TABLE OF CONTENTS

Table of Contents

TABLE OF CONTENTS

Acronyms and Abbreviations

2013 LHMP	Marin County 2013 Local Hazard Mitigation Plan
CalOES	California Governor's Office of Emergency Service
CFR	Code of Federal Regulations
cfs	cubic feet per second
CGS	California Geological Survey
County	Marin County
CRS	Community Rating System
DC3	Marin Disaster and Citizen Corps Council
DFIRM	Digital Flood Insurance Rate Map
DMA 2000	Disaster Mitigation Act of 2000
DSOD	California Division of Safety of Dams
FEMA	Federal Emergency Management Agency

[1]

TABLE OF CONTENTS

FIRM	Flood Insurance Rate Map
FMA	Flood Mitigation Assistance
GIS	Geographic Information System
HMGP	Hazard Mitigation Grant Program
NCDC	National Climatic Data Center
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NWS	National Weather Service
OES	Office of Emergency Services
PDM	Pre-Disaster Mitigation (Program)
RFCP	Repetitive Flood Claims Program
RL	Repetitive Loss
SRL	Severe Repetitive Loss
Stafford Act	Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988
USC	United States Code
NMWD	North Marin Water District

SECTION 1 INTRODUCTION

1.1 OVERVIEW

This section provides a brief overview of the topic, an introduction to hazard mitigation planning, and a brief description of the Disaster Mitigation Act of 2000, grant programs with mitigation plan requirements, local participants, and the 2018 Marin County Multi-Jurisdictional Local Hazard Mitigation Plan.

Marin County (the County) and its partners have developed this Multi-Jurisdictional Local Hazard Mitigation Plan (hereinafter referred to as the MCM LHMP) to assess risks posed by natural hazards and to develop a mitigation strategy for reducing the County's risks. The County has prepared the MCM LHMP in accordance with the requirements of the Disaster Mitigation Act of 2000 (DMA 2000). The Marin County Sheriff's Office of Emergency Services (OES), in conjunction with the Marin County Local Hazard Mitigation Team, has coordinated the preparation of the MCM LHMP in cooperation with municipalities and special district partners. The MCM LHMP replaces the County LHMP that was approved by FEMA in on August 29, 2013and will serve as the current LHMP for all participating jurisdictions. Some participating jurisdictions also have existing single-jurisdiction plans in place that are effective until their expiration date. All MCM LHMP partners will be included in an ongoing MCM LHMP plan review process to facilitate the 2023 plan update process.

This plan draws heavily, and with gratitude, on what the planning team was able to learn from other jurisdictions who have taken on hazard mitigation planning prior to this effort. In addition, the staff serving the Association of Bay Area Governments, the California Governor's Office of Emergency Services, and Region IX of the Federal Emergency Management Agency were of countless assistance to the planning team.

1.2 HAZARD MITIGATION PLANNING

As defined in Title 44 of the Code of Federal Regulations (CFR), Subpart M, Section 206.401, hazard mitigation is "any action taken to reduce or eliminate the long-term risk to human life and property from natural hazards." As such, hazard mitigation is any work to minimize the impacts of any type of hazard event before it occurs. It is a process in which hazards are identified and profiled, the people and facilities at risk are analyzed, and mitigation actions to reduce or eliminate hazard risk are developed. The implementation of the mitigation actions, which include short- and long-term strategies that may involve planning, policy changes, programs, projects, and other activities, is the end-result of this process.

1.3 DISASTER MITIGATION ACT OF 2000

Local hazard mitigation planning is compelled as a matter of law as of the Disaster Mitigation Act signed in 2000 (DMA 2000). On October 30, 2000, Congress passed the DMA 2000 (Public Law 106-390), which amended the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988 (Stafford Act) (Title 42 of the United States Code [USC] Section 5121 et seq.) by repealing the act's previous mitigation planning section (409) and replacing it with a new mitigation planning section (322). This new section emphasizes the need for state, tribal, and local entities to closely coordinate mitigation planning and implementation efforts. This new section also provides the legal basis for the Federal Emergency Management Agency's (FEMA's) mitigation plan requirements for mitigation grant assistance.

To implement these planning requirements, FEMA published an Interim Final Rule in the Federal Register on February 26, 2002 (44 CFR Part 201). The local mitigation planning requirements are identified in their appropriate sections throughout this MCM LHMP and in the FEMA Local Mitigation Planning Crosswalk / Review Tool in Appendix A. In addition, this plan addresses the Community Rating System (CRS) 10-step planning process requirements.

1.4 GRANT PROGRAMS WITH MITIGATION PLAN REQUIREMENTS

Currently, FEMA grant programs are available to participating jurisdictions that have FEMA-approved HMPs and are members of the National Flood Insurance Program (NFIP). Two of the grant programs are authorized under the Stafford Act and DMA 2000.

