WHITE PAPER

Bay Area Wildland Urban Interface
Review of Risks, Plans, and Strategies

Association of Bay Area Governments & Metropolitan Transportation Commission, 2018

Disclaimer

This report does not include assessment nor recommendations regarding response activities related to wildfires. The report touches on notification, evacuation, and shelters, but recommendations on these topics are out of the scope of this work. For more information on these topics we recommend connecting with the Bay Area Urban Areas Security Initiative (UASI), who builds regional capabilities in these areas. The work is supported by two working groups:

1) *Emergency Management Work Group [sheltering resources] http://www.bayareauasi.org/programs/community-resiliency-recovery*
2) *Public Information and Warning Work Group [notification resources] http://www.bayareauasi.org/programs/public-information*

For information on the 2017 North Bay Fires please refer to the County and State after action efforts.

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Preface

The Bay Area is a hazard-rich region. Flooding, earthquakes, landslides, drought, and wildfire all contribute to the region's risk. In 2017 the Association of Bay Area Government's Resilience Program published Risk Landscape, a document that characterized the range of hazards facing the Bay Area. To date the Program had focused many resources on earthquake risks, and partnered with the Bay Conservation Development Commission to study current and future flooding risks. Staff recognized a need to study the region's wildfire risk in greater detail, and in the spring of 2017 began research to document the San Francisco Bay Area's wildfire risks.

On October 8, 2017 the Bay Area experienced the most deadly wildfires in state history, and lost 10,000 homes. The risks being explored in the white paper were realized, and the region's wildfire risk was front and center.

The scope of this White Paper does not focus on the 2017 fires directly, but instead explores the strategies communities currently use to mitigate wildfire risk. The report is a resource for the Metropolitan Transportation Commission, Association of Bay Area Governments and its member jurisdictions to better understand wildland fire risk in the region. The white paper characterizes wildfire hazard in the region, assesses existing wildfire hazard maps, and includes a literature review of Bay Area fire planning documents. A suite of appendices provide links to resources to support communities engaged in wildfire mitigation efforts in their communities. In addition to the paper, a searchable database of wildfire mitigation strategies is also available showcasing the 350+ strategies discussed in the 15 reviewed Bay Area fire planning documents.

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A. The Document Layout

I: Characterization of Fire Risk – A range of mapping and assessment tools enable the characterization and modeling of wildfire risk. Each year new tools with improved accuracy and coverage are being developed to provide planners and decision makers with more information to understand the severity and extent of fire risk. The section describes the hazard mapping resources, general fire impacts, and concludes with a mapping analysis of the intersection of Bay Area wildfire hazard and Bay Area land use and vulnerable populations.

II: Wildland Urban Interface (WUI) Plans and Strategies – In California, the state, local jurisdictions and community groups produce a range of wildfire planning documents. The chapter introduces the plan landscape, the coverage of the plans in the region, and their legislative links. Agency staff reviewed fifteen plans in the region, and aggregated a full list of strategies from each plan. The section summarizes and analyzes the range of wildfire strategies described in the plans, and common funding mechanisms.

III: Summary & Next Steps – The section outlines areas for the regional agencies and local jurisdictions to pursue to reduce wildfire risk with local partners. The next steps are built on areas of convergence between the fifteen studied plans.

I. Characterization of WUI Fire Risk

Risk is often characterized as the intersection of hazards and assets. This section characterizes the Bay Area wildland urban interface (WUI) fire hazard and general asset classes. The section ends with an assessment of hazard maps success in forecasting past wildfire perimeters, and a high-level exposure assessment of land uses and vulnerable populations in the region.

A. Bay Area WUI Fire Hazard

To narrow the paper scope, staff focused research on wildland urban interface fires. Other fire types, including: structural fires, infrastructure explosions, wildland fires, and fire following earthquake all are probable risks for the region, but are not included in this document. ABAG has chosen to focus on WUI wildfire risk because of the potential for regional or sub-regional impacts. However, for some communities other fire hazards like structural fires may be a greater risk. Therefore, as part of this research, staff compiled resources that touched on non-WUI fire impacts. Information on structural fires and fire following earthquake are described in *Appendix H. Other Fire Types and Impacts*.

Fires in the urban environment and in the wildland-urban interface result in direct damage to the built environment and can injure or kill residents. Wildland fires can cause significant impacts to critical structures such as housing; damage linear infrastructure systems that serve the Bay Area, causing subsequent outages; impact air quality in the entire region during the duration of the fire; and impact water quality in watersheds affected by a wildland fire. Wildland and wildland-urban interface fires can also damage natural and open space environments and cause lasting impacts to slopes and soils.

This document focuses research within the nine-county Bay Area. Fires elsewhere in the state can impact Bay Area air quality, and can damage infrastructure and natural systems that the Bay Area is dependent upon. While this research explores the fire risks within the nine-county region, Bay Area communities and agencies should recognize that their risks extend beyond the region. *Appendix H. Other Fire Types and Impacts* describes impacts within the San Francisco Bay Area from the 2013 Rim Fire, which was located several hundred miles away from the Bay Area.

A vivid example of wildland urban interface fire is the 1991 Tunnel Fire in the Oakland and Berkeley Hills. The firestorm occurred within a larger high fire hazard zone that is part of an approximately 60 mile stretch of hills running from the Carquinez Strait to San Jose in the eastern San Francisco Bay Area. The fire happened in an economically well-off, largely built-out residential area that has a long standing fire history linked to hot, dry fall winds and the presence of dense, flammable vegetation. WUI fires continue to be a risk for many Bay Area communities. The October 8, 2017 North Bay fires have many characteristics that closely resembled the Tunnel Fire conditions, and occurred just ten days earlier in the fire season than the October 19, 1991 fire.

There are a number of resources available to help communities characterize their fire risk. The next sections highlight the different entities responsible for fire services, perimeters of past fires, data on climate change's influence on Bay Area fire, a variety of methods for mapping fire hazard, and information on wildfire smoke.

Fire Management Responsibility Areas

In the Bay Area fire management is shared by local, state, or federal entities. For each location in the region, a single agency has direct responsibility. In local areas (incorporated areas), local fire departments or fire protection special districts are responsible. In state areas (unincorporated areas), CAL FIRE is responsible. In Federal areas, the Department of the Interior is responsible. Localities and the State cover most of the region with the exception of West Marin County, and portions of Northern Napa which have large Federal lands. Figure 1 maps Bay Area fire responsibilities.

Many jurisdictions have partnerships and contracts with CAL FIRE for fire services both for managing wildland areas and for fire suppression. During a large wildfire, assets from local, state, and federal resources are tapped regardless of where a fire is burning.

Historic Bay Area Fire Occurrences

Wildfires are common events in the Bay Area. Prior to the 2017 fires in the North Bay, the 1991 fire in the Oakland-Berkeley Hills was the largest urban-wildland fire in the Bay Area, and resulted in $1.7 billion in losses. In that fire, 3,354 single-family dwellings and 456 apartments were destroyed, while 25 people were killed and 150 people were injured. Figure 2 maps the perimeter of fires since 1955. Marin County also includes approximate fire perimeters dating back 100 years. This map includes fires up to December 31, 2016. Figure 3 includes preliminary perimeters from the large 2017 North Bay wildfires. *Appendix B. 2017 North Bay Wildfires – An Early Perspective* includes further discussion on the 2017 fires.

Where fires have occurred in the past can be a determinant of where fires are likely to occur in the future. These maps also provide an opportunity for communities to use a past fire as a scenario to characterize their risk. Sonoma County's 2016 Community Wildfire Protection Plan highlights the impacts of a repeat of a 1964 fire, a fire that shared the name of the 2017 fire. Using scenarios is a helpful tool to articulate risks to decision makers. The Sonoma County example is described further in *Appendix B. 2017 North Bay Wildfires – An Early Perspective*.

Probability of Future Fire – Climate Influenced

Increases in wildfire risk as a result of climate change are primarily due to higher temperatures and longer dry periods over lengthier fire seasons. Potential changes in vegetation, wind patterns, or wind severity could also increase risks. Research out of UC Merced has projected the future fire risk impacted by climate change compared to existing fire risk. In the Bay Area the results are mixed. The research projects a decreased fire risk in some East Bay and South Bay locations (due to the already dry and small vegetation conditions), and a 50% increase in fire risk in portions of the Peninsula and North Bay (due to the more dense levels of vegetation that will be dryer than in the past) by 2085. Generally, across the Bay Area there is fairly limited change in fire risk in the year 2050, with the greatest change occurring between 2050 and 2085, especially in the high emission climate change scenario. The data, pulled from Cal Adapt – a state tool to support Climate Adaptation work – suggests that some jurisdictions might have to adapt more aggressively compared to others. Figure 4 shows the projected fire risk increase for the Bay Area with the greatest increase and decrease areas highlighted. Jurisdictions can use the State's Cal Adapt tool (cal-adapt.org) to explore the best available state level data on climate influence on fire risk.

The future fire risk model analyzes two primary variables: fuel availability and flammability of fuel. In California the change in fire risk is a result of either a densely forested ecosystem becoming drier, or a

dry climate experiencing large vegetation growth after a year of above average precipitation. In the first scenario the suite of climate impacts (higher temperatures, less snow pack, earlier springs) result in previously wet dense fuel ecosystems becoming dry – increasing the fire risk dramatically. In the second ecosystem, dominated by grass and low density shrubs, the risk is often unchanged or decreased because the availability of fuel is the governing variable for fire risk, and the fuel remains unchanged or decreases as a result of projected precipitation (Westerling, 2008). These modeling characteristics are reflected in the Bay Area's future fire risk map, and are why eastern Alameda County with already dry grasses remains unchanged, but western Sonoma County with wetter, dense vegetation will become dryer and more prone to wildfire.

The Bay Area, compared with other portions of California, especially those near the Oregon border and the headwater forests of the Sierra Nevada Mountains, have a much lower projected increase in fire risk due to climate change. Near the Oregon border, many areas are expecting a 500 percent increase in fire risk by 2085, with some areas projected to see their fire risk increase more than 10 times over the remainder of the century.

Existing Fire Hazard Maps for the Bay Area

The State produces a range of wildfire mapping products to support their wildfire management efforts, local efforts, and to meet regulatory requirements. A full set of resources are available through CAL FIRE's Fire and Resource Assessment Program (FRAP) (frap.fire.ca.gov). In addition to these state initiatives, some local governments, or local divisions of CAL FIRE have produced their own fire hazard maps. As part of the 2016 update, the Marin County Community Wildfire Protection Plan used granular mapping to characterize fire risk in the county. At the writing of this paper, Marin County is the Bay Area jurisdiction that has done the most to characterize and map wildfire hazard at the local level. As will be discussed in Section II of the white paper, many jurisdictions have an interest in updates of state fire hazard maps, granular maps of local areas, or granular mapping of high risk areas.

Fire Hazard Severity Zones (FHSZ)

CAL FIRE has developed maps depicting wildfire hazard areas. Figure 5 is a map of fire hazard severity in State Responsibility Areas. Fire hazard severity takes into account vegetation amount, topography, and weather (temperature, humidity, and wind), and represents the likelihood of an area burning over a 30-50 year time period. In Figure 5, shadowed portions of the map depict very high fire hazard severity in Local Responsibility Areas. CAL FIRE only maps very high fire hazard severity in their final local responsibility areas. Local fire departments and protection districts may have other locally available hazard severity information for these areas, but often do not.

In addition to characterizing risk, FHSZ maps are also a regulatory tool. In all state areas, and in local areas within a very high zone, property owners are subject to mandatory code requirements for their structures and adjoining vegetation. The building code requirements, like most code requirements, are not retroactive and are only mandatory for new construction and large renovations. When CAL FIRE produces a Very High Hazard Severity map for a local jurisdiction, the local agency has an opportunity to comment on the map before adoption. In Section II the fire code is discussed in greater detail, with *Appendix I. Fire Code Details* providing an even greater description.

Additional legislation has been tied to the FHSZ designations. If local communities have a Very High designation, they are subject to Senate Bill 1241 (discussed in Section II). In addition to these hooks, the zones were previously used to designate additional parcel fees. Until the 2017 legislative update of Cap

and Trade, property owners paid a special parcel fee to help pay for state fire expenses. As part of the 2017 Cap and Trade legislation, this fee was waived.

Fire Threat

CAL FIRE also has produced a threat map which produces a fire threat rating for all geographies regardless of responsibility. Fire Threat is a combination of two factors: 1) fire frequency, or the likelihood of a given area burning, and 2) potential fire behavior (hazard). Potential fire behavior is a function of the vegetation (fuel) and slope conditions that would support high or very high fire behavior when burned under typical severe weather conditions. Fires that burn in these areas under hot, dry, and windy conditions are difficult to control even by the world's most comprehensive wildland fire protection system. These two factors are combined to create 5 threat classes: Extreme, Very High, High, Moderate, or Not Mapped (Cal Fire, 2003). The Extreme category is concentrated in Southern California, with the only Bay Area occurrence in Marin County with under 2,000 total acres in the category. Figure 6 maps the fire threat layer in the Bay Area counties.

Fire threat can be used to estimate the potential for impacts on various assets and values susceptible to fire. Impacts are more likely to occur and/or be of increased severity for the higher threat classes. The data set was published in 2004 as part of the 2003 California Forest and Range Assessment.

Section 1.C. Bay Area Fire Risk analyzes how well Fire Hazard Severity and Fire Threat have intersected with the region's fire history. The main difference in the layers is not that one is better or worse than the other, but rather that Fire Threat maps fire risk across the entire Bay Area, while Fire Hazard Severity leaves many portions of local/urbanized areas unmapped.

Wildland Urban Interface

CAL Fire also produced WUI maps that highlight areas with burnable vegetation and residential density greater than one unit per 20 acres. These zones represent areas of potential fire and high exposure of people and property. Figure 7 is a map of CAL FIRE-designated WUI zones. Some local fire departments and districts have chosen to identify their own WUI zones based on their local knowledge of the landscape. Santa Rosa is one city example with a self-defined WUI Area. The state level WUI maps are made using state level data and alone, without local vetting, can be a less than polished product. Areas like Foster City captured by the map may be areas that would not be classified as WUI when exploring the model output locally.

Wildfire Ignition Sources

In many of the Bay Area plans there is data on the cause of fire ignitions. After the high number of undetermined ignition sources, power lines, vehicles, campfires, debris burning, and equipment were the highest sources of wildfire ignitions in the region. Across many plans there was recognition that non-natural fire ignitions were the majority of wildfire ignitions. Figure 8 shows the frequency of each ignition type for wildfire plans that included data. In Marin County, data was available for multiple years, while all other plans only reported ignition history for a single year. In addition to the plans included in Figure 8, the Alameda County and Contra Costa County plans provided a narrative of ignition sources, citing that human related ignitions (arson, camp/picnic activities, powerlines, fireworks, fuel reduction activities, smoking, playing with fire, and vehicles) were the most common, with only 1% of fires caused by lightning.

Many of the plans included that the ignition source is important as it relates to fire weather conditions, primarily when there are high winds. When concerned about ignition and severe fire spread conditions, electric line ignitions are especially problematic because they typically occur during periods of high wind activity (Santa Clara County [Community Wildfire Protection Plan, 2016]). The co-occurrence of high winds causing downed power lines with arcing and rapid rates of spread from the ignition site can cause electric fires to have faster spread than other ignition types that are less correlated to wind.

Smoke & Air Quality Mapping

Wildfires are primarily responsible for the worst air quality days in the San Francisco Bay Area. The particulate matter observed in the recent North Bay Fires were at times a full order of magnitude greater than a typical poor day. Figure 9 shows the ten worst air quality days in the region since 2003, six of which were due to wildfire smoke.

Smoke from wildland urban interface fires is complex. In fully wildland fires the smoke is more predictable, and is mostly caused by the burning of organic material. Smoke from these fires is unhealthy by itself. When structures, equipment, and other inorganic components become a source of the smoke, it can be toxic. To help understand the complexities of smoke, the Bay Area Air Quality Management District (BAAQMD) monitors the air and shares information with stakeholders. In addition to what is in the smoke, the Air District forecasts smoke plume directions to inform sub-regions that will have worsened air quality. For local, in-region wildfires, the forecast can be trickier because the plumes are narrow and impact a smaller band of the region. For out-of-region wildfires it is easier to predict impacts because the plumes are broad and will impact large portions of the region similarly.

After the fires are out, air quality impacts remain at a hyper local level. Localized air quality can be diminished adjacent to burn areas with large quantities of ash. Special precautions should be taken to protect those cleaning debris, rebuilding, and living/working adjacent to the burn areas.

