turnouts – A widening in a travelway of sufficient length and width to allow vehicles to pass one another (NFPA, [NFPA 1144](#), 2002, p. 5).

Understory – Low-growing vegetation (herbaceous, brush or reproduction) growing under a stand of trees. Also, that portion of trees in a forest stand below the **Overstory**.

Water Supply – A source of water for fire-fighting activities (NFPA, [NFPA 1144](#), 2002, p. 5).

Wildfire – Any fire occurring on undeveloped land; the term specifies a fire occurring on a wildland area that does not meet management objectives and thus requires a suppression response. Wildland fire protection agencies use this term generally to indicate a vegetation fire. Wildfire often replaces such terms as forest fire, brush fire, range fire, and grass fire ([CDF FRAP 2003 Forest and Range Assessment](#), p. A-17).

Wildland – A region with minimal development as evidenced by few structures; transportation networks may traverse the region. Region typically contains natural vegetation and may be used for recreational or agricultural purposes ([CDF FRAP 2003 Forest and Range Assessment](#), p. A-17).

Wildland-Urban Interface (WUI) – Commonly described as the zone where structures and other human development meet and intermingle with undeveloped wildland or vegetative fuels. In the absence of a CWPP, Section 101 (16) of the HFRA defines WUI as " (I) an area extending ½ mile from the boundary of an at-risk community; (II) an area within 1 ½ miles of the boundary of an at-risk community, including any land that (1) has a sustained steep slope that creates the potential for wildfire behavior endangering the at-risk community; (2) has a geographic feature that aids in creating an effective fire break, such as a road or ridge top; or (3) is in condition class 3, as documented by the Secretary in the project-specific environmental analysis; (III) an area that is adjacent to an evacuation route for an at-risk community that the Secretary determines, in cooperation with the at-risk community, requires hazardous fuels reduction to provide safer evacuation from the at-risk community." A CWPP offers the opportunity to establish a localized definition and boundary for the wildland-urban interface (Source: [Preparing a Community Wildfire Protection Plan](#), March, 2004).

Appendix D: CWPP Action Plan

This appendix provides an action plan tracking table for the CWPP goals and recommendations outlined in Section 8.

Key Goals and Corresponding Action Items	Agency	Status
<p>Goal 1. Continue to identify and evaluate wildland fire hazards and recognize life, property, and natural resource assets at risk, including watershed, wildlife habitat, and other values of functioning ecosystems.</p>		
Continue to collect, analyze, and maintain multi-agency hazard and resource GIS data.		
Maintain an accessible online GIS portal to store and share the multi-agency maps and data developed throughout this CWPP process.		
Utilize the GIS information and modeling results presented in Section 5 of this CWPP for pre-fire planning, and to collaboratively develop priorities for projects throughout the county.		
Develop an inventory of structures with shake and shingle roofing material in each jurisdiction to identify and target education efforts and the need for roof conversions.		
Consider ways to improve the coverage of the fire detection cameras.		
Consider ways to use drone technology for fire protection.		
<p>Goal 2. Articulate and promote the concept of land use planning related to fire risk and individual landowner objectives and responsibilities.</p>		
Continue to promote the concept of land use planning as it relates to fire risk and landowner responsibilities; identify the key minimum elements necessary to achieve a fire safe community and incorporate these elements into community outreach materials and programs.		
Continue to implement the structural ignitability activities outlined in Section 7.2.		
Develop outreach materials outlined in Section 7.1.1.		

Key Goals and Corresponding Action Items	Agency	Status
Coordinate with county and local government staff to integrate Firewise approaches into planning documents and ordinances.		
Identify approaches to increase the number of WUI properties inspected each year.		
Continue to support community chipper programs to encourage compliance with defensible space and vegetation management requirements.		
Continue the structure ignitability efforts currently in place (see Section 7.2).		
Consider how to make the tree removal process less cumbersome and less expensive.		
Goal 3. Support and continue to participate in the collaborative development and implementation of wildland fire protection plans and other local, county, and regional plans that address fire protection and landowner objectives.		
Work collaboratively with county, local, and regional agencies and landowners to develop fuel reduction priorities and strategies based on this CWPP, local CWPPs, and/or other regional plans.		
Support the development and implementation of local-scale CWPPs.		
Provide a collaboration mechanism between private property owners (and Home Owners Associations) and large land owners (i.e., MCOSD, MMWD, NPS)		
Consider the creation of transition zones (areas between developed residential areas and open space areas) where additional defensible space or additional vegetation clearance is needed.		