Hazard Mitigation Grant Program. The Hazard Mitigation Grant Program (HMGP) provides grants to state, local, and tribal entities to implement long-term hazard mitigation measures after declaration of a major disaster. The purpose of the HMGP is to reduce the loss of life and property due to natural disasters and enable mitigation measures to be implemented during the immediate recovery from a disaster. Projects must provide a long-term solution to a problem (for example, elevation of a home to reduce the risk of flood damage rather than buying sandbags and pumps to fight the flood). Also, a project's potential savings must be more than the cost of implementing the project. Funds may be used to protect either public or private property or to purchase property that has been subjected to, or is in danger of, repetitive damage. The amount of funding available for the HMGP under a particular disaster declaration is limited. Under the program, the Federal government may provide a state or tribe with up to 20 percent of the total disaster grants awarded by FEMA and may provide up to 75 percent of the cost of projects approved under the program, subject to a specified program cap. Between 2016 and 2018 several HMGP applications were submitted by participants in this MCM LHMP.

Pre-Disaster Mitigation Program. The Pre-Disaster Mitigation (PDM) Program provides funds to state, local, and tribal entities for hazard mitigation planning and the implementation of mitigation projects before a disaster. PDM grants are awarded on a nationally competitive basis. Like HMGP funding, the potential savings of a PDM project must be more than the cost of

implementing the project, and funds may be used to protect either public or private property or to purchase property that has been subjected to, or is in danger of, repetitive damage. The total amount of PDM funding available is appropriated by Congress on an annual basis. The cost-sharing for this grant is 75 percent Federal and 25 percent non-Federal, although cost-sharing of 90 percent Federal and 10 percent non-Federal is available in certain situations.

1.5 LOCAL PARTICIPANTS

The participating jurisdictions and special districts, referred to in this plan as local participants or partners, are listed below.

- Marin County
- City of Belvedere
- Town of Corte Madera
- City of Fairfax
- City of Larkspur
- City of Mill Valley
- City of Novato
- Town of Ross
- City of San Rafael
- Town of San Anselmo
- City of Sausalito
- City of Tiburon
- North Marin Water District
- Marin County Flood Control and Water Conservation District

1.6 COMMUNITY DESCRIPTION

1.6.1 County of Marin

Marin County, one of 58 counties in the state, is located on northern California's Pacific coast, just north of San Francisco. Marin County is bordered by Sonoma County to the north; the Pacific Ocean to the northwest and southwest; and the City and County of San Francisco to the south. Marin County spans 828 square miles, of which 520 square miles is land and 308 square miles is water. This footprint makes Marin County among the four smallest counties in the State;

the only smaller counties being San Mateo County, Santa Cruz County, and the City and County of San Francisco. The following protected areas are within or contiguous to Marin:

National Protected Areas:

- Golden Gate National Recreation Area (U.S. National Park Service)
- Marin Islands National Wildlife Refuge
- Muir Woods National Monument
- Point Reyes National Seashore
- San Pablo Bay National Wildlife Refuge
- Gulf of the Farallones National Marin Sanctuary

State Parks:

- Angel Island State Park
- China Camp State Park
- Mount Tamalpais State Park
- Olompali State Historic Park
- Samuel P. Taylor State Park
- Tomales Bay State Park

Marine Protected Areas:

- Duxbury Reef State Marine Conservation Area
- Estero Americano State Marine Recreational Management Area
- Estero de San Antonio State Marine Recreational Management Area
- Point Reyes State Marine Reserve & Drakes Estero State Marine Conservation Area

Marin County was incorporated in 1850 as one of the original 27 counties of California. Within its boundaries are 11 municipalities, 20 Census Designated Places, and 8 recognized unincorporated communities. The county seat is the City of San Rafael. According to the U.S. Census Bureau, and using the Population Estimates Program which produces July 1 estimates for years after the last published decennial census (2010), the 3.5% population increase to the 2015 estimate brings the population to 261,221. The county has 111,990 housing units, of a theoretical buildout amount of $120,755. The majority of the county's population resides within the municipalities along Highway 101.

1.6.2 Economy

Marin County has a strong economic base which has changed significantly over the last century. The county's economy was dominated by agriculture in the early part of its history. However, in recent years, Marin's economy has seen increasing job growth in technology-related fields such as biotechnology, computer software, and multimedia. With several attractions including beaches and parks in Marin, tourism is important to Marin County's economy.

Services, retail trade, government, and manufacturing account for the majority of employers in Marin. Some municipalities have also become closely aligned with particular industries. For example, Sausalito is known for its fishing fleet. Health care has a major presence in the City of San Rafael. The county also boasts one the state's highest certified organic and sustainable crop ratios.

1.6.3 Physical Features

Marin County is located along California's Pacific Coast (between San Francisco and Sonoma), including 72 miles of coastline. The highest point in the county, Mount Tamalpais, is 2,572 feet above sea level. The county has many microclimates with varying weather patterns, but the climate is generally Mediterranean with an average annual temperature of 79.7 degrees Fahrenheit. The County consists of areas of mountains/hills, valleys, forests, creeks, bayside wetlands and mud flats, and ocean coasts.

1.6.4 Infrastructure

Transportation

Marin County has an ever-developing transportation system, with most travel concentrated along key highways and arterial streets. There are 5 Highways passing through, terminating, or located wholly in Marin: Interstate 580, U.S. Route 101, State Route 1, State Route 37, and State Route 131. Marin is connected to its surrounding neighbors by bridges. The Golden Gate Bridge is to the south; the Richmond/San Rafael Bridge is to the east; State Route 37 is to the northeast (across filled bay land over San Pablo Bay); and Highway 101 is to the north (which narrows to a 4-lane uncontrolled road that traverses San Antonio Creek). One of the major problems Marin County faces during an emergency is the possibility of being isolated from the surrounding communities and any resources or help. Light rail service recently began supplementing existing transportation options along U.S. Route 101 between Marin and Sonoma Counties.