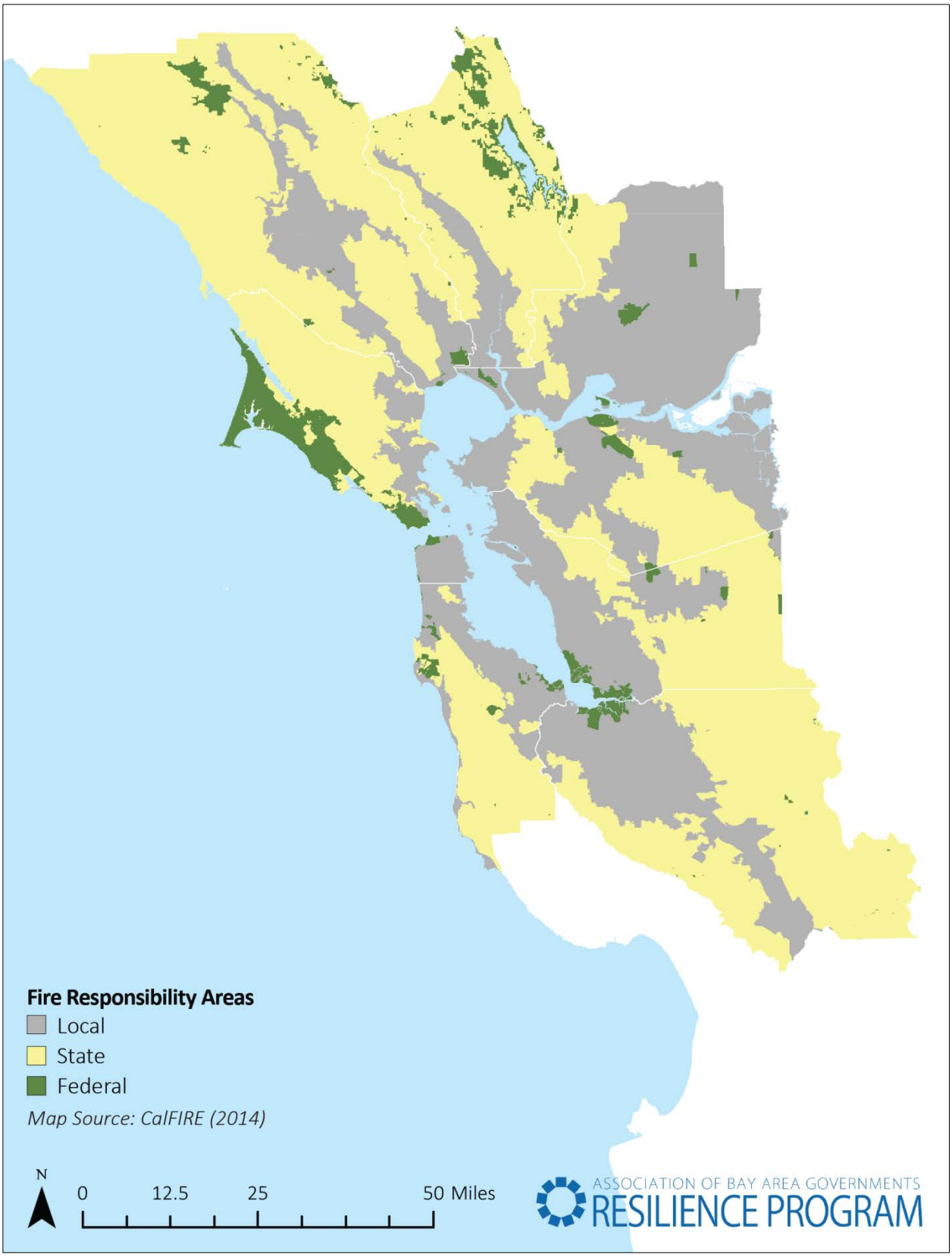

Figure 1 Fire Management Responsibilities in the San Francisco Bay Area

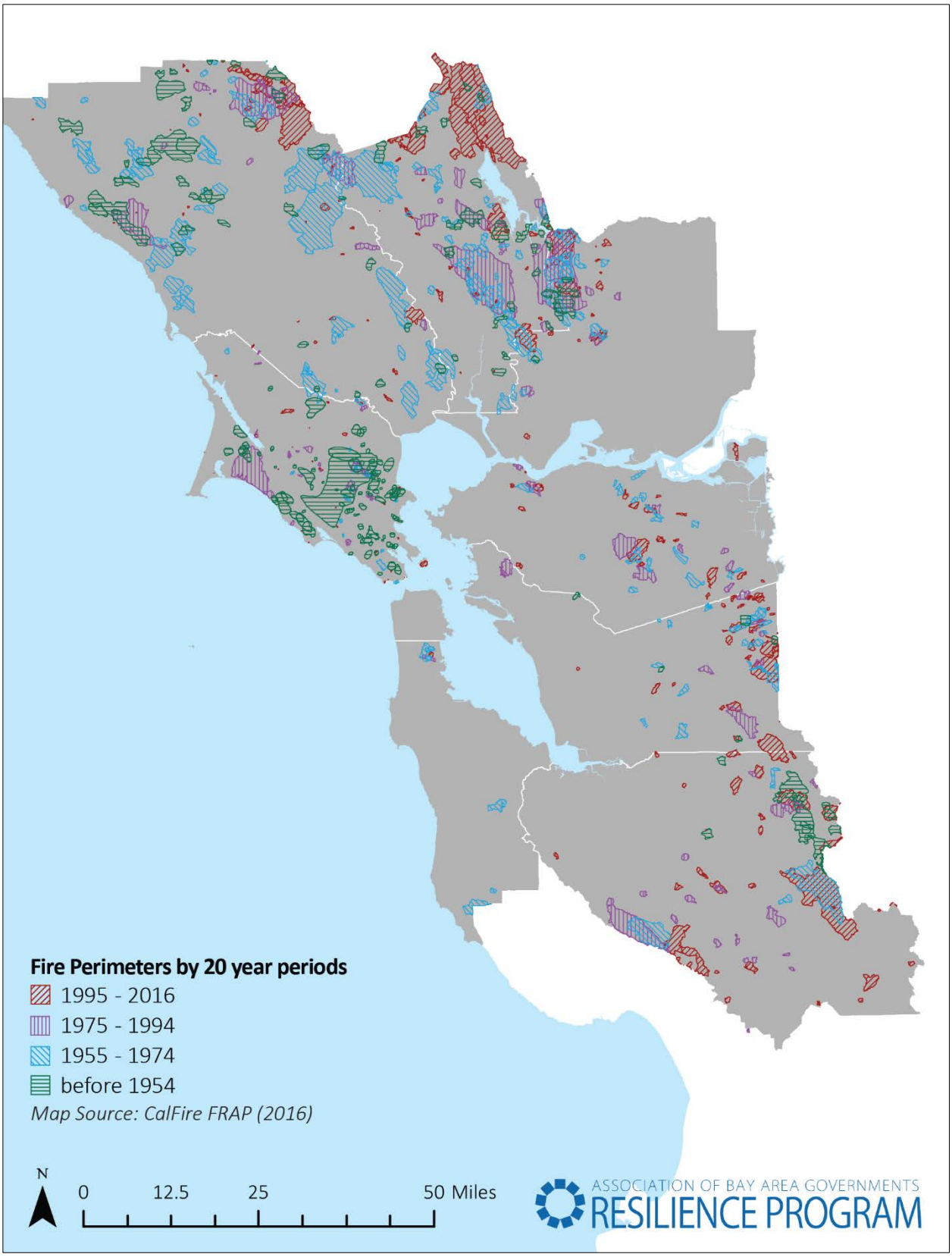

Figure 2 Historic Bay Area Fire Perimeters 1955 – 2016

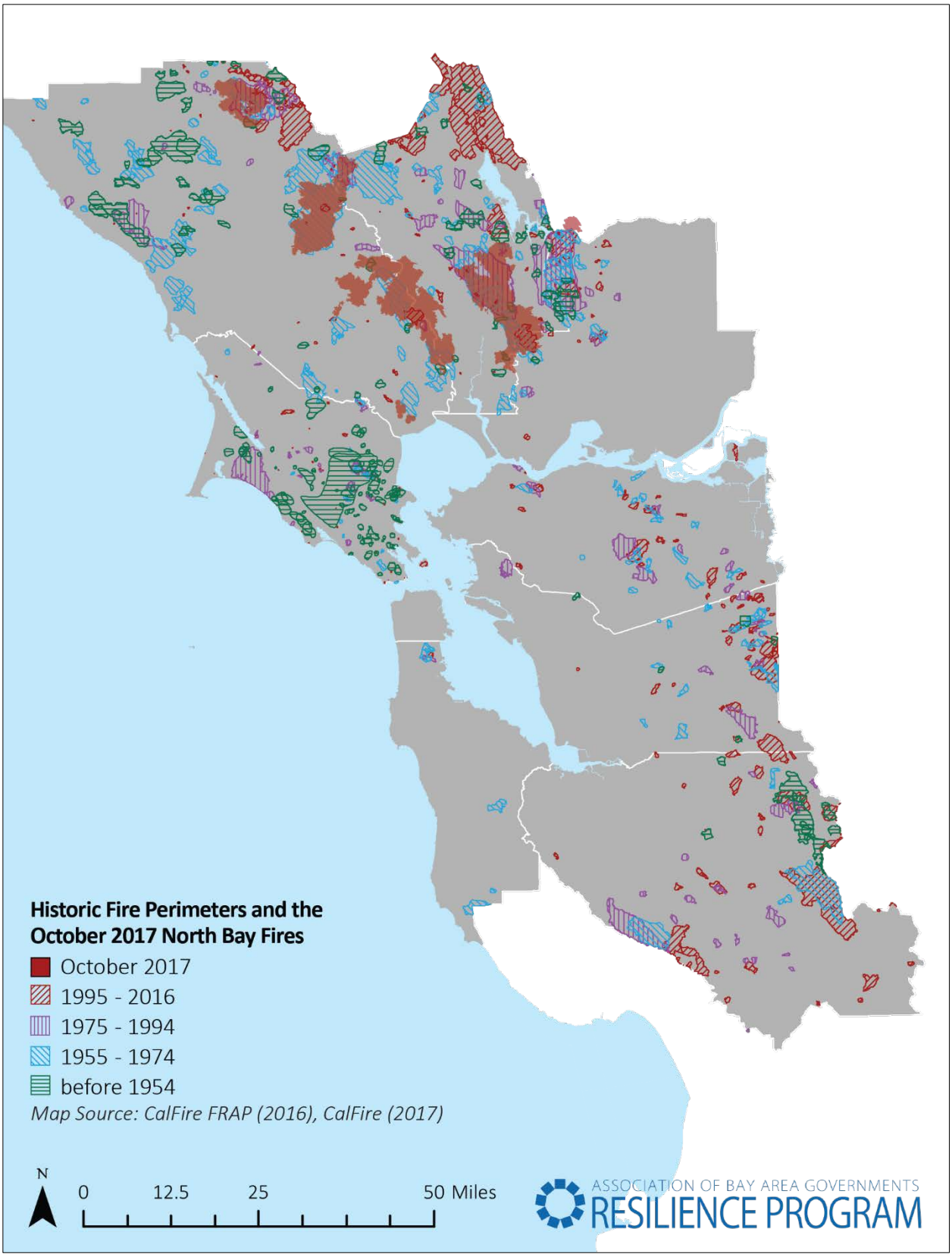

Figure 3 Historic Bay Area Fire Perimeters 1955 – 2016 and Unofficial 2017 North Bay Fire Perimeters