Key Goals and Corresponding Action Items	Agency	Status
<p>Goal 4. Increase awareness, knowledge, and actions implemented by individuals and communities to reduce human loss and property damage from wildland fires, such as defensible space and fuels reduction activities, and fire prevention through fire safe building standards.</p>		
<p>Continue to implement the defensible space and outreach activities outlined in Section 7.2.</p>		
<p>Develop outreach materials outlined in Section 7.1.1.</p>		
<p>Continue inter-agency coordination with Marin’s fire service community and other partners to maintain a community presence and to develop and distribute public information regarding fuel reduction efforts throughout the county.</p>		
<p>Educate landowners, residents, and business owners about the risks and personal responsibilities of living in the wildlands, including applicable regulations and prevention measures and preplanning activities.</p>		
<p>Continue efforts to partner with neighborhoods located in WUI areas to educate them on becoming fire adapted or Firewise communities.</p>		
<p>Continue to educate and prepare communities through an emphasis on the Ready, Set, Go! and the Firewise community programs, and create and support venues in which individual community members can be actively involved in local fire safe councils, community emergency response teams, and other community-based efforts in order to develop readiness plans and educate landowners to mitigate the risks and effects of wildland fire.</p>		

Key Goals and Corresponding Action Items	Agency	Status
Continue to increase education and awareness about structural ignitability and defensible space; develop and distribute educational materials to vendors and contractors who sell or install fire resistant materials, and make these materials available at local home improvement stores.		
Increase the number of annual defensible space inspections and increase enforcement.		
Consider providing defensible space financial assistance for senior citizens.		
Better enforce defensible space compliance with absentee property owners.		
Develop and distribute more information about fire resistant landscaping.		
Create a fire blog.		
Develop an App for evacuation route information.		
Goal 5. Integrate fire and fuels management practices with landowner priorities and multiple jurisdictional efforts within local, state, and federal responsibility areas.		
Continue to implement the vegetation management and fuel reduction activities outlined in Section 7.2.		
Continue implementation of the countywide fuel break and fire plan implementation.		

Key Goals and Corresponding Action Items	Agency	Status
Continue to implement and maintain vegetation management projects along highly-traveled roadways and access points into all public lands in order to minimize ignitions.		
Prioritize evacuation routes for fuel reduction programs		
Develop traffic congestion controls along evacuation routes		
Implement stronger parking enforcement along evacuation routes		
Continue to maintain foot trail network in Mill Valley		
Implement maintenance program for foot trail network in Fairfax		
Encourage community-level drills for evacuation preparedness		
Develop a program to address fuel reduction on vacant properties.		
Consider grazing as a fuel reduction strategy.		
Consider if additional vegetation reduction are required from roadways that are key evacuation routes into or out of a particular neighborhood		
Create extended or enhanced vegetation fuels management along all identified evacuation routes from developed residential and open space areas.		
Create transition zones to extend shaded fuel breaks between developed residential areas and open space areas.		
Identify and implement vegetation management projects in priority WUI communities throughout the county.		

Key Goals and Corresponding Action Items	Agency	Status
Work to reduce regulatory barriers that limit hazardous fuels reduction activities (e.g., tree removal process).		
Use the published science on fire ecology to assess the costs, benefits, and best implementation tools for different fuels reduction and vegetation management strategies that are intended to reduce fire risk to lives and property.		
Continue to develop strategic partnerships and funding opportunities with local industries to support fuel reduction projects.		

MARIN COUNTY FIRE DEPARTMENT

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in collaboration with