Utilities

Municipal utilities in Marin County include water (drinking water, stormwater, sanitary sewerage), power (electricity and natural gas), telecommunications, and solid waste. Several

water management utilities supply treated water for domestic and fire suppression purposes. These distribution systems rely largely on the County's topography for collecting surface water, storing it in reservoirs, and distributing it with gravity-fed systems. As such, the water management utilities are separated by both functional area and geography, but they are working more and more to coordinate within watersheds.

Marin Municipal Water District (MMWD) is the largest water district in Marin, serving central and southern portions of the county east of Mount Tamalpais and Bolinas Ridge. North Marin Water District (NMWD) serves Novato and communities along Tomales Bay including Olema, Point Reyes Station, Inverness, and Dillon Beach. Bolinas and Stinson Beach, two communities in West Marin, have separate water and sanitary districts. There are 23 agencies providing wastewater services in Marin County, including special districts, municipalities, JPAs and the Federal and State government.

(Citation: https://www.marincounty.org/depts/gj/reports-and-responses/reports-responses/2013-14/~/media/Files/Departments/GJ/Reports%20Responses/2013/SewerScoopI.pdf)

Stormwater utilities such as open channels, catch basins and storm drains are managed by the cities, towns, and the county in unincorporated areas and are coordinated through the Marin County Stormwater Pollution Prevention Program (MCSTOPPP). Additionally, the Marin County Flood Control and Water Conservation District maintains some larger drainage infrastructure where zones have been designated. The District and some cities/towns such as San Rafael, Corte Madera, and Novato operate stormwater pump stations.

Natural gas and electricity distribution occurs through infrastructure owned and maintained by PG&E, a private utility corporation. Natural gas is piped into Marin from the central valley around the North Bay through Solano, Napa, and Sonoma Counties. The main transmission pipelines are underground along Highway 101 and flow south, branching into local distribution lines and private laterals. PG&E also brings power into Marin around the North Bay on overhead transmission lines that emanate from the Ignacio substation in Novato. Additional substations are located along Hwy 101 in Las Gallinas, San Rafael, Greenbrae, and Mill Valley to the South and in Novato, Stafford, Tocaloma, Olema, Bolinas and Woodacre to the North and East.

Telecommunications include telephone service, cable television and wireless services. AT&T maintains infrastructure for providing landlines, while Comcast provides cable television. A variety of cellular and wireless service companies operate in Marin and provide access points in the form of cellular towers, wireless antennas and equipment.

There are six solid waste haulers that operate within Marin County organized geographically and with agreements with cities and towns. All of this garbage, recycling, and greenwaste is brought to one of two processing centers; Redwood Landfill in Novato and Marin Resource Recovery Center in San Rafael.

1.6.5 Participating Municipalities

Marin County has 11 cities and towns, all of which participated in the preparation of this Plan. Using the most up-to-date information provided by the U.S. Census Bureau, these cities and key aspects of their socioeconomic and demographic qualities are described below.

City of Belvedere

The City of Belvedere had an estimated population of 2,068 in 2010, with 1,045 housing units in the City. The City has a total area of 2.406 square miles. The median income for a household in the City was $130,796 and the per capita income for the City was $113,595. Approximately 2.9 percent of families and 5.7 percent of the population were below the poverty line (2010 data, U.S. Census Bureau).

Belvedere was incorporated as a city in 1896.

Town of Corte Madera

The Town of Corte Madera had an estimated population of 9,253 in 2010, with 4,026 housing units in the Town. The Town has a total area of 4.406 square miles. The median income for a household in the Town was $79,839 and the per capita income for the Town was $46,326. Approximately 2.7 percent of families and 4.5 percent of the population were below the poverty line (2010 data, U.S. Census Bureau).

Corte Madera was incorporated in 1916.

Town of Fairfax

The Town of Fairfax had an estimated population of 7,441 in 2010, with 3,585 housing units in the Town. The Town has a total area of 2.204 square miles. The median income for a household in the Town is $58,465 and the per capita income for the Town is $34,080. Approximately 4.3 percent of families and 6.5 percent of the population is below the poverty line (2010 data, U.S. Census Bureau).

Fairfax was incorporated as a town in 1931.

City of Larkspur

The City of Larkspur had an estimated population of 11,926 in 2010, with 6,376 housing units in the City. The City has a total area of 3.243 square miles. The median income for a household in the City was $66,710 and the per capita income for the City was $56,983. Approximately 1.8 percent of families and 3.7 percent of the population were below the poverty line (2010 data, U.S. Census Bureau).

Larkspur was incorporated as a city in 1908.

City of Mill Valley

Mill Valley had an estimated population of 13,903 in 2010, with 6,534 housing units in the City. The City has a total area of 4.847 square miles. The median income for a household in the City was $90,794 and the per capita income for the City was $64,179. Approximately 2.7 percent of families and 4.5 percent of the population were below the poverty line (2010 data, U.S. Census Bureau).

Mill Valley was incorporated as a city in 1900.