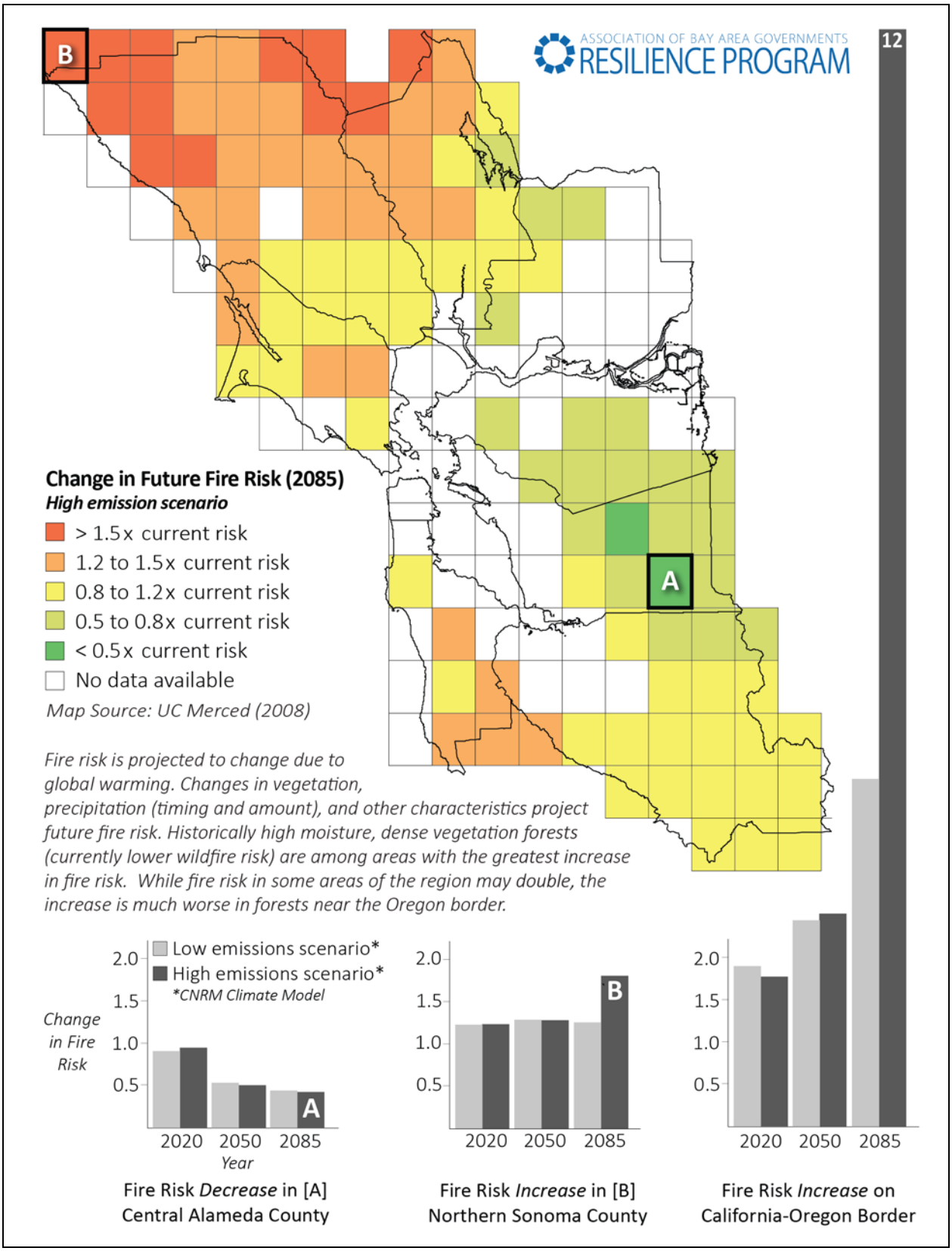

Figure 4 Climate Change Influence of Future Fire Risk

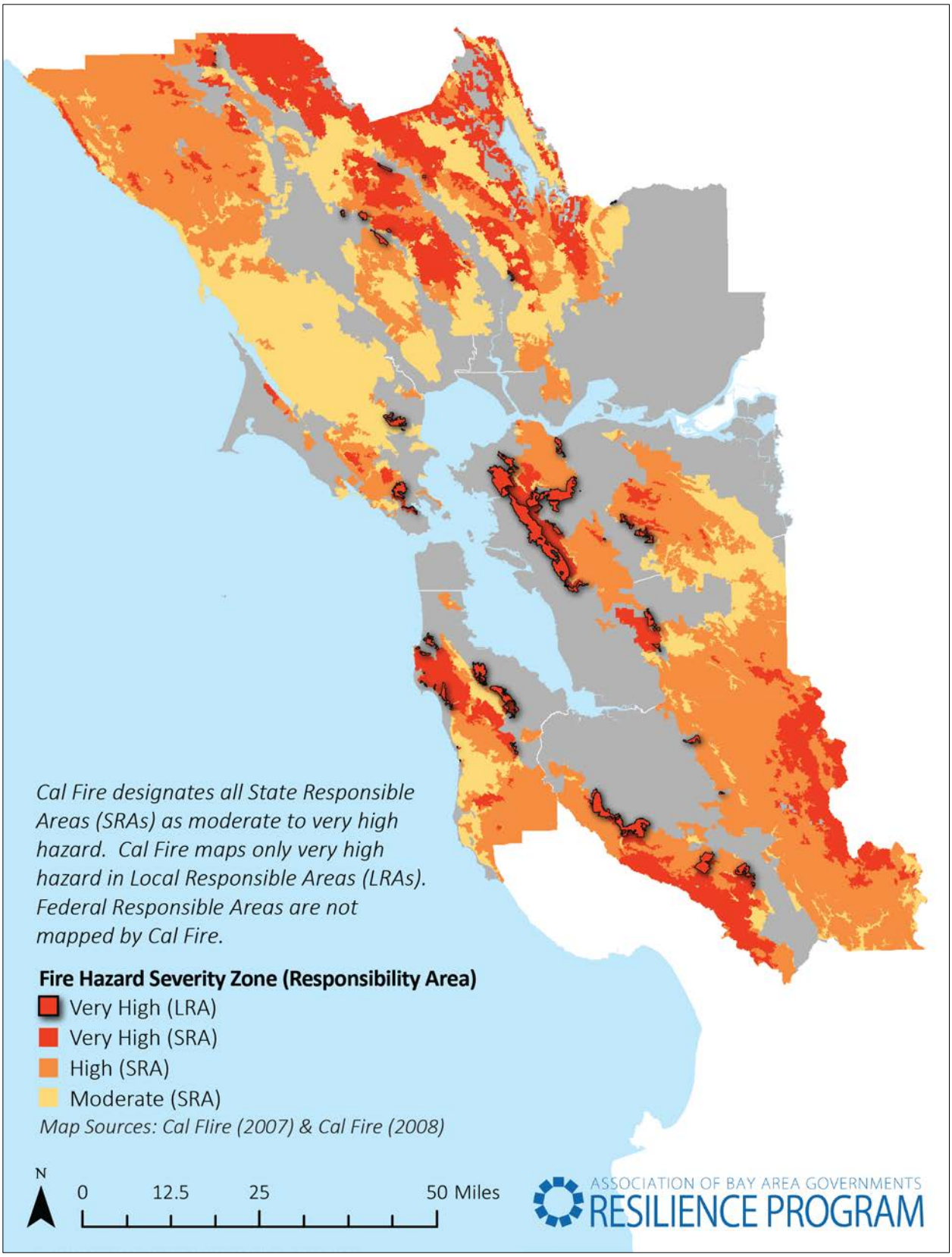

Figure 5 Fire Hazard Severity Zones with Local Responsibility Areas Outlined

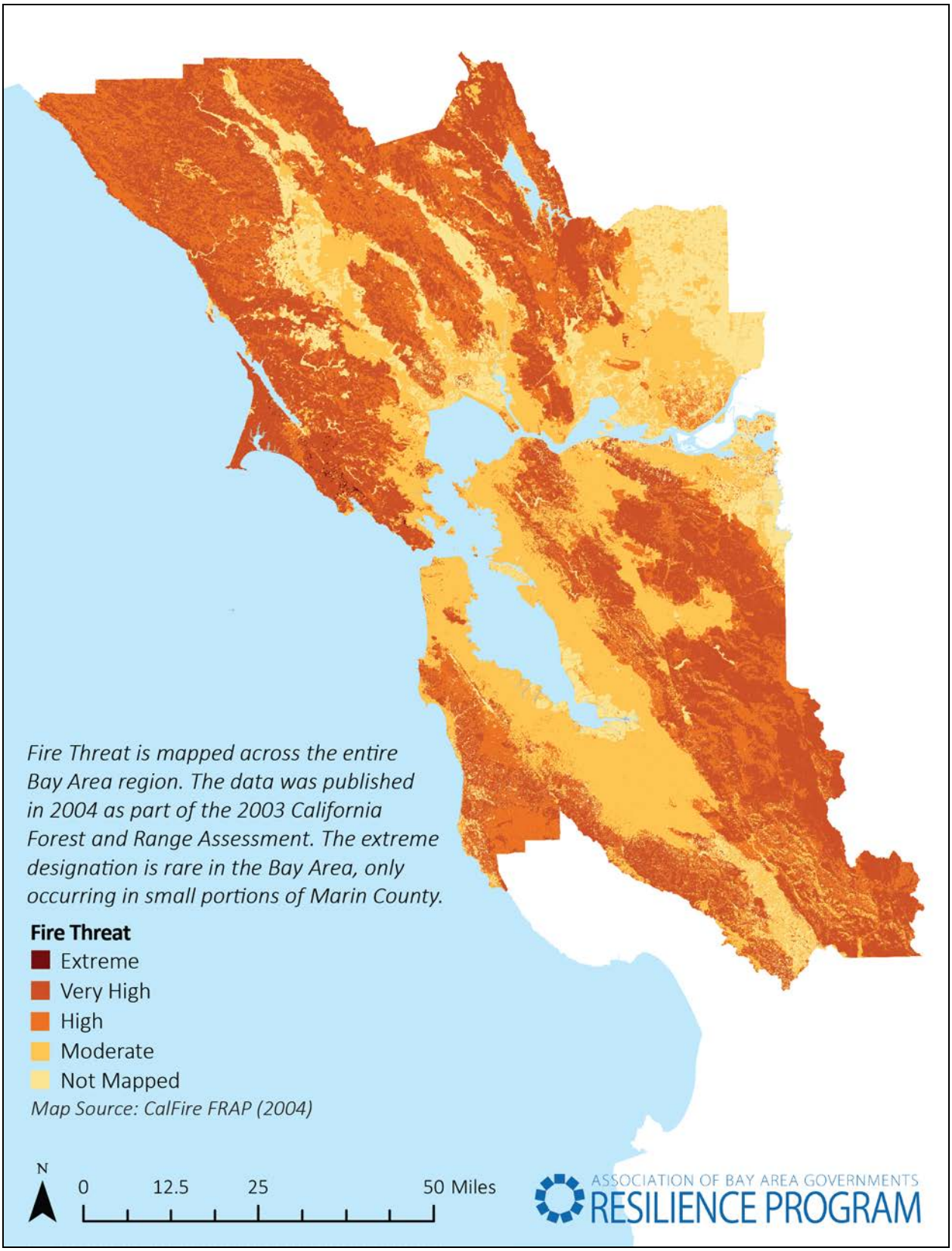

Figure 6 Fire Threat in the San Francisco Bay Area

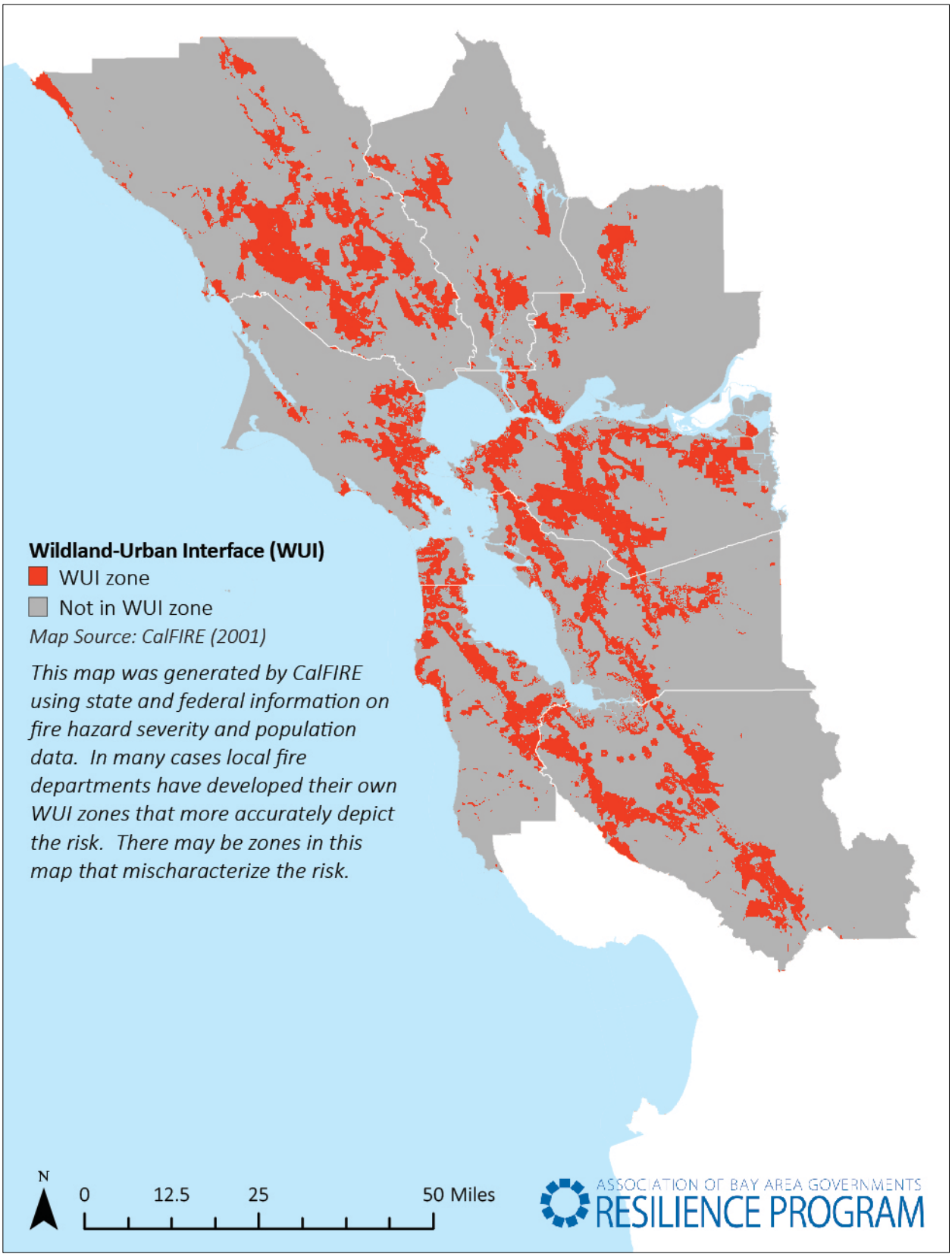

Figure 7 State Defined Wildland Urban Interface

Ignition Source	Plan (Ignition Data Year(s))						
	Summation of All Plans	**Marin CWPP** (1974-2014)	**Marin Unit Plan** (2005-2014)	**Santa Clara, Alameda, Contra Costa Unit Plan** (2015)	**San Mateo Unit Plan** (2015)	**Santa Clara CWPP** (2014)	**Sonoma, Napa, Solano Unit Plan** (2013)
Unkown, Undetermined	1	1	1	1	1	1	1
Powerlines	2	5	2	2	6	3	2
Vehicles	3	5	3	2	6	2	4
Campfire	4	2	5	7	9	not included	not included
Debris Burning	5	10	4	6	4	4	2
Equipment	6	5	6	4	3	not included	not included
Arson	7	4	not included	5	2	not included	not included
Accidental, Playing with Fire	8	3	not included	not included	9	6	not included
Smoking	9	8	not included	9	5	5	not included
Lightning	10	9	not included	7	6	7	not included
Railroad	11	11	not included	9	9	not included	not included

Figure 8: Ignition Source Ranked by Frequency for Bay Area Plans with Ignition Data.

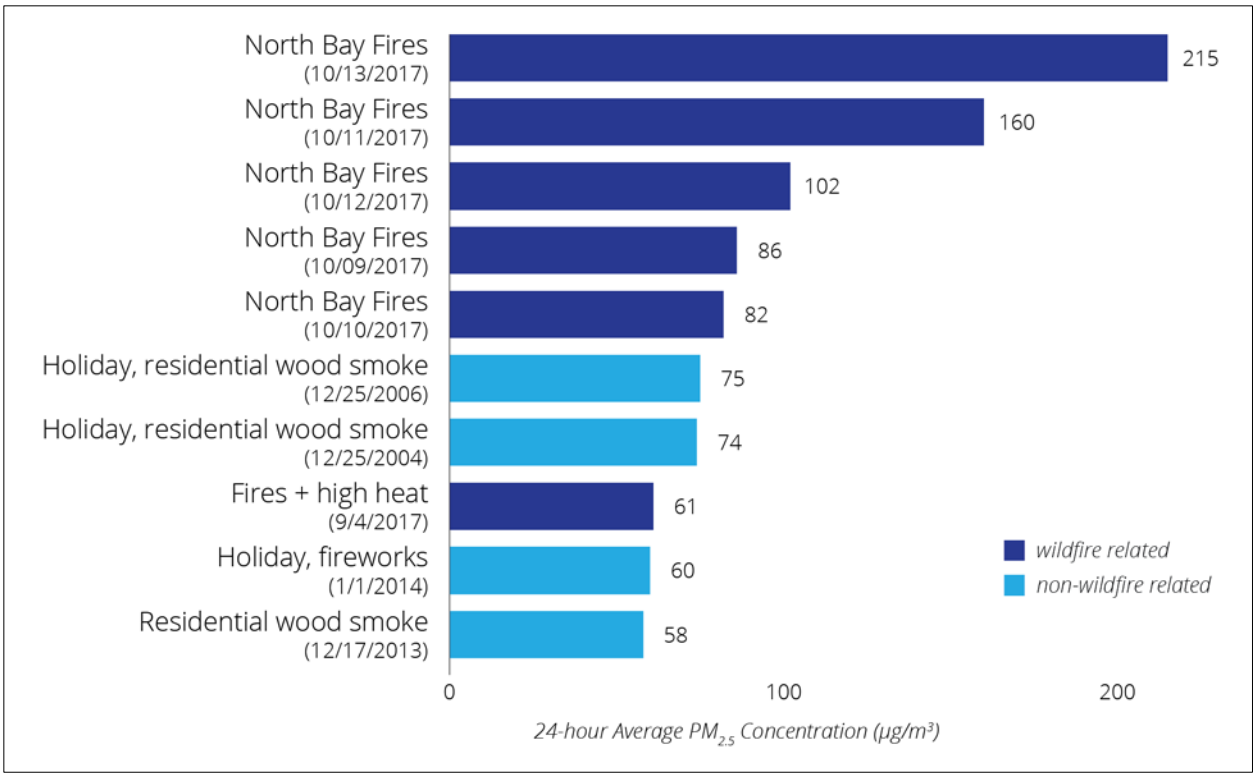

Figure 9 Top Ten $PM_{2.5}$ Days in the Bay Area Since 2003 (BAAQMD, 2018)

B. Fire Impacts on Assets

Fires have significant impacts. Their most devastating and focused impact is burning assets. The result of burned landscape can create cascading hazard impacts, resulting in impaired water quality, increased mudslide risk, increased landslide risk, and possible change to flooding dynamics. In addition to the impacts of burning, fires also produce smoke that has direct impacts on people and the built environment. A general characterization of fire impacts on people, buildings, infrastructure, and the environment is provided. For more information on assets and including asset impacts in a risk assessment, Risk Profile 2017 provides additional discussion (ABAG, 2017a).

People

Fires threaten safety and public health. Without warning and sufficient evacuation strategies, fires can kill and injury people. In addition to the fire directly, smoke causes severe public health impacts. Smoke impacts are much more widespread than the fire itself, and strategies are needed to address this risk. This research focused efforts on studying in-region wildfire risks, but smoke impacts from fires burning out of the region can have smoke impacts on Bay Area residents. Conversely, wildfires within the region can worsen air quality for Central Valley residents, who bear the brunt of poor air quality.

For healthy people, smoke from wildfire will cause temporary health impacts. Chest tightness, congestion, watery eyes, and a dampened immune system are common symptoms that can take time to recover from once the poor quality air has cleared. For individuals who have trouble breathing to begin with, smoke becomes an added challenge. Children are at greater risk because they breathe at a higher

rate than adults, so they'll take in greater quantities of smoke relative to their body weight. The elderly and populations with cardiovascular, lung disease, emphysema, and bronchitis are at a higher risk as well.

Fire deaths in the state of California have been steadily declining over the past three decades (see Figure 10). This data set does not distinguish which deaths were from wildfires versus other fire types. Much of the decline has been credited to updated building codes which have targeted structural fire risks with strategies like fire sprinklers. The data set also does not include any deaths that were associated with indirect smoke impacts.

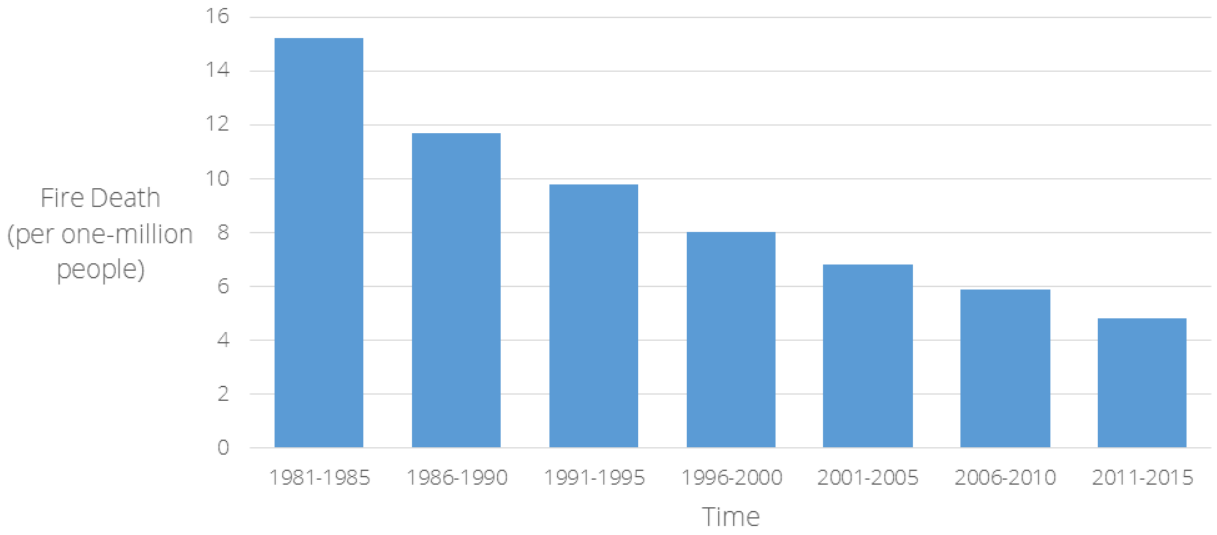

Figure 10 Fire Death Rates per Million Population in California

Vulnerable Populations

Certain members in the community are more at risk of being harmed by disasters and specifically fires than others, including the very young, the very old, the disabled and the chronically ill, and residents without access to vehicle. These individuals are more susceptible to the extreme conditions created by a disaster and have less mobility to evacuate out of harm's way.

In 2013 ABAG and BCDC worked with stakeholders to define vulnerable population characteristics that make individuals less able to prepare for, respond to, and recover from disasters. Ten census-collected attributes were determined to be indicators for high social vulnerability and were mapped to uncover block groups in the region with high percentages of socially vulnerable populations. The ten indicators are: population over 75, population under 5, housing cost burdened, transportation cost burdened, no high school diplomas, very low income, limited English households, people of color, no vehicle households, and rental households. For each indicator, a specific level of significance was determined that indicates that the particular block group has a higher than average concentration of that indicator. Block groups with more than one indicator were aggregated to create a vulnerability "score" for that block group. While these indicators were developed for earthquake and flooding risk, they are also applicable for other hazards such as fire. For more information on vulnerable population see Stronger Housing Safer Communities, 2015, http://resilience.abag.ca.gov/projects/stronger_housing_safer_communities_2015/.

Buildings

Buildings and their contents are at risk of being destroyed by fire. Not all structures are equal in their ignitability. Some construction materials are more resistant to fire and while other construction materials or design methods are at a higher risk for igniting.

For a long time, the California building code has incrementally adjusted portions of the fire code to address structural fire concerns. This has resulted in standards such as fire sprinklers, building materials, and fireproofing elements. Most fire code improvements were focused on reducing structural fires rather than WUI fire risks. In 1991, the State adopted the first WUI code in Chapter 49 of the California Fire Code. The code required defensible space standards and required the California Board of Forestry to map WUI areas. It wasn't until 2005 and 2008 that the California Building Code Chapter 7A and the California Residential Code Section R327 were improved to include increased building standards for new construction. The code has standards for roofing, attic ventilation, exterior walls, underfloors (decking, floors), and ancillary structures. It applies to buildings built in State Responsibility Areas and Local Responsibility Areas with a Fire Hazard Severity Zone rating of Very High (see Figure 5 for these areas). Buildings constructed prior to 2005 and buildings outside of the above described areas do not have to meet these WUI fire code standards. For more on the building codes see *Appendix I. Fire Code Details*. Individual jurisdictions are able to pass more stringent standards that require a broader area of homes to comply with the WUI code, or require property owners within the regulated area to bring their structures up to code, often in the form of a triggering action, like the owner requesting a permit for a large renovation.

In order to accurately characterize WUI fire risk, the attributes of buildings are needed. It is important to know if a structure is located within a high fire hazard zone, but the risk is much greater if it has a wood roof and exposed eaves, which are vulnerable characteristics of fire-prone buildings. To best understand a community's WUI fire risk it is important to understand the attributes of buildings in the community.

Infrastructure

In fires, above ground infrastructure is at risk to damage. Telecommunication and electric poles and lines can be damaged in fires, and mechanical infrastructure components like transformers and electrical equipment can also be damaged not only by fire, but by smoke leading to power outages. In the 2013 Rim Fire, infrastructure equipment for power generation was damaged by dense smoke. Linear transportation infrastructure such as roads and rail lines are not a significant fire risk compared with other utilities, but debris clearance following a fire can limit access, and structures such as transit stations can be impacted. Fire can also impact transit by burning buses or trains, impacting transit service after a fire. In areas with old local roads there can be infrastructure such as bridges that are built with wood, which are at risk of damage.

Aside from components that can burn above ground, watershed basins can be impacted by fires. The reduction of vegetation in a watershed can result in greater erosion leading to greater turbidity in streams and lakes. The nutrient mix after a fire can also result in different conditions making algae blooms a greater possibility in the years following the fire. Lastly, for fires that burn into urbanized areas, the range of plastics and chemicals that burn in the fire can result in toxic byproducts that wash into waterways or down into groundwater aquifers.

Underground infrastructure can experience damage in high intensity fires depending on its proximity to the surface and the intensity of the fire. In the recent 2017 North Bay fires, there was significant damage

to storm water infrastructure. Underground plastic pipes and metal culverts melted in the fire, causing cascading impacts during the rainy season, which for late summer fires, is often only weeks or months away.

Environment

Fire is a natural process, but with increases in ignitions caused by humans (electrical lines, equipment, campfires, fireworks, etc.), decades of robust fire suppression, and anthropogenic climate change, the dynamics have become less natural. Fires impact different environments differently. In forests, the intensity of the fire is a key characteristic that influences the impact of the fire. Historically, more frequent low intensity fires burned underbrush and small trees, leaving larger trees. In recent decades, fires in the region have been higher intensity which has resulted in complete vegetation loss.

Because fires can cause so much damage, and when uncontained are unpredictable, fire management typically translates into suppression of many fires. The result, recognized across the Western United States, has been an increase in forest density, especially in the number of smaller trees. This has led to high intensity fires that burn all vegetation. Following a fire, vegetation that was endemic to a location may be less likely to come back, with new species taking over.

The loss of vegetation and changes to surface soils caused by the fire alters the environment. When all supporting vegetation is burned away, hillsides become destabilized and prone to erosion. In high heat fires, the burned surface soils are harder and absorb less water. When winter rains come, this leads to increased runoff, erosion, and can cause landslides in hilly areas. For more information on Bay Area landslide hazard, see Risk Profile (ABAG, 2017a).

As mentioned in the Infrastructure section above, the erosion and debris flow potential can cause cascading impacts in the waterway systems. Water species reliant on specific conditions, both physical, and nutrient-based are impacted by drastic changes.

C. Bay Area Fire Risk

The first two portions of this section described the Bay Area fire hazard and a subset of Bay Area assets. Their intersection offers a glimpse into the risk posed by wildfires in the region. At the regional scale there are limited comprehensive data sets for the region, which limits the ability to effectively characterize and quantify regional WUI risk. Some communities in the region that have more granular information about their hazard or their assets are capable of producing much more robust and meaningful WUI risk assessments that can help to communicate needs and prioritize risk reduction strategies.

Analysis of Bay Area Wildfire Mapping

The multiple mapping data sets discussed in the hazard section provide multiple ways for jurisdictions to characterize their wildfire risks. ABAG performed GIS analyses to understand how successful current maps are in predicting past wildfire extents. The white paper provides summary results. For detail on the analysis performed please refer to *Appendix E. Further Discussion on Wildfire Mapping Data Analysis* which has details on the analysis, and data sources used.

Success of Fire Hazard Severity Zones and Fire Threat in Mapping Historic Fire Perimeters (1955-2016)

In a literature review of local wildfire planning efforts, Wildfire Hazard Severity Zones were the most commonly stated resource to characterize hazard. A GIS mapping intersection was done to determine

two key features: Table 1, of areas that have burned in the last 65 years, how much of the burned area was in different Severity Zones; and Table 2, what percent of different Severity Zones have burned.

Table 1 Percentage of Burned Area in Each Fire Severity Zone

Very High	38%
High	28%
Moderate	23%
Not Mapped	11%
Total	100%

Table 2 Percentage of Fire Severity Zone that has Burned

Very High	45%
High	18%
Moderate	24%
Not Mapped	5%
All Areas	18%

The analysis should give users confidence that the Fire Hazard Severity Zones have been decent predictors of fire risk. In 65 years, 45% of Very High areas have burned. It also begs the question of whether more mapping is needed for areas that are characterized as unmapped. Eleven percent of the area that has burned in the Bay Area has occurred in the unmapped areas.

CAL FIRE also uses the Fire Threat layer to characterize fire risk. Unlike Fire Hazard Severity Zones, Fire Threat maps fire hazard at all locations in the region. Table 3 and Table 4 share the results to the same assessment, completed for Fire Threat.

Table 3 Percentage of Burned Area in Fire Threat Classifications

Extreme[1]	0.1%
Very High	56%
High	34%
Moderate	8%
Little or No Threat	3%
Total	100%

[1] In the Bay Area there are only 681 acres classified as Extreme Threat. Because of this, it makes up just a small portion of the overall area (850,000 acres) that has burned in the region from 1950 – 2016.