City of Novato

The City of Novato had an estimated population of 51,904 in 2010, with 21,158 housing units in the City. The City has a total area of 27.440 square miles. The median income for a household in the City was $63,453, and the per capita income for the City was $32,402. Approximately 3.1 percent of families and 5.6 percent of the population were below the poverty line (2010 data, U.S. Census Bureau).

Novato was incorporated as a city in 1960.

Town of Ross

The Town of Ross had an estimated population of 2,415 in 2010, with 884 housing units in the Town. The Town has a total area of 1.556 square miles. The median income for a household in the Town is $102,015 and the per capita income for the Town is $51,150. Approximately 5.6 percent of families and 8.5 percent of the population is below the poverty line (2010 data, U.S. Census Bureau).

Ross was incorporated as a town in 1908.

Town of San Anselmo

The Town of San Anselmo had an estimated population of 12,336 in 2010, with 5,538 housing units in the Town. The Town has a total area of 2.677 square miles. The median income for a household in the City is $71,488 and the per capita income for the City is $ $41,977. Approximately 2.5 percent of families and 5.1 percent of the population is below the poverty line (2010 data, U.S. Census Bureau).

San Anselmo was incorporated as a town in 1907.

City of San Rafael

The City of San Rafael (San Rafael) is the county seat of Marin County. San Rafael had an estimated population of 57,713 in 2010, with 24,011 housing units in the City. The City has a total area of 22.422 square miles. The median income for a household in the City was $60,994

and the per capita income for the City was $35,762. Approximately 5.6 percent of families and 10.2 percent of the population were below the poverty line (2010 data, U.S. Census Bureau).

San Rafael was incorporated as a city in 1874.

City of Sausalito

Sausalito had an estimated population of 7,061 in 2010, with 4,536 housing units in the City. The City has a total area of 2.257 square miles. The median income for a household in the City was $87,469 and the per capita income for the City was $81,040. Approximately 2.0 percent of families and 5.1 percent of the population were below the poverty line (2010 data, U.S. Census Bureau).

Sausalito was incorporated as a city in 1893.

Town of Tiburon

The Town of Tiburon had an estimated population of 8,962 in 2010, with 4,025 housing units in the Town. The Town has a total area of 13.182 square miles. The median income for a household in the Town was $106,611 and the per capita income for the Town was $85,966. Approximately 1.6 percent of families and 3.3 percent of the population were below the poverty line (2010 data, U.S. Census Bureau).

Tiburon was incorporated in 1964.

1.6.6 Participating Special Districts

As noted previously, two of the participating jurisdictions are special districts. Information about each district is described as follows.

North Marin Water District

North Marin Water District (NMWD) was formed in April 1948 following voter approval under the California State law known as the County Water District Law (Division 12 of the California Water Code).

NMWD primarily serves the City of Novato and surrounding unincorporated areas in Marin County, encompassing approximately 75 square miles. The Novato Service Area has approximately 20,750 active service connections serving approximately 24,000 dwelling units, as well as commercial, industrial and institutional customers. The estimated Novato Service Area population is 61,000. NMWD also provides service to several small improvement districts in the West Marin Service Area near the Pacific Ocean, via approximately 800 service connections.

NMWD owns and operates Stafford Lake and the associated treatment plant, which provides approximately 20% of Novato's water. The lake lies four miles west of downtown Novato and collects runoff from 8.3 square miles of watershed property located upstream at the upper tributary reaches of Novato Creek. Water from Stafford Lake is drawn by the intake tower and fed by gravity or by pumping (depending on the lake level) into the treatment plant located just below the dam. In addition to providing water supply for domestic needs and firefighting purposes, Stafford dam provides flood protection for the greater Novato area. The Marin County Flood Control and Water Conservation District has partnered with NMWD to share in the cost of obtaining additional flood liability insurance.

Water from the Russian River via connection to the Sonoma County Water Agency's aqueduct provides the remaining 80% of the Novato Service Area supply of water. This water originates from both the Eel River and the Russian River watersheds. The water supply for the West Marin Service Area is derived from groundwater.

NMWD maintains and operates approximately 340 miles of pipeline, 42 tanks totaling over 37 million gallons of storage, and associated pump stations, hydropneumatic systems, and regulator valves. NMWD sizes its storage tanks to meet operational, firefighting and emergency requirements. Storage requirements for both the Novato and West Marin Service Areas are updated on a 5-year cycle, and are based in part on input provided by Novato Fire Protection District and Marin County Fire.

Ensuring water quality and protecting public health is one of NMWD's primary goals. Water quality data is routinely collected throughout the distribution systems and at water sources.

Marin County Flood Control and Water Conservation District

The District's geographical boundary is the same as the County's and, as a whole, it has no source of revenue. Instead, revenue is collected via ad valorem taxes and fees paid by property owners in one of eight zones covering distinct geographical areas within the District. All expenditures by the District require authorization by the Board of Supervisors of the District and the five members of the Marin County Board of Supervisors serve on the District's board.

Eight zones have been established within the District to address specific flooding problems in eight watersheds across Marin County.

1.7 DESCRIPTION OF THE MULTI JURISDICTIONAL LOCAL HAZARD MITIGATION PLAN

A multi-jurisdictional hazard mitigation plan is a plan jointly prepared by more than one jurisdiction. Jurisdictions can benefit in several ways when they choose to participate in a multi-jurisdictional planning process. Among such benefits, this process:

- Enables comprehensive approaches to mitigation of hazards that affect multiple jurisdictions;
- Allows economies of scale by:
    - Leveraging individual capabilities; and
    - Sharing costs and resources;
- Avoids duplication of efforts; and
- Imposes an external discipline on the process.

The remainder of this MCM LHMP consists of the sections described below.

Section 2: Planning Process

Section 2 describes the planning process. Specifically, this section describes the plan development process and identifies members of the Planning Committee and Plan Review Committee; including a description of the meetings held as part of the planning process (relevant documents are attached in the Appendixes). This section also documents public outreach and stakeholder involvement activities and discusses the review and incorporation of relevant plans, reports, and other appropriate information.

Section 3: Hazard Analysis

Section 3 describes the process through which the Planning Committee identified, screened, and selected the hazards to be profiled in the MCM LHMP. The hazard analysis includes the nature, history, location, extent, and probability of future events for each hazard.

Section 4: Vulnerability Analysis

Section 4 identifies the methodology for analyzing potentially vulnerable assets—population, residential building stock, RL and SRL properties, and critical facilities and infrastructure. This information was compiled by assessing the potential impacts from each hazard using Geographic Information System (GIS) data. The resulting information identifies the full range of hazards that each plan participant could face and the potential social impacts, damages, and economic losses. The results of the analysis are provided in each local-participant-specific appendix (Appendix G

through Appendix X). Additionally, the impacts of the hazards on future development areas, natural and beneficial function, and life/safety warning/evacuation procedures are discussed at the end of this section to meet the compliance requirements for CRS Activity Worksheet 510.

Section 5: Mitigation Strategy

Section 5 provides a blueprint for reducing the potential losses identified in the vulnerability analysis. The Planning Committee reviewed mitigation projects identified in the prior LHMP of the eight participating jurisdictions with existing plans. Every participating jurisdiction with an existing LHMP assessed their progress on previously identified actions and revised their list to reflect updated priorities. Actions common to all jurisdictions were consolidated into a list of "common actions".

Section 6: Plan Maintenance

Section 6 describes the formal plan maintenance process to ensure that the MCM LHMP remains an active and applicable document. The process includes monitoring, evaluating, and updating the plan (relevant documents are attached in Appendix F); monitoring mitigation projects and closeout procedures (relevant documents attached in Appendix F); implementing the plan through existing planning mechanisms; and achieving continued public involvement.

SECTION 2 PLANNING PROCESS

2.1 OVERVIEW

This section summarizes the planning efforts; details how the plan was updated and who was involved in this process; documents public outreach and stakeholder involvement efforts; and summarizes the review and incorporation of existing plans, studies, and reports used to develop the MCM LHMP. Additional information regarding the meetings and public outreach efforts is discussed below and provided in more detail in Appendix C, D and E.

2.2 INITIAL PLANNING PROCESS, 2011–2013

As noted previously, the initial basis for this plan was 2013 Marin County LHMP and LHMPs of partner jurisdictions with current approved and adopted plans. This plan was prepared by the Marin County Local Hazard Mitigation Plan Team, which consisted of representatives from the County Office of Emergency Services, Department of Public Works, Fire Department, and Community Development Agency. The 2013 LHMP development occurred from December 2011 to July 2013. The 2012 LHMP was adopted by the Marin County Board of Supervisors on October 16, 2012 and approved by FEMA on August 29, 2013.

2.3 PLAN UPDATE PROCESS, 2013–2018

Pursuant to approval and adoption of the 2013 LHMP, the County LHMP Team established a schedule of team meetings to provide opportunity for review and documentation of any changes to LHMP relevant plans, projects, programs, as well as Notices of Intent (NOIs) submitted to CalOES by their respective groups. In April 2016 the Marin County Sheriff's OES kicked off the official update process. The 2018 plan process became a multi-jurisdictional process to include all municipalities and select Special Districts. The Marin County Sheriff's OES determined that the standing Marin Disaster and Citizen Corps Council (DC3) included almost all of the relevant stakeholders and therefore would make up the 2018 MCM-LHMP Plan Review Committee. The DC3 consists of local emergency managers from the County, cities, and special districts as well as non-governmental agencies, private sector, and special districts that have been delegated the authority of local government emergency services directors, City Managers, and the Director of Emergency Services (a member of the County Board of Supervisors) who serves as the DC3 Chairperson.

The MCM LHMP's Planning Committee is shown below in Table 2-1. The 2018 DC3, serving as the MCMLHMP Plan Review Committee, is shown below in Table 2-2.