Table 4 Percentage of Fire Threat Classifications that has Burned

Extreme	34%
Very High	32%
High	23%
Moderate	5%
Little or No Threat	4%
All Areas	18%

An important distinction to recognize is the difference in past burned areas for "moderate" values in Fire Threat and Fire Hazard Severity maps. Moderate for Fire Hazard Severity Maps has burned 3x more frequently than the moderate value for Fire Threat. When using either mapping layer the above tables are helpful tools to characterize Very High, High, Moderate attributes.

In the Local Responsibility Area (LRA) specifically, 33,230 acres have burned. As mentioned previously for the Fire Hazard Severity Zones, only the Very High risk is mapped in the LRA, while Fire Threat is mapped across all responsibility areas. Of the 33,230 total acres burned, 5,110 acres were in the Very High Fire Hazard Severity Zones, while 28,120 acres were in unmapped areas. As a percentage of total area, 10% of very high LRA land has burned, while only 2% of unmapped LRA land has burned, but of the burned LRA, 85% was out of the mapped areas. Comparatively, because the Fire Threat map characterizes all areas, there is data for each threat category. The categories appear to be poor determinants of risk in LRA when looking at the percent of total burned area, but this is largely because a much greater percent of LRA by area is in lower threat zones. When reclassified as percent of severity zone burned we see that 12% of Very High LRA fire threat has burned while only 5% of high, 2% of moderate, and 1% of little/no threat have burned.

Table 5 In the LRA, the Percent of Area Burned in Different Hazard Zones 1955-2016

Fire Hazard Severity Zone	% of Total Burned Area	% of Severity Zone Burned
Very High	15%	10%
High	-	-
Moderate	-	-
Not Mapped	85%	2%

Fire Threat Zone	% of Total Burned Area	% of Severity Zone Burned
Extreme	0%	0%
Very High	10%	12%
High	16%	5%
Moderate	61%	2%
Little or No Threat	13%	1%

Exposure of Land Use to Fire Hazard Severity Zones

Using the Fire Hazard Severity Map, an exposure assessment was conducted on the region's land use, based on ABAG's five regional land use categories (2005). This analysis looks at the distribution of land use within each Severity Zone as well as the percentage of land in each Severity Zone for each land use category.

Table 6 Percent of Severity Zone in Each Land Use by Area

	Fire Hazard Severity			
Land Use Value	Unmapped	Moderate	High	Very High
Open Space, Agriculture	50%	82%	71%	70%
Commercial & Industrial	8%	0%	0%	0%
Education/Public/Semi-Public	5%	2%	1%	1%
Residential	25%	14%	27%	26%
Other[1]	12%	2%	1%	2%
TOTAL	100%	100%	100%	100%

[1]Other is a combination of Land Use Values "Water, Other/Unknown, Mixed Use, Mixed Use: Other"

Table 7 Percent of Land Use Area in Each Severity Zone

	Fire Hazard Severity				
Land Use Value (acres)	Unmapped	Moderate	High	Very High	Total
Open Space, Agriculture (2,917,000)	32%	22%	31%	15%	100%
Commercial & Industrial (158,000)	98%	2%	1%	0%	100%
Public and Education (138,000)	72%	9%	12%	7%	100%
Residential (1,087,000)	43%	10%	32%	15%	100%
Other[1] (258,000)	83%	6%	6%	4%	100%
Total (4,559,000)					

[1]Other is a combination of Land Use Values "Water, Other/Unknown, Mixed Use, Mixed Use: Other"

Table 6 highlights a few trends that someone familiar with the region might expect. Nearly all of the Very High zone is open space and residential land, with 70% in open space. Almost all commercial and industrial land uses are completely out of mapped fire risk zones, and nearly three-quarters of public and education land uses are out of mapped fire risk zones.

Table 7 shows that by area nearly half of residential land is in high or very high fire hazard zones. Using a more detailed land use attribute set with 15 different land use categories, the residential category can be dissected further to discover that a big portion of the land area under residential is defined as “mixed use: residential and open space/agriculture”. Table 8 shows how the different sub categories of residential uses break out.

Table 8 Acres of Residential Land Use in Each Severity Zone

	Fire Hazard Severity				
Land Use Value	Unmapped	Moderate	High	Very High	Total
Residential	454,687	54,406	37,005	44,546	590,644
Mixed Use: Res. & Com./Ind.	3,890	32	9	-	3,932
Mixed Use: Res. & O.S./Ag.	11,302	56,129	305,861	119,323	492,616
Total	469,880	110,567	342,876	163,870	1,087,192

Nearly half of the area falls into the "Residential and Open Space/Agriculture" sub section. The Open Space/Agriculture category also represents over 73% of the Very High residential share. The land use layer is helpful in understanding the amount of different areas in different severity zones, but fails to express how many homes are in the zones. Unfortunately a regional parcel level assessment was not conducted for this study due to constraints of the project scope and limited parcel data available at a regional level. However, at the local level where more granular information may be known at the parcel level, an assessment can be done categorizing by number of homes rather than number of acres.

Exposure of Vulnerable Communities to Fire Hazard Severity Zones

As discussed in the section on Vulnerable Populations on page 20, of key importance is recognizing where vulnerable communities are located relative to hazards. At a regional scale, demographic data is used to highlight general trends in population (for example: income, education, age, language) to flag areas where communities are less able to prepare for, respond to, and recover from a disaster. Across the region at a local level there may be more detailed efforts underway that are focused on understanding where there are individuals within the community that need special support for evacuation. Table 9 highlights the exposure of vulnerable residents (as defined by section on Vulnerable Populations on page 20), in Fire Hazard Severity zones.

Table 9 Vulnerable Community Populations (in number of residents) in each Fire Hazard Severity Zone.

		Fire Hazard Severity				
		Unmapped	Moderate	High	Very High	Total
Community Vulnerability (0 lowest, 10 highest)	3	1,138,447	46,515	41,452	42,296	1,268,710
	4	838,361	12,370	6,630	11,317	868,677
	5	570,102	2,913	2,981	2,956	578,952
	6	411,869	396	198	1,742	414,205
	7	351,600	575	-	-	352,174
	8	147,587	554	-	-	148,141
	9	10,533	-	-	-	10,533
	Total	3,468,498	63,322	51,261	58,311	3,641,392

In the region of 7.5 million residents (in 2015), census block groups totaling 3.64 million residents were classified as having a community vulnerability rating of 3 or greater. This does not mean that everyone within the census block is vulnerable, but rather they live in a block group with a proportionally higher concentration of vulnerable populations as compared with other block groups. Of the 3.64 million residents living in communities with a vulnerability score greater than 3, 3.46 million are in the unmapped fire hazard severity zones. The good news is that the vast majority of the remaining census tracts that are in areas of marked fire hazard severity are communities with lower community vulnerability score. In fact there is not a single census tract with a community vulnerability indicator score above 7 located in high and very high severity zones (see Table 9).

This analysis portion only highlights key takeaways of the analysis and does not include details of the data sets and assumptions and approximations used to complete analysis. *Appendix E. Further Discussion on Wildfire Mapping Data Analysis* has more tables, and breakdowns that provide additional information on differences between Local, State, and Federal lands as well as values in acres.

II. WUI Plans and Strategies

A. Local Fire Plans – Lay of the Land

Jurisdictions and agencies use a range of plans to characterize wildfire risks and develop responsive strategies. Some plans are led by grassroots engagement with threatened communities, while others are organized by fire agencies or jurisdictions to meet state of federal requirements or guidelines.

Common Stakeholders & Networks

Most planning processes recognize the need for collaborative input, and are developed with the support of other key stakeholders. The most common authors and key stakeholders included in wildfire planning documents are:

Fire Safe Councils – Most communities in the region have citizen-organized councils focused narrowly on wildfire issues. In some counties, a countywide council provides input on fire planning efforts, and acts as an engagement and network to encourage individual action by property owners. Other Fire Safe Councils represent individual neighborhoods, with a particular focus on fire safety within a single subdivision. In other cases the county has a Fire Safe Council, with more localized councils providing an opportunity to engage on local issues. Some councils are the lead or co-lead on planning processes, while others are primarily an engagement and dissemination platform to educate residents of risks and to promote preparedness, mitigation programs, and training. Some councils apply for grants and are the implementation leads for projects.

Local Government (Fire Department) and/or Fire Special District – In incorporated portions of the Bay Area, cities develop fire-related plans, or incorporate fire hazards into elements of comprehensive planning. Cities also carry responsibilities for land use zoning, building permitting and inspection, and maintenance of infrastructure. Many communities have a fire department with key functions to reduce fire risk and to respond to fires. Other communities are set up differently, and instead rely on a fire special district to provide their service. Often times the special district provides services to multiple jurisdictions. *Appendix D. List of Fire Districts in the San Francisco Bay Area* lists and maps all the fire districts in the nine-county region. In total there are over 166 fire agencies in the nine-county Bay Area.

CAL FIRE – The state is responsible for providing fire services to unincorporated land that is not federally owned. In some cases CAL FIRE has contracts to provide fire services to other areas. The state agency leads annual operational planning efforts, and works on long range wildfire planning. Statewide, CAL FIRE has 21 units; the Bay Area Counties are divided into four units. Within each unit there are battalions that provide service to a smaller area. CAL FIRE also has staff that develop fire hazard maps for the state, and other staff focused on supporting local governments with fire planning and implementation.

Outside of these three stakeholders there are other entities that play important roles in wildfire planning and in response to fires. Large land owners (open space preserves, water districts, etc.), community/neighborhood based organizations, residents, and a myriad of state and federal agencies can all be major players in planning.

Common Plans

Unit Fire Management Plans (Unit Plans) are completed on an annual basis by the CAL FIRE Pre-Fire Engineer in each Unit area. The Unit Plans document assessments of the fire situation within each of CAL FIRE's 21 Units and six contract counties. The plans include stakeholder contributions and priorities, and identify strategic areas for pre-fire planning and fuel treatment as defined by the people who live and work with the local fire problem (CAL FIRE, 2012). CAL FIRE Unit staff are the leads on these plans.

Community Wildfire Protection Plans (CWPP) emanate from the 2003 Federal Healthy Forest Restoration Act (HFRA) in response to destructive wildfires in 2002. The HFRA was intended to direct funding and guidance for better forest management practices throughout wildland and WUI areas. In the Act, CWPPs were incentivized to prioritize future fuel reduction projects. CWPPs needed to meet three overarching criteria (Firewise, 2016):

1. Formed through ***collaborative*** efforts among different agency/government stakeholders and impacted parties;
2. Identify and prioritize areas for ***fuel reduction treatments***; and
3. Recommend measures that communities can take to reduce the ***ignitability of structures***.

Communities that are covered under a CWPP are prioritized for federal grant funds through the Bureau of Land Management, U.S. Department of the Interior, and the California Fire Safe Council. CWPP's are commonly led by a community organized fire safe council, local jurisdictions, or fire district.

Local Hazard Mitigation Plans (LHMP) emanate from the 2000 Disaster Mitigation Act (DMA),which amended the Stafford Disaster Relief and Emergency Assistance Act to include a new approach to hazard mitigation planning and implementation efforts. The DMA established requirements for states, tribal, and local entities to create FEMA approved plans that would open up funding opportunities through the Hazard Mitigation Grant Program (FEMA, 2004). Plans are required to document and assess local hazard, including fire, and develop mitigation strategies to reduce risk. LHMP's are led by local governments, or by a County, with local governments annexing onto the County plan.

Safety Elements are a required component of every city and county's general plan. The goal of the safety element is to reduce the potential short and long-term risk of death, injuries, property damage, and economic and social dislocation resulting from fires, floods, droughts, earthquakes, landslides, climate change, and other hazards. The safety element must identify hazards and hazard abatement provisions to guide local decisions related to zoning, subdivisions, and entitlement permits.

The recent introduction of climate risk to the discussion of the safety element, mandated by SF 379, adds a focus on longer term preparation of a community for a changing climate. Policies in a safety element should identify hazards and emergency response priorities, as well as mitigation through avoidance of hazards by new projects and reduction of risk in developed areas. As California confronts mounting climate change impacts, local governments are now required to include a climate change vulnerability assessment, measures to address vulnerabilities, and comprehensive hazard mitigation and emergency response strategy as explained further in the SB 379 section below. (OPR, 2017). Safety Elements are completed by local governments.

Other Plans are used for narrower strategy focus. Examples of other plans include: Fuel Management, Vegetation Management, Open Space Management, Timber Harvest, Wildfire Management, and Pre-

Attack plans. Many CWPP's and Unit Plans reference these plans and the plan implementation as a key priority.

Integration of Plans

Over the past decade there have been numerous efforts to coordinate and align hazard mitigation and climate adaptation planning with other planning efforts. Many plans by themselves do not have any exacting requirements to ensure implementation. A suite of state legislation is increasingly requiring jurisdictions to use mitigation and adaptation planning efforts to inform their safety element – the plan with the strongest connection to local decision making. Figure 11 shows the relationship between three state laws that incentivize (carrot) or require (stick) greater integration of fire planning in day-to-day local government actions. While Unit Plans and Community Wildfire Protection Plans do not have any laws requiring their incorporation into the Safety Element or LHMP, many call out strategies to incorporate specific strategies into those documents.

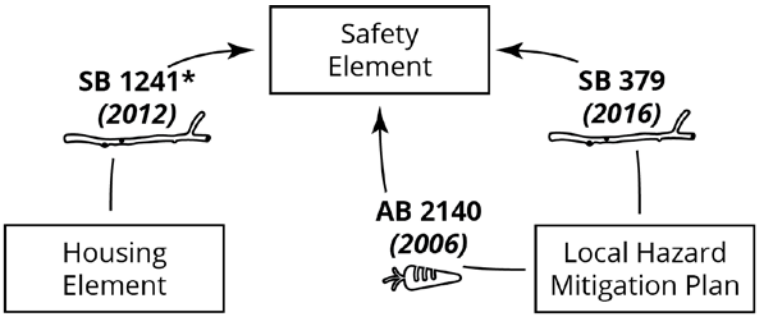

Figure 11 Key Local Fire Planning Documents and Carrot and Stick Plan Consistency Laws

**SB1241 does not impact all communities. 34 Bay Area cities are subject to SB1241 and are listed in Appendix D.*

AB 2140 authorizes local governments to adopt their LHMPs with the safety elements of their general plans (Gov. Code § 65302.6). Integration or incorporation by reference or annexation is encouraged through a post-disaster financial incentive that authorizes the state to use available California Disaster Assistance Act funds to cover local shares of the 25% non-federal portion of grant-funded post-disaster projects when approved by the legislature (Gov. Code § 8685.9) (OPR, 2017). The incorporation of LHMPs with the safety element was further strengthened by SB 379.

SB 379, codified at Government Code section 65302(g)(4), requires cities to address climate change adaptation and resilience in the safety element of all general plans. Specifically, "upon the next revision of a local hazard mitigation plan, adopted in accordance with the federal Disaster Mitigation Act of 2000 (Public Law 106-390), on or after January 1, 2017, or, if a local jurisdiction has not adopted an LHMP, beginning on or before January 1, 2022, the safety element shall be reviewed and updated as necessary to address climate adaptation and resilience strategies applicable to the city or county (OPR, 2017).

SB 1241 (Kehoe, Statutes of 2012) revised the safety element requirements for state responsibility areas and very high fire hazard severity zones (Government Code Sections 65302 and 65302.5). Specifically, during the next revision of the housing element on or after January 1,

2014, the safety element shall be reviewed and updated as necessary to address the risk of fire in state responsibility areas and very high fire hazard severity zones. SB 1241 requires that the draft element of or draft amendment to the safety element of a county or a city's general plan be submitted to the State Board of Forestry and Fire Protection and to every local agency that provides fire protection to territory in the city or county (OPR, 2014*). Appendix C. List of Bay Area Cities with a Very High Fire Hazard Severity Zone & Subject to SB 1241* has a list of jurisdictions that are subject to this law.

B. Bay Area Fire Plans

Each of the described plans in Section II, A have unique geographic boundaries. Figure 12 illustrates (as of Summer 2016) where jurisdictions have each plan type. The majority of jurisdictions in the region have a Local Hazard Mitigation Plan, Community Wildfire Protection Plan, and a Unit Plan. All cities are required to have a General Plan with a Safety Element. Figure 13 illustrates the boundaries for Unit Plans, and Figure 14 shows the boundaries for CCWPs.

The maps are not intended to highlight jurisdictions who do not have a certain plan, but instead for jurisdictions to recognize that if they'd like to understand what their strategies for wildfire mitigation are, they may need to look at a number of documents to understand the complete set of actions. Because there are many types of planning documents that all have unique requirements and motivations, a complete approach to wildfire mitigation may be represented in multiple documents. Similarly, a community that invests in a robust process for one planning process may have sufficient information to craft strategies and follow through.

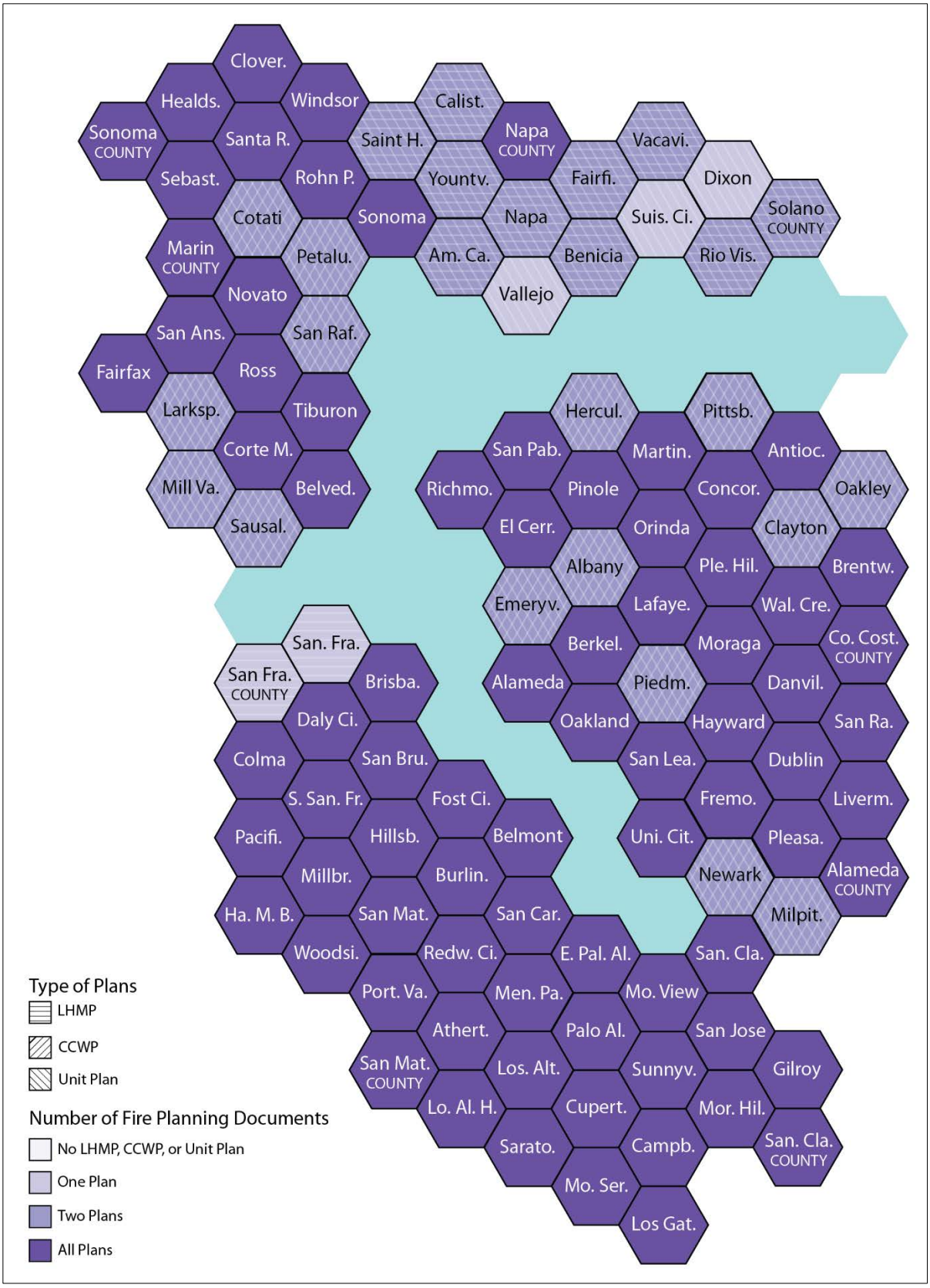

Figure 12 Wildfire Fire Plan Coverage in San Francisco Bay Area Local Jurisdictions (as of Summer '17)