Table 2-1. Planning Committee

Department, Agency, or Municipality	Name
Marin County Sheriff's Office	Thomas Jordan, Emergency Services Coordinator
Marin County Department of Public Works	Hannah Lee, Civil Engineer Beb Skye, Engineering Technician Felix Meneau, Assistant Engineer Gerhard Epke, Senior Program Coordinator
Marin County Fire Department	Scott Alber, Fire Marshal
Marin County Community Development Agency	Kristen Drumm, Senior Planner Alex Westhoff, Planner
City of Belvedere	Irene Borba, Director of Planning & Building Laurie Nilsen, Emergency Services Coordinator
Town of Corte Madera	Kelly Crowe, Associate Civil Engineer Matt Cobb, Battalion Chief Hamid Khalili, Police Captain Adam Wolff, Planning and Building Director Peter Brown, Public Works Director
City of Fairfax	Mark Lockaby, Chief Building Official Michele Gardner, Deputy Town Clerk
City of Larkspur	Matt Cobb, Battalion Chief Bob Quinn, Public Works Superintendent Neal Toft, Planning Director Julian Skinner, Public Works Director .
City of Mill Valley	Tom Welch, Fire Chief Andrew Poster, Public Works Director Elisa Sarlatte, DPW Engineering Manager
Town of Ross	Richard Simonitch, Public Works Director Heidi Scoble, Planning Manager Erik Masterson, Police Chief
Town of San Anselmo	Sean Condry, Public Works Director Elise Semonian, Planning Director Dave Donery, Town Manager
City of San Rafael	Talia Smith, Senior Management Analyst Quin Gardner, Emergency Management Coord Robert Sinnott, Deputy Fire Chief Kevin McGowan, Asst Public Works Director Bill Guerin, Public Works Director

Table 2-1. Planning Committee

Department, Agency, or Municipality	Name
City of Sausalito	Jonathon Goldman, Public Works Director Bill Frass, Police Captain Lilly Whalen, Clerk Mike McKinley, Emergency Services Coordinator
Town of Tiburon	Kyra O'Malley, Associate Planner Laurie Nilsen, Emergency Services Coordinator Scott Anderson, Community Development Director
City of Novato	Nancy Andrews, Senior Management Analyst Bob Brown, Community Development Director Bill Tyler, Fire Chief Jim Correa, Police Captain Dave Jeffries, Consultant
North Marin Water District	Drew McIntyre, General Manager Rocky Vogler, Chief Engineer Pippin Cavagnaro, Associate
Marin County Flood Control and Water Conservation District	Hannah Lee, Civil Engineer Felix Meneau, Assistant Engineer Gerhard Epke, Senior Program Coordinator

Table 2-2. MCM LHMP Plan Review Committee

DC3 Position Title	Name
Chairperson	Judy Arnold
Marin Managers	Joe Chinn
Schools	Michael Grant
Emergency Medical Services	Miles Julihn
Access and Functional Needs	Peter Mendoza
MIDC	Denis O'Leary
Transit	Mohamed Osman
Health and Human Services	Lisa Santora
Police Chiefs	Tricia Seyler-Campbell
Public Works	Eric Steger

Table 2-2. MCM LHMP Plan Review Committee

DC3 Position Title	Name
At Large Representative	Bill Tyler
MCCMC	Catherine Way
Fire Chiefs	Jason Weber
American Red Cross	Debbie Yee
Economic Forum	Garry Lion
District 1	Frank Cox
District 2	Michael McDermott
District 3	Keith Kennedy
District 4	Anne Sands
District 5	Ed Schulze

DC3 = Marin County Disaster and Citizen Corps Council

County LHMP Team members attended and facilitated meetings with the Planning Committee and coordinated numerous activities to create the 2018 MCM LHMP. Members of the Plan Review Committee were provided project updates at Marin County Disaster and Citizen Corps Council DC3) meetings and draft plans for review via email. Additional information regarding the meetings and public outreach efforts is provided in more detail in Appendix C, D and E.

Community Rating System Program Planning Process

Several participating jurisdictions in the MCM LHMP are also participants in FEMA's Community Rating System (CRS), including the County of Marin, City of Sausalito, Town of Fairfax, Town of San Anselmo, Town of Ross, Town of Corte Madera, and the City of Novato. The County of Marin hosts regular CRS coordination meetings and invites all jurisdictions, even those that aren't currently part of CRS. The Marin County Public Works Community Rating System representative who hosts those multi-jurisdictional meetings also participated on the MCM LHMP Planning Committee in order to address the CRS Floodplain Management Planning requirements.

2.4 PUBLIC OUTREACH AND STAKEHOLDER INVOLVEMENT

2.4.1 Meetings

During the planning process, Marin County Sheriff's OES staff made presentations at Marin County Disaster and Citizen Corps Council (DC3) and County Emergency Manager group meetings to discuss the MCM LHMP. The Marin County DC3 is an advisory body whose mission is to contribute to a unified effort in improving disaster preparedness, mitigation, response and recovery countywide. These efforts are achieved through a partnership of cooperation and collaboration with all levels of government, non-government and the private sector. Current DC3 members include representatives from Marin County Sheriff's OES, county Fire Chiefs, American Red Cross, Marin County Economic Forum, Public Works, and county Health and Human Services, to name a few. The Marin County DC3 meetings are open to the public and the details for each meeting (including time, date, location, and agenda) are posted on the Sheriff's Office website. At these meetings County staff gave presentations on the MCM LHMP and discussed progress to date, the plan adoption process and answered any general questions and comments about the update process.

Copies of the agenda and meeting minutes for DC3 / Plan Review Committee meeting and copies agendas for the Planning Committee meetings are provided in Appendix E.