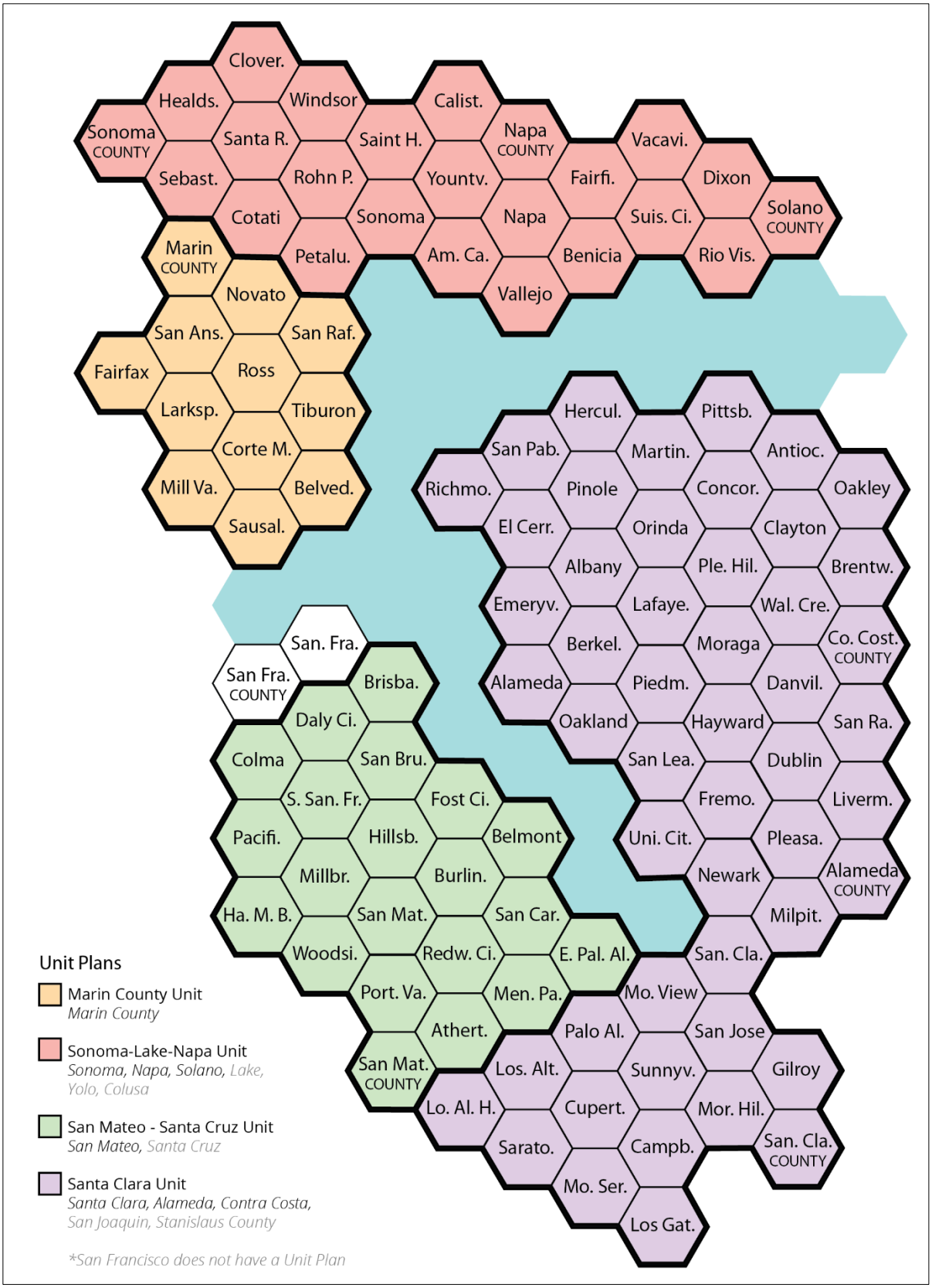

Figure 13 CAL FIRE Unit Management Plan Boundaries in the San Francisco Bay Area

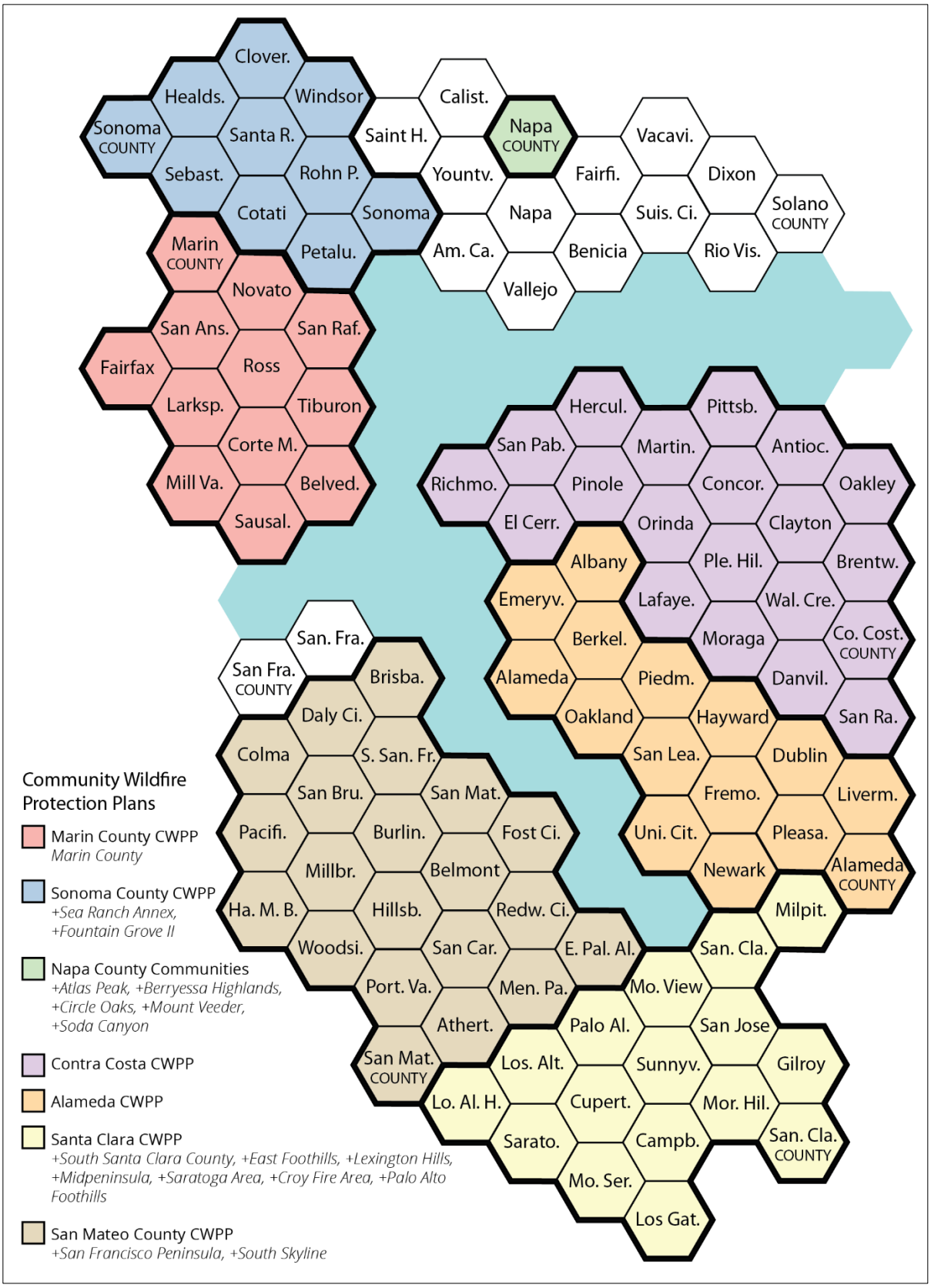

Figure 14 Community Wildfire Protection Plans in the San Francisco Bay Area

Analysis of Bay Area Fire Plans

Each Fire Plan in the region is unique, with different resources available to complete the work, and with different goals/scopes. This section summarizes some of the tools in use in the Bay Area to manage fire risk.

Napa County's CWPP's were focused on single neighborhoods, and were produced primarily by local Fire Wise Councils made up of local residents. None of the Napa CWPP plans were longer than 21 pages. In comparison, the Santa Clara County CWPP was supported by consultants and was much more expansive, with hundreds of pages and twelve appendices. While reviewing plans in the region, a number of qualities were noted to understand what elements/resources different communities were incorporating into their plans.

Risk Assessments, and Climate Change

Risk assessments are a key element recommended as part of each plan type's (CWPP, Unit Plan, and LHMP) guidance document. For LHMPs, a risk assessment is required. As staff reviewed plans, key elements of wildfire risk assessments were noted. Figure 15 below shows how different planning processes used different assessment elements. This matrix reflects only what was in the plan document and does not reflect risk assessments that may have informed the planning process but that were not included in the plan itself.

Does the Plan…	Contra Costa, Alameda, Santa Clara Unit Plan	Contra Costa CWPP	Alameda CWPP	Santa Clara CWPP	San Mateo Unit Plan	San Mateo CWPP	Marin Unit Plan	Marin CWPP	Sonoma, Napa, Solano Unit Plan	Sonoma CWPP	Napa CWPP's (6)
designate WUI areas?	No	No	No	Yes	Trace	Trace	Yes	Yes	No	Yes	N/A
include ignition history?	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	N/A
have historic fires listed?	No	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Yes	N/A
have fuel/vegetation layer?	No	No	No	Yes	No	No	Yes	Yes	No	Yes	N/A
include a hazard Layer	Yes	Yes	Yes	Yes	No	Yes	No	Yes	No	Yes	N/A
include an asset layer?	No	Trace	No	Yes	No	Trace	No	Trace	No	Trace	N/A
include asset attributes?	No	No	No	Yes	No	No	No	No	No	No	N/A
intersect hazard & asset?	No	Yes	Yes	Yes	No	No	No	Yes	No	Yes	N/A
discuss climate change	No	Yes	Trace	Yes	No	No	Trace	Yes	No	Yes	N/A
express climate change in hazard?	No	No	No	No	No	No	No	Trace	No	No	N/A

Figure 15 Elements of Risk Assessments and their Inclusion in Bay Area Fire Plans.

Two risk assessments in the region stood out as leaders in using modeling to assess their risk. Marin County's CWPP and Santa Clara County's CWPP each included a robust risk assessment. Both plans characterized the hazard using granular local data, and included discussion of how assets were at risk to the fire.

To date, climate change has not been well referenced within the documents; only Marin County included the influence of climate change in fire hazard characterization.

C. Bay Area Fire Plan Strategies

ABAG staff used the 15 Fire Plans to explore strategies Bay Area stakeholders were recommending to reduce wildfire risk. The strategies were organized into a database and used to develop three sections:

- High Level Bay Area Strategy Insight and General Wildfire Strategies
- Description of General Strategies & List of Most Commonly Cited Strategies
- Funding Options

For more background, *Appendix F. Further Discussion on Bay Area Wildfire Plan Strategies* has a longer description of the strategies, and a link to the strategy database.

High-Level Bay Area Strategy Insight and General Wildfire Strategies

Risk is the product of vulnerability and consequence. In Bay Area Fire Plans, a suite of strategies are recommended to reduce either value. Figure 16 is a visual representation of the common categories most strategies fall within and whether they reduce the likelihood of damage (vulnerability), or if they reduce the impact of a fire (consequence). In addition to the topical strategy areas represented in the visualization, there are a number of different mediums to implement each of the strategies. For example, many plans have multiple strategies focused on defensible space; some focus on research, others focus on educational resources, while others suggest policies, programs, or inspections.

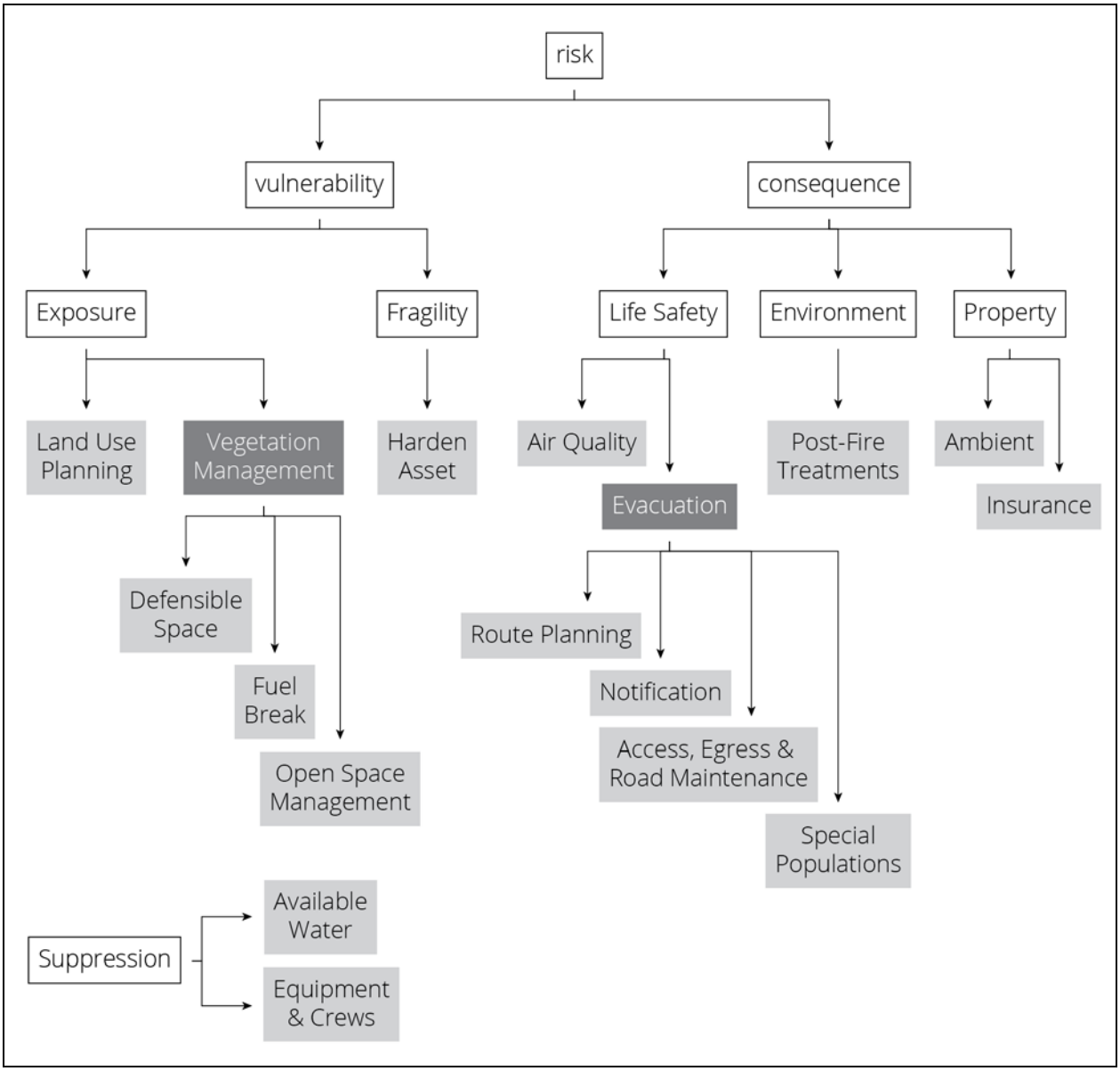

Figure 16 Visualization of Wildfire Risk Reduction Measures

Within each of the strategy categories described in Figure 16 above, there are a wide range of elements that specific strategies may target. Below is a general description of what each category attempts to address.

Strategy Types to Reduce Vulnerability

Reduce Exposure through Land Use Planning – Where homes, businesses, and infrastructure are located can be a powerful way to reduce wildfire risk. Different locations within a city can present drastically different wildfire risk. Locating important assets in areas of low fire risk is a straightforward method to reduce risk. When using land use as a fire management tool it is critical that other considerations like flood risk, transit access, and economic feasibility are considered as well.

Reduce Exposure through Vegetation Management – Vegetation is a key variable in determining the fire risk for a specific area. In the Wildland Urban Interface, vegetation (grass, shrubs, trees) is the primary fuel source that powers fires. Most strategies to address vegetation occur in three sub-areas:

> ***Defensible Space*** – The amount of vegetation and its proximity to a home has a large influence on the likelihood the structure will be damaged by a wildland fire. Depending on the local conditions, many strategies recommend anywhere between 30 and 100 feet of vegetation clearance around structures, with the distance largely dependent on the slope of the property as well as the vegetation height.
>
> ***Fuel Breaks*** – Areas can be greatly protected when there is a break in vegetation. Across the region fire crews use paved roads, dirt roads, and fire break specific lines to provide a barrier where a fire may have a reduced chance of spreading. Any fuel break by itself will not stop a wildfire, but they provide an increased probability of success for fire suppression activities.
>
> ***Open Space Management*** – The makeup of vegetation in the wildland and open space areas can drastically change the likelihood and intensity of fires. Types of vegetation and densities of vegetation can change fire characteristics. If fires are less intense in wildland areas, they're less likely to spread in an uncontrollable manner.

Reducing Fragility by Hardening Assets – Certain construction methods and materials are less likely to ignite when they are exposed to fire, or when embers from a nearby fire are present. By making structures or infrastructure less likely to catch fire, there is a greater likelihood assets will survive nearby fires. This is also sometimes referred to as structure ignitability.

Strategy Types to Reduce Consequence

Air Quality – Given that a fire has occurred, developing strategies to reduce exposure to smoke can improve the health of impacted populations. When appropriate, moving people away from the smokiest areas, having shelter facilities with filters to improve building air quality, or providing the appropriate masks can reduce public health impacts.

Minimizing Consequences through Evacuation – Nothing is risk proof. When fires and other hazards are too great, having a strategy to move people to safety is imperative. Improving evacuation outcomes requires a variety of approaches:

> ***Route Planning*** – Having a plan in place to rapidly move everyone out of an area is critical. Evacuation plans, like many of these strategies requires research, plans, education, and training.

Notification – When there is a hire fire risk, or when there is a fire that poses a risk, a robust communication channel is needed. Red flag warnings and a variety of emergency management messaging platforms are used to warn of heightened risk and issue evacuation orders.

Access, Egress & Road Maintenance – In many cases alterations may be needed to ensure safe evacuation. Narrow roads, single routes, or roads with overhanging vegetation are dangerous. When safe routes are designated they should be maintained to provide safe evacuation.

Special Populations – Many community members require assistance to evacuate. The car-less, disabled, elderly, and youth are populations that need special attention.

Post Fire Treatments – Following a fire, there are a suite of actions that can improve ecosystem health. Some strategies include rehabbing any fire breaks created during the fire, or shoring up waterways to handle rainfall in a post-fire landscape.

Insurance – Coverage for homeowners, renters, and businesses can reduce the financial hardship. Having coverage is a good start, but having sufficient coverage is also important.

Ambient – Following a disaster that displaces households and businesses, having a community that can meet the needs of the displaced individuals is key. When vacancy rates are low, or when people don't have a local network on which to rely, they are less able to stay in the community.

Managing Fires by Suppression

Having firefighting assets in place to suppress wildland fires near development can prevent fires from expanding, or allow for greater resources to protect the urban environment. Having available equipment (trucks, tenders, aircraft), crews (firefighters, first responders), and accessible water all improve the ability to contain fires. The plans described in this white paper do not focus on listing equipment or crew needs; however there are many strategies that focus on ensuring water availability for fire-fighting in the wildland urban interface.

Strategy Mediums and Methods

Within each strategy category, there are often specific strategies to achieve the desired goal. While reviewing the plans a number of common mediums and methods were continually referenced. To help characterize the plan strategies a set of common mediums/methods were used:

- Research (data collection, analysis, exploratory)
- Education (resource, activity)
- Networking (professional-to-professional, professional-to-public, public-to-public)
- Plans (long range, operational)
- Policies (code, ordinance)
- Programs
- Projects
- Training
- Funding
- Inspection

To get a high-level picture of where fire plans in the region focus strategies, a matrix of strategy category and strategy medium was produced, see Figure 17. In total 368 strategies across the Unit Plans

and CWPP were sorted. “General” was added to categories to represent strategies that embodied comprehensive approaches. Vegetation management was the overwhelming focus of the plans in the region, followed by evacuation and structure ignitability strategies. As for strategy medium, the strategies were well distributed with education and research at the top.

	General	Vegetation Mgmt	Structure Igniteability	Water Supplies	Evacuation	Notification	Total
Research	20	27	1	1	10	1	60
Education	41	33	9	0	6	5	94
Network	24	14	0	3	2	1	44
Plan	15	3	0	0	15	0	33
Policy	1	12	9	1	2	0	25
Program	1	16	0	0	4	0	21
Project	2	37	0	7	6	1	53
Training	1	0	0	0	3	1	5
Funding	5	4	2	0	0	0	11
Inspection	3	16	2	0	1	0	22
Total	113	162	23	12	49	9	368

Figure 17 Matrix of Strategy Category and Medium

Funding Sources

Many strategies discussed in the plans require funds to implement. Grants are a common funding source, while other plans have strategies focused on long-term funding for mitigation. The Santa Clara County Community Wildfire Protection Plan goes into great detail on grant funding sources. An excerpt of this portion of the plan is included in *Appendix G. Wildfire Funding Opportunities – From Santa Clara County CCWP*. In addition to grant opportunities, two Bay Area communities have been able to fund WUI mitigation programs and projects with local funding approaches.

Grant Opportunities

Appendix G. Wildfire Funding Opportunities – From Santa Clara County CCWP has a broader set of potential grant sources and opportunities. Three of the larger grant opportunities are described here:

CAL FIRE has a range of grants. The Fire Prevention Fund provides over $15 million annually for areas within the SRA for both mitigation projects as well as planning efforts. Government entities as well as organizations like Fire Safe Councils can be awarded grants.

> *In 2017 CAL FIRE awarded 11 grants to Bay Area communities ranging from $22,500 to $200,000, all for fuel management (CAL FIRE, 2017).*

Federal Emergency Management Agency has a Pre Disaster Mitigation Grant Program and Hazard Mitigation Grant Program that can be used to support WUI mitigation projects. Between 2005 and 2010 the nine-county region secured $14.9 million in grants to support a range of vegetation management projects and programs. The largest awarded grant was for $3 million.

> *The East Bay Regional Park District was successful in retrieving five HMGP and PDMC grants between 2007 and 2009. The average grant award was over $2 million (ABAG, 2017b). In total for all-hazards projects the region has received over $330 million since 1994, but no wildfire projects within the region have been funded since 2009.*
>
> *Outside of the region El Dorado County and San Bernardino Counties have each received HMGP funds to administer a wood shake roof replacement program for existing homes. The program offers homeowners up to 70% of the cost of replacement with a maximum of $6,500 and $4,500 respectively. In San Bernardino County the program is accompanied by an ordinance requiring roof replacement for many triggers (County of San Bernardino County, 2016).*

California Fire Safe Council works annually to bundle a suite of funding opportunities into a single process. The grants focus on reducing the risk of WUI fires and often have a focus on vegetation management projects. In the past the grants have a maximum of $200,000.

> *Fire Safe Councils in San Mateo ($133,000) and Santa Clara ($186,000) Counties were each awarded 2017 grants for vegetation management projects and a public wildfire education program respectively.*

Local Funding – Assessment Districts

Assessment districts are an effective funding tool to pay for collective WUI mitigation projects. They can be used for annual maintenance, as well as projects with long-term reduction in WUI risk. One of the best examples of local funding is the Oakland Wildfire Prevention Assessment District. The District has had a complex history. First instituted by City Council in 1993, the district operated for four years before

California Proposition 218 required the assessment to be voted on by the residents of the district. After a stint of special funding from the local budget, in 2003 the assessment was approved by voters in the district with 74% of the property owners voting in favor. The following ten years, the district generated $1.7 million in annual revenue with a $65 assessment on Oakland Hills properties. The funding paid for vegetation management along 300 miles of roads, provided contractor training, replaced fire danger signs, paid for remote automated weather stations, defensible space inspectors, and staff to support projects and explore grant opportunities. Unfortunately, when the District required a re-approval vote in 2014, it fell 66 votes short of the 2/3 threshold. A 2017 report to Oakland City Council highlights the accountability failures that led to less support for the district (City of Oakland, 2017).

Local Funding – Municipal Service Tax

The Marin County CWPP recommended placing a Municipal Service Tax on a future ballot to support a robust vegetation management program. The City of Mill Valley Community Facilities District (within Marin County) already has a $266 annual tax (with a 2% annual increase to keep up with inflation) on single family residences to pay for a suite of services, including “reduce fire hazards.” Over $300,000 of the annual funds go to vegetation removal, chipper programs, and educational mailings. The city has a process for fixed and low-income residents to be exempt from the tax. In 2016 the tax was supported by 77% of the voters (City of Mill Valley, 2017).

III. Next Steps

Aggregating the strategies from 15 Bay Area wildfire plans allowed for common themes to rise to the surface. Based on the analysis of fire planning documents and a regional level GIS analysis the following six recommendations are made:

1. Coordination of planning processes and documents.
2. Collect, analyze, and communicate parcel/building-specific information.
3. Thoughtful expansion of the WUI code.
4. Develop high quality, locally relevant educational collateral.
5. Explore and pilot cost-effective methods of vegetation management.
6. Invite air quality experts to comment on wildfire plans and offer strategies to address smoke impacts.

A commonality across all strategies was a need to connect the wildfire mitigation work with non-fire focused entities. Most of the strategies listed benefit from others' support, or alignment with like efforts rather than in parallel.

Coordination of planning processes and documents.

There is a suite of planning documents which communities can use to characterize their wildfire risks and prioritize mitigation strategies. At the state and federal level, there should be some consideration of opportunities for plans to be coordinated and streamlined, enabling communities using one robust plan to access funding sources currently tied to a single plan. For the time being, separate planning processes should build upon one another, taking advantage of a single vulnerability assessment and existing public engagement platforms built in past efforts, as well as link important strategy actions to implementation-oriented documents, like the general plan, specific plan, and capital improvement budget. These plans are often produced in planning departments, finance departments, or city manager and administrator offices.

Many of the plans call for the need to connect more closely with the broader hazard mitigation, climate adaptation and resilience planning efforts. Having fire-focused research, strategies, and plans is a great way to dig deep into the issues, but they must be successfully integrated into larger strategies that can support their implementation.

Local and regional growth strategies should focus future growth outside of highest WUI risk areas. As part of the next Regional Transportation Plan and Sustainable Communities Strategy, ABAG and MTC will consider natural hazards and climate impacts in areas of focused growth. The current plan designates Priority Development Areas, that are projected to absorb the majority of the region's forecasted growth. By area, only .5% of PDAs are in fire hazard severity zones and half of the acreage exposed to fire hazard severity zones is in a single PDA. Continued focus on driving future growth into PDAs will support a goal of limiting residential exposure to wildfire. Local governments who have areas of growth outside of PDAs should work to reduce the amount of new construction occurring in the highest fire risk areas.

Appendix A. Annotated Bibliography of Fire Planning Resources has a suite of documents that can support the integration of wildfire planning into the General Plan and other elements of local government. The resources provide detailed recommendations and processes to be aware of for stakeholders who want to integrate WUI strategies into land use plans.

Collect, analyze, and communicate parcel/building-specific information.

Some communities have used Hazus or wildfire-specific modeling to understand their WUI risk by number of physical assets, acreage, or financial assets exposed. In most cases these models are developed with assumed building data. Knowing which buildings have fire-resistant roofs and which do not has a large impact on the risk assessment. Granular information about individual buildings would allow jurisdictions to develop more accurate and detailed risk assessments, leading to targeted outreach and education in specific locations. In addition to informing agency decisions about risk, the data can be shared with individual homeowners to educate them about their specific risks. In Santa Clara County's CWPP they specifically call out a need for more granular data for two products: (1) improve their risk assessment model at a finer scale, (2) produce an interactive tool for citizens to use online that shows them the degree of fire hazard, as well as their unique risk because of their building and parcel attributes.

Building-specific information is not a unique need to wildfire mitigation strategies. It can also support many other mitigation programs focused on upgrading existing buildings. Greenhouse gas mitigation strategies focused on energy efficiency as well as water efficiency efforts have strategies focused on building-level data collection. Many communities are also interested in building inventories for seismic and flood mitigation policies. While the specific data may be different for different risks, the process for collecting the data could be coordinated. Similar to Santa Clara County's desire to have a public-facing building inventory to educate homeowners on their specific wildfire risks, other efforts are attempting to build similar platforms that use building-specific data to showcase opportunities to mitigate risk or reduce greenhouse gasses or water consumption. The foundation for all of these strategies is good building-level information. Communities interested in many policies might consider a comprehensive approach to building-level data collection.

Thoughtful expansion of the WUI code.

The WUI code could be expanded in three ways: (1) expand the areas that are subject to the WUI code; (2) increase the triggers for structural hardening by adjustments to the state standard, or by local amendment; and (3) improve enforcement of the code. Expansion of the code needs to be done in a measured manner to ensure the benefits outweigh the costs and that there are appropriate resources to support an increased enforcement need. These three elements are interdependent. If you change the boundary of areas subject to the WUI code, or increase the frequency of retrofit projects, more resources will be needed for inspection. Changes to the first two without enforcement can diminish the quality of the efforts.

Expand the areas that are subject to the WUI code.

Currently, all SRA lands and Very High Severity Zones in the LRA are subject to the WUI codes. There are areas within local jurisdictions that have high and moderate severity zones, but they're not included in the State's final maps. The state produced draft maps in 2007 with high and moderate zones marked at the local level. The analysis performed in this white paper, and the recent North Bay Fire illustrates that unmapped areas still do burn. Jurisdictions can choose to expand the areas of their cities subject to the WUI code to decrease risk.

Increase triggers for structural hardening by adjustments to the state standard or by local amendment.

The structural hardening components of the WUI code apply only to new construction. Other jurisdictions across the state have adopted amendments to the California Fire Code to require building

owners to meet the updated building code standards at a variety of trigger levels (10% remodel, point of sale, etc.). Increasing the frequency of triggers will accelerate building retrofits to meet the fire code. Jurisdictions with very high risk and resources could consider a mandatory compliance, similar to actions taken by jurisdictions for seismically-deficient buildings.

Increase the enforcement of the code.

Many plans in the region called for greater resources to expand the number of inspections completed each year. Other plans described strategies to increase efficiency, tracking, or partnerships to increase inspections. With improved enforcement, the existing areas subject to the code will have higher compliance, reducing their risk.

Develop high quality, locally relevant education collateral.

Every plan reviewed listed the need for better resources to support private property owners with decision support information to mitigate their risk and prepare for possible evacuation. Federal and state agencies produce generic model resources to support jurisdictions. Elements of documents are helpful, but other elements can be counter-productive to local goals (i.e. keeping vegetation moist at all times may work for communities with robust water supplies, but is counter-productive per drought considerations in much of California). Each property owner has a unique set of variables that make generic resources less helpful. Supporting residents with targeted information will help ensure the quality of the work they take on, and increase action.

In addition to having locally relevant educational materials, many jurisdictions specifically call out the need for comprehensive materials that talk about all fire related considerations (vegetation management, structural ignitability, street standards, evacuation preparations, etc.), rather than separate resources for each component. In addition to the breadth of the material, having information that describes the problem, and provides specific resources (i.e. standards, funding/financing, process, contact information) will help prevent people from getting stuck, not knowing how to proceed with a project that may require a permit, coordination with a large land owner, or finding a contractor.

Bay Area focused model resources that are adaptable may provide a base to allow individual jurisdictions or neighborhoods to make high-quality, locally relevant decision support resources for their community. Similar educational documents targeted at homeowners to inform them of ways their home can be made more safe, healthy or green are being developed by other stakeholders. Any efforts to coordinate and align homeowner engagement may make limited resources go further.

Explore and pilot cost effective methods of vegetation management.

Plans across the region call for studying the cost effectiveness of different vegetation management methods, as well as efforts needed to streamline the regulatory process. For individual homeowners, large open space managers, and government, vegetation management is expensive and sometimes a permit-fraught process. This is a challenge across the state of California, with state and federal agencies key stakeholders for any efforts to streamline the regulatory element of vegetation management.

In a handful of documents, agencies and departments were curious about the costs and benefits of goat grazing, as well as mechanical treatments with revenue generating potential. In some areas in the state mechanical treatments to reduce forest density generate revenues, some of which can have a net revenue to help pay for further management elsewhere. These strategies are being discussed for Sierra Nevada Mountain forests (PPIC, 2017).

Many plans call out a need for developing a database of vegetation management costs associated with different management techniques to help communities choose the best approach, with better understandings of costs. It should be recognized that many of the permit issues and delays can be a result of other communities being in opposition to projects that have negative impacts on the area (habitat, erosion, aesthetics). A process that bring the stakeholders in at the beginning may make for more streamlined processes during implementation.

Invite air quality experts to comment on wildfire plans and offer strategies to address smoke impacts. Smoke from wildfires is an impact that threatens community health well beyond the burn area. The recent North Bay fires registered the top five ever recorded bad air quality days in the Bay Area. The consideration of wildfire smoke impacts should be considered in communities response plans for evacuation and shelters, with special accommodations made for those most vulnerable to smoke impacts (see *Section 1.B. Fire Impacts on Assets* for more discussion on this).

The plans reviewed do not discuss the air quality challenge, nor were any solutions recommended. Bringing in air district partners for discussion may result in new strategies that will reduce the impacts of smoke on the community.

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V: APPENDICES

Appendix A: Annotated Bibliography of Wildfire Planning Resources

Appendix B: 2017 North Bay Wildfires – An Early Perspective

Appendix C: List of Communities with a Very High Fire Hazard Severity Zone & Subject to SB 1241

Appendix D: List of Fire Districts in the SF Bay Area

Appendix E: Further Discussion on Data Analysis

Appendix F: Further Discussion on Bay Area Wildfire Plan Strategies

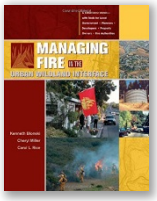
Appendix G: Outtake of the Santa Clara County CCWP Appendix on Funding Opportunities

Appendix H: Other Fire Types & Impacts

Appendix I: Fire Code Details

A. Annotated Bibliography of Fire Planning Resources

Documents Focused on Supporting Local Governments



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Blonski, B., Miller, C., Rice, C. 2010.
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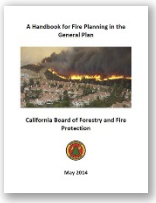

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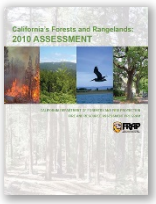

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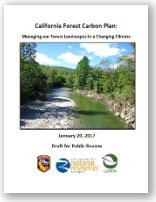

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Public Policy Institute of California. September 2017.
http://www.ppic.org/publication/improving-the-health-of-californias-headwater-forests/

B. 2017 North Bay Wildfires – An Early Perspective

This White Paper does not provide findings and lessons learned from the devastating 2017 fires in California. Other after action reports and studies have been commissioned, and will be better resources for stakeholders to use as they develop strategies to address WUI risks.

Following the North Bay Fires, MTC offered support to the impacted local governments to help facilitate the rebuilding and recovery process. This support was documented in a report out to the ABAG Executive Board on May 17, 2018. A recording of the report is available here: http://baha.granicus.com/MediaPlayer.php?publish_id=878755fa-5ac9-11e8-8074-00505691de41

The fires in Sonoma, Napa, and Solano Counties destroyed over 8,000 structures (Figure 18). The dollar value for the fire's damage has exceeded $10 billion, and the reconstruction is expected to take many years.

Before the fires occurred, the research of local fire planning documents had highlighted Sonoma County's use of a fire scenario to describe WUI risk. In 2016 the County approved the Community Wildfire Protection Plan. In the report, under the risk assessment section, the plan used two 1964 fires to showcase that those same fires would cause significantly more damage in 2016 than occurred in 1964 due to subsequent development.

> "In September of 1964, the Hanley fire, fueled by dry weather and 70 mile per hour winds, swept across the Napa-Sonoma County border. It burned out of control through Knights Valley, Franz Valley, and Mark West Canyon and was finally stopped when it reached the northern parts of Santa Rosa. Simultaneously, a fire burned through Nunn's Canyon to the edge of Route 12. Together, these fires burned 65,800 acres, over 100 homes and destroyed millions of dollars in property.
>
> If we superimpose the areas burned by these two fires on today's built environment, we find that 3,500 buildings are currently located in these areas. These buildings include many private homes, one public middle school, ten sites with hazardous materials, a PG&E substation, and high-tech commercial space. An estimated 9,600 people live in this area.
>
> The cost of damage to buildings, their contents and agriculture could easily exceed one billion dollars. Developments including Franz Valley, Mark West Estates, Foothills Ranch, Porter Creek, and Heights Subdivision would be devastated by a repeat of these fires. Firefighting costs could reach multiple millions.
>
> Stringent fire safety standards in Sonoma County coupled with improved mutual aid systems may prevent a repeat of the 1964 fires; however, it is not inconceivable that a large uncontrolled wildland fire burning on a severe weather day could overwhelm resources and cause significant damage." – Sonoma County CWPP (2016)

The 2017 fires were eerily similar to the 1964 fires that Sonoma County had used to explore their present day fire risk. Figure 19 shows the high overlap between the two fire years. In the end, the 2017 fires were even worse than a direct repeat of the 1964 fires. The excerpt from the 2016 Sonoma County CWPP highlights the value of scenario planning as a method to explore risks.