In addition to meetings of the Planning Committee and the Plan Review Committee, the County LHMP Team conducted one-on-one plan finalization meetings with each participating municipality on the following dates:

- City of Belvedere - 7/12/18
- Town of Corte Madera - 7/19/18
- City of Fairfax - 7/23/18
- City of Larkspur - 7/18/18
- City of Mill Valley - 7/25/18
- City of Novato - 7/18/18
- Town of Ross - 7/7/18
- City of San Rafael - 7/24/18
- Town of San Anselmo - 7/23/18
- City of Sausalito - 7/30/18
- City of Tiburon - 7/12/18
- North Marin Water District - 7/25/18

2.4.2 Media Announcements

Marin County Sheriff's OES issued a media release announcing the kick-off of the MCM LHMP update process and sent the release to the Marin Independent Journal and the Point Reyes Light. The media release also provided the MCM LHMP Website link and contact information should further information be desired. A November 4, 2014 on-air interview with national news outlet The Weather Channel also highlighted the MCM LHMP effort and it's benefit to the communities of Marin County.

Copies of the media release and Point Reyes Light article are provided in Appendix E.

2.4.3 Public Workshops and Virtual Engagement Series

County staff working on the MCM LHMP hosted a total of 6 Public Workshops. These workshops were held in the North, South – Central, and West areas of the County and were conducted at each location during both working hours and in evenings to insure availability for residents from all areas of the County during business hours and in evening hours. All workshop announcement and outreach materials listed each of the participating jurisdictions so that residents would be aware that this was an all county effort. Workshops consisted of a presentation on the basics of Hazard Mitigation Planning, the update and multi-jurisdictional planning process, and a review of resources for the public. Resources, such as MarinMap and the the California Office of Emergency Services (CalOES) Hazard Mitigation activities and projects website, were available on-line so that attendees without internet access at home could view these resources.

In addition to in-person workshops, a Virtual Engagement Series (VES) was posted online so that members of the public unable to attend one of the 6 workshops could have access to the workshop contents and ability to comment on the planning process. Over 100 public comments were obtained via the VES process and as such were incorporated in the drafting of the MCM LHMP.

2.4.4 Website

As noted above, Marin County Sheriff's OES re-launched the County's HMP Website, which was first used during the development of the 2013 LHMP. For the MCM LHMP, the Website provided information about disasters in Marin County, the DMA 2000, HMP update requirements, and the planning process overview. In addition, Marin County Sheriff's OES posted hazard maps as they were completed and provided copy of the Final Draft online for review and comment. The MCM LHMP Website is located at:

http://portal.countyofMarin.org/portal/page/portal/cov/emergencies/mitigation/plan. A snapshot of the MCM LHMP Website is provided in Appendix E. The County has also developed and launched a Community Rating System website which includes the Final Draft MCM LHMP. The

website is at: https://www.marincounty.org/depts/pw/divisions/creeks-bay-and-flood/fema-flood-information

SECTION 3 HAZARD ANALYSIS

3.1 OVERVIEW

A hazard analysis includes the identification and screening of each hazard and then the profiling of each hazard. Consistent with DMA 2000 and reasonable local capabilities this hazard analysis includes natural hazards (not human-caused, such as terrorism). Natural hazards result from unexpected or uncontrollable natural events of significant size and destructive power.

Per the local mitigation planning requirements, this hazard analysis consists of the following two steps:

1. Hazard identification and screening

2. Hazard profiles

3.2 HAZARD IDENTIFICATION AND SCREENING

As the first step in the hazard analysis, the MCM LHMP Planning Committee reviewed the list of hazards presented in Table 3-1 and the following questions:

- Is the hazard included in the 2013 County of Marin (unincorporated) LHMP?
- Is the hazard included in any of the most recent LHMPs of non-County jurisdictions?
- Is the hazard included in the 2007 Marin Countywide Plan (2015 update)?
- Is the hazard included in the 2013 or draft 2018 State of California Multi-Hazard Mitigation Plan?
- Has the hazard occurred in Marin County and been declared a Presidential or State emergency or disaster in the past 40 years?

The results of the screening are presented in Table 3-1.

Table 3-1. Hazard Screening

Hazard	Profiled in prior LHMPs	Profiled in 2007 Marin Countywide Plan	Declared Emergencies and Disasters in Marin County, 1970 to Present		Profiled in this Plan
			State	Federal	
Agricultural	X		X		No. Human caused, not significant.
Snow Avalanche					No. Snow extremely rare in this climate.
Coastal erosion		X		X	Yes. See Severe Storm.
Dam failure	X	X			Yes. See Earthquake.
Drought	X	X	X		Yes. See Wildfire
Earthquake	X	X		X	Yes.
Sea Level Rise &Storm Surge &Subsidence		X			Yes. See Severe Storm.
Flood	X	X	X	X	Yes. See Severe Storm.
Fog					No.
Hailstorm					No. Hailstorms extremely rare in this climate.
Heat					Yes. See Wildfire.
Hurricane					No. Hurricanes do not occur in this climate.
Landslide/mudslide/"debris flow"	X	X		X	Yes. See Severe Storm and Wildfire.
Levee Failure		X			Yes. See Severe Storm.
Liquefaction	X	X			Yes. See Earthquake.
Severe wind & tornado					Yes. See Severe Storm.
Severe storm			X	X	Yes.
Volcano					None.
Tsunami/seiche	X	X			Yes.
Wildfire/fire	X	X	X	X	Yes.