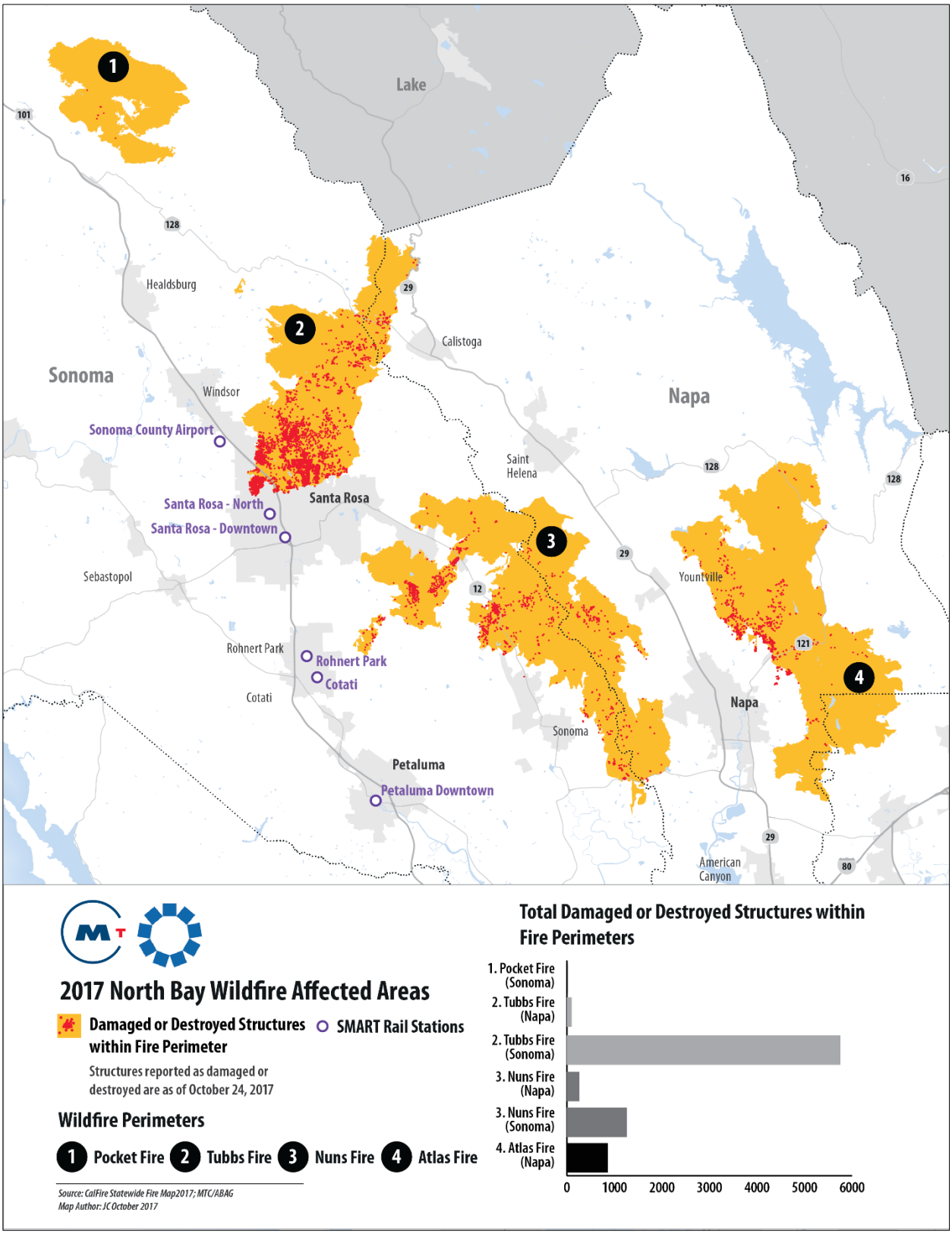

Figure 18: 2017 North Bay Wildfire Affected Areas and Damaged or Destroyed Structures within Fire Perimeters

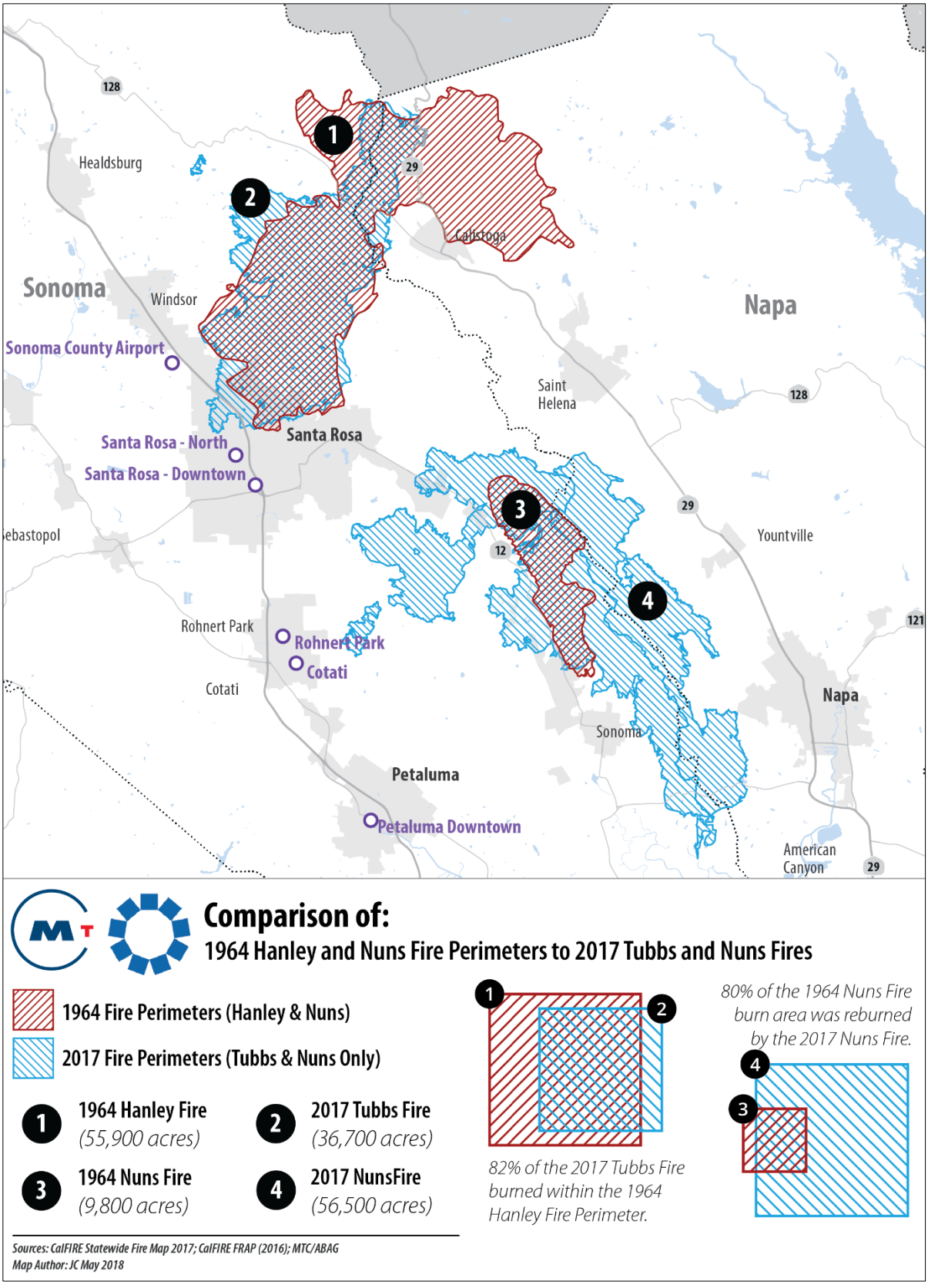

Figure 19: Comparison of 1964 Hanley and Nuns Fire Perimeters to 2017 Tubbs and Nuns Fires

C. List of Bay Area Cities with a Very High Fire Hazard Severity Zone & Subject to SB 1241

Jurisdictions with a Very High Fire Hazard Severity Zone are required by SB 1241 to update their safety element/housing element when they update their housing element or local hazard mitigation plan. 34 jurisdictions have a VHFHSZ and are subject to the law:

Alameda County (5)

- Berkeley
- Oakland
- Piedmont
- Pleasanton
- San Leandro

Contra Costa County (7)

- Danville
- El Cerrito
- Lafayette
- Moraga
- Orinda
- Pinole
- Richmond

Marin County (3)

- Larkspur
- Mill Valley
- Novato

Napa County (2)

- Calistoga
- Yountville

San Francisco (0)

San Mateo County (8)

- Belmont
- Half Moon Bay
- Hilsborough
- Portola Valley
- Redwood City
- San Carlos
- San Mateo
- Woodside

Santa Clara County (6)

- Cupertino
- Los Gatos
- Monte Sereno
- Morgan Hill
- San Jose
- Saratoga

Solano County (0)

Sonoma County (2)

- Cloverdale
- Santa Rosa

D. List of Fire Districts in the San Francisco Bay Area

Below is the best available knowledge of Fire Districts and Departments in the nine-county Bay Area.

County		Department/District Name	Jurisdiction Served
Contra Costa	1	Concord Naval Weapons Station - South	Concord
	2	El Cerrito Fire Department	El Cerrito Unincorporated Contra Costa County
	3	Rodeo-Hercules Fire Protection District	Hercules Unincorporated Contra Costa County
	4	John Muir Historic Site	Martinez (partial)
	5	Shell Oil Refinery	Martinez (partial)
	6	Moraga-Orinda Fire Protection District	Moraga Orinda Unincorporated Contra Costa County
	7	East Contra Costa Fire Protection District	Oakley Brentwood Unincorporated Contra Costa County
	8	Pinole Fire Department	Pinole
	9	Dow Chemical	Pittsburg
	10	Chevron	Richmond
	11	Richmond Fire Department	Richmond
	12	San Ramon Valley Fire Protection District	San Ramon Danville Unincorporated Contra Costa County Dublin (portion)
	13	Byron Airport	Unincorporated Contra Costa County
	14	Crockett-Carquinez Fire Protection District	Unincorporated Contra Costa County
	15	Concord Naval Weapons Station - North	Unincorporated Contra Costa County
	16	Tesoro	Unincorporated Contra Costa County
	17	Contra Costa Water District - Los Vaqueros Reservoir	Unincorporated Contra Costa County
	18	Buchanan Field Airport	Unincorporated Contra Costa County
	19	C & H Sugar Company Fire Department	Unincorporated Contra Costa County
	20	Contra Costa Fire Protection District	Unincorporated Contra Costa County San Pablo Lafayette Walnut Creek Pleasant Hill Martinez Concord Pittsburg Antioch
Alameda	21	Alameda Fire Department	Alameda
	22	Albany Fire Department	Albany
	23	Berkeley Fire Department	Berkeley
	24	Dublin Fire Department	Dublin
	25	Emeryville Fire Department	Emeryville
	26	Fremont Fire Department	Fremont
	27	Hayward Fire Department	Hayward
	28	Livermore-Pleasanton Fire Department	Livermore Pleasanton Unincorporated Alameda County
	29	Newark Fire Department	Newark
	30	Oakland Fire Department	Oakland
	31	Piedmont Fire Department	Piedmont
	32	San Leandro Fire Department	San Leandro
	33	Alameda County Fire Department	Unincorporated Alameda County
	34	Fairview Fire Protection District	Unincorporated Alameda County
	35	Union City Fire Department	Union City
Santa Clara	36	Campbell Fire Department	Campbell
	37	Los Altos Fire Department	Los Altos
	38	Los Altos Hills County Fire District	Los Altos Hills
	39	Milpitas Fire Department	Milpitas

Santa Clara (continued)	40	South Santa Clara County Fire Protection District	Morgan Hill Gilroy Unincorporated Santa Clara County
	41	Mountain View Fire Department	Mountain View
	42	Palo Alto Fire Department	Palo Alto
	43	San Jose Fire Department	San Jose
	44	Santa Clara Fire Department	Santa Clara
	45	Saratoga Fire Protection District	Saratoga (Portion)
	46	Sunnyvale Fire Department	Sunnyvale
	47	Santa Clara County Central Fire Protection District	Unincorporated Santa Clara County Cupertino Saratoga (portion) Monte Sereno Los Gatos
San Mateo	48	Belmont Fire Protection District	Belmont
	49	Brisbane Fire Department	Brisbane
	50	Burlingame Fire Department	Burlingame
	51	Colma Fire Protection District	Colma Unincorporated San Mateo County
	52	Daly City Fire Department	Daly City
	53	Foster City Fire Department	Foster City
	54	Half Moon Bay Fire Protection District	Half Moon Bay Unincorporated San Mateo County
	55	Hillsborough Fire Department	Hillsborough
	56	Menlo Park Fire Protection District	Menlo Park Atherton East Palo Alto
	57	Millbrae Fire Department	Millbrae
	58	Pacifica Fire Department	Pacifica
	59	Redwood City Fire Department	Redwood City
	60	San Bruno Fire Department	San Bruno
	61	South County Fire Protection District	San Carlos
	62	San Mateo Fire Department	San Mateo
	63	South San Francisco Fire Department	South San Francisco
	64	CAL FIRE - Unincorporated San Mateo County	Unincorporated San Mateo County
	65	Montara Point Fire Protection District	Unincorporated San Mateo County
	66	Woodside Fire Protection District	Woodside; Portola Valley
San Francisco	67	San Francisco Fire Department	San Francisco County/City
Marin	68	Belvedere Fire Department	Belvedere
	69	Corte Madera Fire Department	Corte Madera
	70	Ross Valley Fire Service - Fairfax	Fairfax
	71	Larkspur Fire Department	Larkspur (partial)
	72	County Service Area 17 - Kentfield-Larkspur	Larkspur (partial) Unincorporated Marin County
	73	Mill Valley Fire Department	Mill Valley
	74	Novato Contracted	Novato (Partial)
	75	County Service Area 1 - Loma Verde	Novato (partial) Unincorporated Marin County
	76	County Service Area 20 - Indian Valley, Country Club and Domingo Canyon	Novato (partial) Unincorporated Marin County
	77	Novato Fire Protection District	Novato (Partial) Unincorporated Marin County
	78	Ross Fire Department	Ross
	79	Ross Valley Fire Service - San Anselmo	San Anselmo
	80	San Rafael Fire Department	San Rafael
	81	County Service Area 23 - Terra Linda	San Rafael (partial)
	82	Sausalito Fire Department	Sausalito
	83	Tiburon Fire Protection District	Tiburon Unincorporated Marin County
	84	County Service Area 28 - West Marin	Unincorporated Marin County
	85	County Service Area 29 - Paradise Cay	Unincorporated Marin County

Marin (continued)	86	County Service Area 33 - Stinson Beach	Unincorporated Marin County
	87	Stinson Beach Fire Protection District	Unincorporated Marin County
	88	Inverness Public Utility District Volunteer Fire Department	Unincorporated Marin County
	89	Kentfield Fire Protection District	Unincorporated Marin County
	90	Bolinas Fire Protection District	Unincorporated Marin County
	91	County Service Area 14 - Homestead Valley	Unincorporated Marin County
	92	County Service Area 19 - San Rafael	Unincorporated Marin County
	93	Sleepy Hollow Fire Protection District	Unincorporated Marin County
	94	County Service Area 9 - Northbridge	Unincorporated Marin County
	95	County Service Area 13 - Upper Lucas Valley	Unincorporated Marin County
	96	County Service Area 27 - Ross Valley	Unincorporated Marin County
	97	County Service Area 16 - Greenbrae	Unincorporated Marin County Larkspur (Partial)
	98	County Service Area 18 - Las Gallinas	Unincorporated Marin County San Rafael
	99	County Service Area 6 - Gallinas Creek	Unincorporated Marin County San Rafael (partial)
	100	County Service Area 31 - Fire Service in Unincorporated Marin	Unincorporated Marin County Tiburon (partial)
	101	Southern Marin Fire Protection District	Unincorporated Marin County Tiburon (partial) Corte Madera (partial)
Somona	102	Lakeville Volunteer Fire Company	Unincorporated Sonoma County
	103	Cloverdale Fire Protection District	Cloverdale Unincorporated Sonoma County
	104	Rancho Adobe Fire Protection District	Cotati
	105	Healdsburg Fire Protection District	Healdsburg
	106	Petaluma Fire Protection District	Petaluma
	107	Rohnert Park Fire Protection District	Rohnert Park
	108	Santa Rosa Fire Protection District	Santa Rosa Unincorporated Sonoma County
	109	Sebastopol Fire Protection District	Sebastopol
	110	Sonoma Fire Protection District	Sonoma
	111	Cazadero Community Services District	Unincorporated Sonoma County
	112	Occidental Community Services District	Unincorporated Sonoma County
	113	Bodega Bay Fire Protection District	Unincorporated Sonoma County
	114	Timber Cove Fire Protection District	Unincorporated Sonoma County
	115	Two Rock Coast Gaurd Fire Protection District	Unincorporated Sonoma County
	116	Two Rock Volunteer Fire Company	Unincorporated Sonoma County
	117	Kenwood Fire Protection District	Unincorporated Sonoma County
	118	Knights Valley Volunteer Fire Company	Unincorporated Sonoma County
	119	Mayacamas Volunteer Fire Company	Unincorporated Sonoma County
	120	Bennett Valley Fire Protection District	Unincorporated Sonoma County
	121	Bloomfield Volunteer Fire Company	Unincorporated Sonoma County
	122	Bodega Volunteer Fire Company	Unincorporated Sonoma County
	123	Valley Ford Volunteer Fire Company	Unincorporated Sonoma County
	124	Valley Of The Moon Fire Protection District	Unincorporated Sonoma County
	125	Wilmar Volunteer Fire Company	Unincorporated Sonoma County
	126	Monte Rio Fire Protection District	Unincorporated Sonoma County
	127	Russian River Fire Protection District	Unincorporated Sonoma County
	128	San Antonio Volunteer Fire Company	Unincorporated Sonoma County
	129	Annapolis Volunteer Fire Company	Unincorporated Sonoma County
	130	Camp Meeker Volunteer Fire Company	Unincorporated Sonoma County
	131	Forestville Fire Protection District	Unincorporated Sonoma County
	132	Schell-Vista Fire Protection District	Unincorporated Sonoma County
	133	Community Services Area 40	Unincorporated Sonoma County
	134	Sea Ranch Volunteer Fire Company	Unincorporated Sonoma County
	135	Sotoyome Volunteer Fire Company	Unincorporated Sonoma County
	136	Eldridge Fire Department	Unincorporated Sonoma County
	137	Fort Ross Volunteer Fire Company	Unincorporated Sonoma County
	138	Geyserville Fire Protection District	Unincorporated Sonoma County

Sonoma (continued)	139	Glen Ellen Fire Protection District	Unincorporated Sonoma County
	140	Gold Ridge Fire Protection District	Unincorporated Sonoma County
	141	Graton Fire Protection District	Unincorporated Sonoma County
	142	Mountain Volunteer Fire Company	Unincorporated Sonoma County
	143	Windsor Fire Protection District	Windsor (partial) Unincorporated Sonoma County
	144	Rincon Valley Fire Protection District	Windsor (partial) Unincorporated Sonoma County
Napa	145	American Canyon Fire Protection District	American Canyon Unincorporated Napa County
	146	Calistoga Fire Department	Calistoga
	147	Napa Fire Department	Napa
	148	Saint Helena Fire Department	St. Helena
	149	CAL FIRE - Sonoma-Lake-Napa Unit	Unincorporated Napa County
	150	Yountville Fire Department (CAL FIRE Contract)	Yountville
Soalno	151	Cordelia Fire District	Unincorporated Solano County
	152	Benicia Fire Department	Benicia
	153	Dixon Fire Department	Dixon
	154	Fairfield Fire Department	Fairfield (partial)
	155	Travis Air Force Base	Fairfield (partial)
	156	Rio Vista Fire Department	Rio Vista (partial)
	157	Suisun City Fire Department	Suisun City
	158	California Department of Forestry & Fire Protection	Unincorporated Solano County
	159	Dixon Fire District	Unincorporated Solano County
	160	Suisun Fire District	Unincorporated Solano County
	161	Vacaville Fire District	Unincorporated Solano County
	162	Ryer Island Fire District	Unincorporated Solano County
	163	East Vallejo Fire District	Unincorporated Solano County
	164	Montezuma Fire District	Unincorporated Solano County Rio Vista (partial)
	165	Vacaville Fire Department	Vacaville
	166	Vallejo Fire Department	Vallejo Unincorporated Solano County

E. Further Discussion on Wildfire Mapping Data Analysis

The tables in *Section I.C. Bay Area Fire Risk* are available in excel format on the report website: http://resilience.abag.ca.gov/wildfires/. The first sheet of each file has meta data on both the GIS data and geoprocessing operations, as well as the attribute tables and excel analysis. The GIS data is available for download on the Resilience Program's Open Data Page: http://resilience.abag.ca.gov/open-data/.

The files included online are:

Fire Perimeter Severity Tables – Summarizes the intersection of Fire Hazard Severity with past fire burn perimeters.

Fire Perimeter Threat Tables – Summarizes the intersection of Fire Threat with past fire burn perimeters.

Fire Perimeter Comparison Severity Threat – Compares results of the above two tables.

Fire Land Use Severity Tables – Summarizes the intersection of Fire Hazard Severity with different a regional land use layer.

Fire Community Indicators Tables – Summarizes the intersection of Fire Hazard Severity with community vulnerability.

F. Further Discussion on Bay Area Wildfire Plan Strategies

Staff extracted strategies from all of the CCWP and Unit Plans in the region to understand the universe of existing strategies. The strategies are available in an accompanying spreadsheet and can be searched by their plan origin, and the tags used in Figure 17. In the spreadsheet, the first sheet has meta data on the tags used in the strategy "database" and includes descriptions of how to use the pivot table to study different intersections among strategy keywords.

When staff looked at the aggregate of strategies there were thirteen strategies that were common among the fifteen studied plans. Many strategies were listed multiple times within a plan, or were common across all plans. Below is a list of the 13 most cited strategies within the Bay Area region. These do not necessarily reflect the most effective strategies, or the overall priorities of the region, but they are the strategies that appeared most frequently.

General – Collaborative Planning Process

Most plans recognized a need to jointly plan, exercise, and support the other stakeholders within their planning area. Strategies often cited national, state, and local agencies as well as the need to partner directly with neighborhoods to support planning. In six of the eight counties plans recognized a need to partner with other agency partners as well as with neighborhood groups.

General – Comprehensive Public Awareness Campaign

Each plan recognized the need to have a robust and comprehensive public awareness strategy. Many plans suggested blending separate campaigns focused on individual actions into a comprehensive campaign focused on preparedness, mitigation, and response. Departments across the region

mentioned efforts to message at local events and local schools, and an interest in using social media in a more significant way. For a more comprehensive approach to fire risk, the plans mention the need to have a single resource (pamphlet, website, app) that has all the information in a single location, that has locally relevant material.

Land Use – Conduct, Integrate, and Maintain wildfire planning documents.

All the plans recognized the needs to consistently maintain the documents and improve their quality as new information and resources are available. Many plans recognized the suite of planning documents and the need to align their strategies, and attach strategies to Local Hazard Mitigation Plans, the Safety Element, or a special ordinance. To achieve this goal, many plans called out the need to work directly with local government staff to integrate fire approaches into the more comprehensive documents.

Vegetation Management – Special Resources for Species and Site Conditions

The most frequently cited strategy was the development and dissemination of resources on specific species management as it relates to vegetation management. In the Bay Area, vegetation management is complex because of the varied species, site conditions, and techniques necessary to perform vegetation management for each unique case. The plans discussed needs for materials to support stakeholders (individual residents, forest management crews, and large land owners) in performing vegetation management appropriately to limit other environmental consequences, and in a cost effective manner. Across multiple planning documents, goat grazing was discussed as an exciting technique that should be studied further and expanded.

Vegetation Management – Defensible Space Inspections

Property owners living in State Responsibility Areas (SRA) and Very High Fire Hazard Severity Zones in the LRA are required by the code to maintain clearance of flammable vegetation around their property. A property owner's clearance responsibility is limited to 100 feet from his or her structure(s) or to the property line, whichever is closer, and is limited to their lands. Responsible fire departments/agencies have the authorization to inspect and levy fines for violations of the defensible space code. The LE 100 inspection is a standard form used in many communities. For more on the specific code language see Appendix I. Fire Code Details.

Vegetation Management – Defensible Space Programs

Beyond education resources to help residents maintain defensible space around their property, many communities have supported programs to make the process easier for residents. Programs to provide access to a wood chipper and/or easy green waste disposal are common strategies. Some plans recognized two important additions to defensible space program offerings: (1) support for residents who are physically unable to perform the necessary work and/or don't have the financial resources to complete the work, and (2) address defensible space on absentee and vacant properties which don't only increase the risk for the vacant property, but also the surrounding neighbors.

Vegetation Management - Fuel Breaks & Large Land Owners

A suite of fuel break strategies are common in most planning documents. The strategies range from efforts to map the location and quality of the fuel breaks, strategies to leverage existing roads as fuel breaks, and the expanded use of shaded fuel breaks. Shaded fuel breaks are a technique to not remove

all vegetation, but instead remove underlying brush and thinning tree cover. In some areas the shaded fuel break provides a better balance between wildfire protection and ecosystem and aesthetic goals. Many plans call for shaded fuel breaks in transition zones between open space areas and developed residential zones.

Hardening Assets – Provide resources for retrofit.

Many plans recognize that the state mandated code only requires new building construction to meet the WUI code for structures. Plans recognized a need to educate both homeowners and contractors on structure ignitability retrofits. Specific strategies suggested partnerships with local home improvement stores to promote educational materials on structure ignitability retrofits.

Hardening Assets – Inspect and enforce the code.

The building code requires new construction to meet stricter standards. An inspection process is outlined in the code to ensure that standards for roofs, vents, windows, doors, decking, underfloors and auxiliary structures are met. For more information on the code requirements, and the inspection process for new construction see Appendix I. Fire Code Details.

In some jurisdictions, amendments have been made to the state fire code to require buildings at point of remodel to require WUI code upgrades to the building be made. Different thresholds (i.e. projects greater than 50% the cost of structure) are used in different regions, and some jurisdictions do not have this local amendment. When these amendments are in place, it's important that inspection be used to enforce the regulation.

Suppression – Study and expand water storage.

Only a few plans called out the need to expand the amount of water for firefighting in the WUI. Some plans were interested in exploring mutual use of water supply for recreation areas, irrigation, or other water storage uses. The plans also explored an interest in studying opportunities to expand water storage for multi-use projects (i.e. drinking water at trailhead and for firefighting purposes). A few plans specifically called out increasing existing storage standards for private properties – increasing the minimum above 5,000 gallons.

Suppression – Use new technologies to detect fires.

A number of new exciting technologies are being developed that have the potential to monitor forest health in real time and detect fires quickly. A combination of flying drones, stationed cameras, and satellites have the potential to improve the awareness of real time risk, and be alerted more quickly to ignitions. Some strategies call for the expansion of these systems while others are focused on studying their potential use for their district/agency.

Evacuation – Develop and train evacuation plans for all WUI communities and ensure special population needs are met.

Ensuring neighborhoods have an evacuation plan in place is an important first step. Many plans call for the review of current plans, and require secondary access routes where none exist. Some plans mentioned engagement activities to train/exercise the plan with residents, as well as engagement

activities to train residents on the evacuation plan and educate them on other preparedness measures they should have in place before an evacuation order is issued.

Many plans mentioned an overall need to know where special needs populations are, so plans can be made to assist those who are unable to evacuate by themselves. This includes disabled, elderly, and children.

Evacuation – Maintain evacuation routes free of vegetation and vehicular congestion

In after-action reports from past fires across the globe, responders have noted that evacuation was less successful because evacuation routes had fire-caused debris on the roadways. This is a dangerous condition, that many plans call out. Some plans call for prioritized vegetation management along evacuation routes, or specific programs for vegetation management along evacuation routes.

In addition to vegetative debris blocking evacuation, traffic congestion and parked vehicles can hinder evacuations. In the 1991 Oakland Hills Fire the narrow roadways combined with parked cars resulted in a poor evacuation. Some plans call for strict parking standards in areas that are a high fire risk and where roads are narrow. The fire code for new construction also requires sufficient access and egress to allow for evacuation as well as emergency vehicles to effectively access properties with space to turn around their large vehicles.

G. Wildfire Funding Opportunities – From Santa Clara County CCWP

In Appendix D of the 2016 Santa Clara County Community Wildfire Protection Plan there is a summary of funding opportunities. The appendix provides summaries of the funding programs and when available details about past funding amounts and processes. You can access Appendix through Santa Clara Counties website: http://www.sccfd.org/santa-clara-county-community-wildfire-protection-plan

H. Other Fire Types and Impacts

Sidebar 1 – Structural Fires

The most frequent fires are structural fires. Mostly caused by accidents, structure fires occur during all seasons and can begin from a variety of ignition sources.

In California, over the decades, structural fires have decreased, in large part due to the successful adoption and enforcement of building codes. Increased indoor water sprinkler requirements, reduced material flammability, improved alarm systems, and better fire escape egress have all reduced the frequency of structural fires, their spread, and their impact on life safety. These code improvements have resulted in safer new buildings, but as is common with many building code upgrades, improvements are rarely retroactive. Older buildings built before current code standards may not be required to update. It is often up to local building code amendments and ordinances to require existing buildings of certain types to upgrade their systems.

These deficiencies in older buildings was realized on December 2, 2016 w Oakland warehouse fire during an event caused 36 fatalities. The single structure fire was more deadly than the 1991 Tunnel fire which destroyed over 3,000 homes and killed 25. Across California, there were 107 deadly residential structure fires reported to the U.S. Fire Administration in 2016 (U.S. Fire Administration, 2017). This count only captures reported fires and only captures residential fires – which omit fires like the December 2 warehouse fire.

Sidebar 2 – Fire Following Earthquakes

Fire following an earthquake can lead to large scale urban conflagrations. The urban fire conflagration that followed the 1906 San Francisco Earthquake did more damage than the earthquake itself. In the 1906 earthquake, liquefaction-related ground deformation damaged water pipelines and this disruption to the water supply contributed significantly to the extent of the fire spread (USGS, 2017).

The scale of the fire following earthquake risk is a combination of two earthquake impacts: (1) simultaneous ignitions across a wide area, (2) extensive damage to water pipeline infrastructure. In an earthquake electrical, natural gas appliances and infrastructure cause ignitions across a wide scale. The greater the shaking the greater chance of ignitions (Scawthorn, 2008). In a significant earthquake along the San Andreas or Hayward faults hundreds (if not a thousand) ignitions could begin simultaneously. At the same time that ignitions occur, the water pipelines are also expected to have significant breaks which can drain the system rapidly. The combination of many ignitions and limited water supplies to suppress the fires creates the large fire following earthquake risk.

As a result of the 1906 earthquake the City and County of San Francisco invested in an auxiliary water supply system, a redundant water supply system specifically designed for firefighting. The system includes cisterns throughout the city and pipes and additional pumping stations. The City of Berkeley took a novel approach to the problem, investing in an the Berkeley Above Ground Water Supply System (BAWSS). The system is mobile and consists of trucks, pumps, and large diameter flexible hose. The system can be deployed quickly and pump water five miles inland from the San Francisco Bay. No other Bay Area cities have a redundant firefighting system to the likes of San Francisco and Berkeley. But many cities share their same risk.

Sidebar 3 – Rim Fire & Headwater Study & Climate Change Impact

On August 17, 2013 a fire began in the Stanislaus National Forest, 150 miles east of San Francisco. The fire grew rapidly from 16,204 acres on August 21st to 201,795 acres on August 30th. In total, the fire burned 257,314 acres surrounding San Francisco's water and power facilities. The fire was not considered contained until October 24th.

There were initial fears that the fire and future runoff would contaminate the Hetch Hetchy watershed. Because the fire was largely outside of the Hetch Hetchy watershed there were no serious water quality issues; however, the power system was impacted. Two of the three hydroelectric powerhouses were taken offline on August 19th, because the facilities as well as the transmission lines were threatened by the fire. The rooftop of the Holm powerhouse caught fire and sensitive equipment inside the building suffered smoke damage. During the disruption in generation, San Francisco purchased energy on the open energy market, amounting to $860,000 (2013 dollars). During the event, there was enough capacity on the open market to meet the demand (ABAG, 2014).

The event highlighted the Bay Area's reliance on infrastructure systems that are hundreds of miles away. In this instance the fire did not disrupt water supply, nor did the fire interrupt energy sources enough to disrupt the grid. The fire does highlight the potential for other fires to disrupt key Bay Area infrastructure systems. Strategies that reduce fire risk in the Sierra Nevada mountains will make the Bay Area's water and energy supplies more reliable.

For a statewide assessment of wildfire risk in the Sierra Nevada, and it's potential impacts to the Sierra watersheds, the Public Policy Institute of California published Improving the Health of California's Headwater Forests (PPIC, 2017).

I. Fire Code Details

There are two key elements to the WUI fire code: (1) defensible space clearance that must be upkept continuously, and (2) building standards for new construction. In both cases the minimum standards outlined in the state code only require these codes to be enforced in SRA and Very High Fire Hazard Severity Zones in the LRA. Local jurisdictions can increase the extent of the standards if they choose. The suite of codes are well outlined in the California Fire Code Chapter 49. The chapter outlines refers readers to other codes. A summary of Chapter 49 and it's referenced codes is described in this appendix, and includes links to the full code language.

California Fire Code Chapter 49 Requirements for Wildland-Urban Interface Fire Areas.

Adopted frequently. Current code last adopted in 2016.

The code defines state responsibilities, maps, and plans, and calls out sections of different codes that must be met. The code calls out two key sections:

1. Section 4905 Wildfire Protection Building Construction
    a. Refers readers to comply with three specific elements of the California Building Standards Code. The Code applies to State Responsibility Areas, and in Local Responsibility Areas where "substantial evidence in the record [shows] that the requirements of this section are necessary for effective fire protection."
        i. ***California Building Code, Chapter 7A.***
        ii. ***California Residential Code, Section R327.***
        iii. ***California Referenced Standards Code, Chapter 12-7A.***
2. Section 4906 Hazardous Vegetation and Fuel Management
    a. Mandates that all Fire Hazard Severity Zones (Moderate, High, and Very High) in the SRA, and Very High Severity Zones in the LRA are required to comply with the following code requirements.
        i. ***Public Resources Code, Section 4291***
        ii. ***California Code of Regulations, Title 14, Division 1.5, Chapter 7, Subchapter 3, Section 1299.***
        iii. ***California Government Code, Section 51182***
        iv. ***California Code of Regulations, Title 19, Division 1, Chapter 7, Subchapter 1, Section 3.07.***
        v. *For SRA only*
            1. ***Public Resources Code 4290***
            2. ***California Code of Regulations, Title 14, Division 1.5, Chapter 7, Subchapter 2, Section 1270***
        vi. *For LRA only*
            1. ***Government Code 51175 - 51189***

California Building Code 7A

Applies to properties permitted after December 1, 2005.

Applies to building materials, systems, and/or assemblies used in the exterior design and construction of new buildings located within a Wildland-Urban Interface Fire Area – defined as all SRA lands, and Very

High Fire Hazard Severity Zones in the LRA (which is supported by Government Code Sections 51177(c), 51178, and 5118). The code has requirements for the following building elements. Within each section there are further references to specific standards.

1. Roofing
2. Attic ventilation
3. Exterior walls
4. Underfloors (decking, floors)
5. Ancillary buildings and structures

California Residential Code Section R327

Adopted regularly

All requirements apply to buildings built after July 1, 2008. Some (roof and attic ventilations sections) apply to buildings built after December 1, 2005.

The code reads similar to California Building Code 7A and focuses on materials and construction methods for exterior wildfire exposure. This code includes Section R372.3 which describes the specific building and material standards for testing. This code includes the same sections described in California Building Code 7A but expands within each section and includes an additional subsection on windows and doors.

California Referenced Standards Code, Chapter 12-7A

Goes into much greater detail than both CRC Section R327 and CBC 7A. It provides greater detail into the fire resistant testing standards for materials and building components.

PRC 4291

Adopted in 2009.

Requirements apply to buildings built after January 1, 2010.

The code primarily focuses on defensible space requirements for property owners. In addition to defensible space requirements is states that new construction, including a building damaged by a fire, be built to standards outlined by Government Code Section 51189. It also makes the Department of Forestry and Fire Protection responsible for the development and maintenance of fuels management guidance.

California Code of Regulations, Title 14, Division 1.5, Chapter 7, Subchapter 3, Article 3, Section 1299.

Provides guidance for the implementation of PRC 4291 to increase the survivability of buildings that exist with the SRA. It outlines a the specific set of defensible space requirements for two zones:

1. Zone 1 – Applies to area within 30 feet of a building.
2. Zone 2 – Applies to area between 30 and 100 feet of a building.

Additional defensible space beyond 100 feet can be required, but cannot require clearance beyond the property line.

California Code of Regulations, Title 19, Division 1, Chapter 7, Subchapter 1, Section 3.07.

Focuses on required clearances. No combustible material shall be placed within 10 feet of any building, and reiterates (more succinctly) the defensible space requirements in Subchapter 3.

PRC 4290

Adopted June 1989

Requires properties permitted after 1990 to meet the following regulations:

1. Road standards for fire equipment access.
2. Standards for signs identifying streets, roads, and buildings.
3. Minimum private water supply reserves for emergency fire use.
4. Fuel breaks and greenbelts.
5. *these regulations do not supersede local regulations which equal or exceed minimum regulations by the state.

California Code of Regulations, Title 14, Division 1.5, Chapter 7, Subchapter 2, Section 1270

The regulations have been in effect since September 1, 1991.

Provides the minimum wildfire protection standards for buildings and development in the SRA. The code has requirements for the following sections. It also grants the responsible fire agency/department to inspect for compliance with the regulations.

1. Emergency access – regulations for road width, supportive of surface loads, grades, turnarounds and turnouts, and driveways.
2. Signing and building numbering – regulations for roads and properties.
3. Private water supply reserves for emergency fire use – regulations for quantities and locations of water supplies, with details for hydrants and valves
4. Vegetation modification – reiterates the defensible space regulations with an additional section on the use of greenbelts for subdivision plans.

Government Code 51175 – 51189

Outlines many of the already described regulations. The code describes the procedural process for designated local areas as Very High Fire Hazard Severity and set the original designation date as January 1, 1995 for all Bay Area counties, and by January 1, 1996 for all CA counties. The code calls for the VHFHSZ designation in LRA to be updated every five years and when possible coincide with general plan updates [Note, this has not been updated every five years]. The code also requires property owners to disclose during transfers of the property (1102.6a and 1103.2 Civil Code) that it is in the VHFHSZ.

California Government Code, Section 51182

Is specific to defensible space regulations. Violations of regulation are punishable by a fine between $100-500 for the first infraction, $250-$500 for the second infraction, and greater than $500 and charged with a misdemeanor for the third infraction. The local agency can also contract the necessary defensible work space and place the expenses as a lien on the property.

Links to Full Code Text

CFC Chapter 49
https://up.codes/viewer/california/california_fire_code_2016/chapter/49/requirements-for-wildland-urban-interface-fire-areas#49

CBC 7A

http://www.fire.ca.gov/fire_prevention/downloads/ICC_2009_Ch7A_2007_rev_1Jan09_Supplement.pdf

CRC Section R327

http://osfm.fire.ca.gov/codedevelopment/pdf/wildfire%20protection%20building%20construction/2010-Part-2%205-CBC-SecR327.pdf

CRSC Chapter 12-7a

https://codes.iccsafe.org/public/chapter/content/2375/

PRC 4290 & 4291

https://leginfo.legislature.ca.gov/faces/codes_displaySection.xhtml?sectionNum=4290.&lawCode=PRC

https://leginfo.legislature.ca.gov/faces/codes_displaySection.xhtml?sectionNum=4291.&lawCode=PRC

California Code of Regulations, Title 14, Division 1.5, Chapter 7, Subchapter 3, Article 3, Section 1299.

https://govt.westlaw.com/calregs/Browse/Home/California/CaliforniaCodeofRegulations?guid=IB643BB30D48311DEBC02831C6D6C108E&originationContext=documenttoc&transitionType=Default&contextData=(sc.Default)

California Code of Regulations, Title 19, Division 1, Chapter 7, Subchapter 1, Section 3.07.

https://govt.westlaw.com/calregs/Document/I70D8EA3025E411E089088B03F1E6C213?viewType=FullText&originationContext=documenttoc&transitionType=CategoryPageItem&contextData=(sc.Default)

California Code of Regulations, Title 14, Division 1.5, Chapter 7, Subchapter 2, Section 1270

https://govt.westlaw.com/calregs/Browse/Home/California/CaliforniaCodeofRegulations?guid=I944CA9B2D48311DEBC02831C6D6C108E&originationContext=documenttoc&transitionType=Default&contextData=(sc.Default)

Government Code 51175 – 51189

http://www.fire.ca.gov/fire_prevention/downloads/GovernmentCode51175.pdf