After discussing and reviewing public input on each hazard identified as listed in Table 3-1, the Planning Committee determined that the following hazard groups pose the greatest threat to Marin County and should therefore be profiled or re-profiled in the main body of the MCM LHMP. Hazards specific to individual jurisdictions is profiled in that jurisdiction's annex to the main body of this plan. The Planning Committee's decisions were based on the likelihood of the hazard's occurrence and the feasibility of mitigation. Sections in which hazards are profiled are indicated in parentheses.

- Earthquakes and liquefaction (3.3.1)
    - Dam failure (3.3.2)
- Severe storm (3.3.3)
    - Debris flow (landslides) (3.3.4)
    - Flooding (3.3.5)
    - Wind (3.3.6)
- Tsunami (3.3.7)
- Wildfire (3.3.8)
    - Post-fire debris flow (3.3.9)

All hazards included in the 2013 Marin County (single jurisdiction) LHMP are included in this multi-jurisdictional plan, except for terrorism and agricultural biological hazards as these are caused by human activities and not natural phenomena. Hazards new to the MCM LHMP are: post-fire debris flow and severe storm, which includes wind, in addition to flooding and debris flow which were in the 2013 LHMP (due to the local climate, freezing temperatures and snow are not considered major threats to Marin's infrastructure).

Hazards selected for inclusion in this MCM LHMP are those that pose the greatest threat to the County, based on the factors shown in Table 3-1, including the occurrence of a state or presidential disaster declaration for the hazard. Planning Committee members also used their collective knowledge of the hazards and each hazards' potential threat to determine whether or not to include the hazard in this MCM LHMP. This methodology places a focus on current hazards, in which the hazards' threats are easily identifiable, and for which there is a history of the hazards' occurrence.

A future hazard that poses a threat to the County is climate change. Climate change is not considered as a separate hazard in this MCM LHMP. Climate change is expected to cause or contribute to numerous other hazards that are already addressed in this and related documents, including wildfires, flooding, severe winter storms, and coastal erosion.

For example, two effects of climate change that are already occurring are sea level rise and an increase in the number, frequency, and size of wildfires. These effects have already been experienced in California over the last century. Wildfires have also increased substantially in frequency, duration, and size in recent years. The forested area burned in the western United States from 1987 to 2003 was 6.7 times the area burned from 1970 to 1986. Warmer

temperatures and longer dry seasons are the main causes of the increase in forest wildfire risk. Sea level in the San Francisco Bay Area has risen eight inches in the past century and could rise nearly 70 inches by the end of the century. Furthermore, as sea level rise submerges more low-lying areas, storm surge will reach further inland, impacting even more of the county's natural and built resources. Additionally, coastal erosion will be exacerbated by rising sea levels, including both beaches and bluff-tops.

Sea level rise and future storm effects and potential adaptation measures are being evaluated through County led planning efforts including Bay Adaptation and Waterfront Evaluation (BayWAVE) for bay-side communities and Collaboration Sea Level Marin Adaptation Response Team (C-SMART) for outer coast communities. C-SMART's "Marin Ocean Coast Sea Level Rise Vulnerability Assessment" evaluated West Marin vulnerabilities spanning near, medium, and long-term sea level rise and storm scenarios. Likewise, BayWAVE's "Marin Shoreline Sea Level Rise Vulnerability Assessment" analyzed potential physical, social and economic impacts to all of Marin's Bayside communities exposed to sea level rise, up to the end of the century. These two assessments estimate that by 2100 around 7,000 acres, 9,000 parcels, 10,000 buildings and 120 miles of roads throughout Marin County will be exposed to sea level rise and the 100-year storm.[2] Additionally, C-SMART's Adaptation Report outlined potential adaptation solutions for West Marin, including natural and built engineering methods, home retrofits, and relocation of vulnerable assets. Further site-specific evaluation and engineering is necessary to better understand feasibility, environmental impacts, and costs for project implementation. The county is seeking funding for such adaptation planning on Marin's Ocean Coast and Bayside.

3.3 HAZARD PROFILES

The hazards selected by the Planning Committee were profiled based on existing available information. The hazard profiling consisted of describing the individual hazard profile, disaster history, location, probability of future events, extent, impacts, and vulnerability.

The hazards profiled for Marin County are presented below in alphabetical order. The order does not signify level of risk.

3.3.1 Earthquakes and Liquefaction

Hazard Profile

[2] County of Marin, Marin Bay Waterfront Adaptation and Vulnerability Evaluation (BayWAVE), (June 20, 2017) at 25, http://www.marincounty.org/main/baywave/vulnerability-assessment; County of Marin, Marin Ocean Coast Sea Level Rise Vulnerability Report (CSMART), September 2015

According to the 2013 State of California Multi-Hazard Mitigation Plan (and consistent with the Draft 2018 State Hazard Mitigation Plan) earthquakes represent the most destructive source of hazards in terms of both recent history and probability of future destruction at magnitudes greater than previously recorded. Earthquakes can cause direct damage in several ways including fault rupture, earth shaking, landslides, liquefaction, and tsunamis. Indirect effects may include hazardous materials spills, water distribution failure, fires, dam failure, etc. Earth shaking, liquefaction, and dam failure are being described in section 3.3.1 and 3.3.2. Tsunamis (3.3.7) and fires (3.3.8) are addressed as separate disasters although they can be related. There is not a significant amount of infrastructure or homes located on faults, so their rupture does not represent a significant risk.

Given most of Marin's development occurred prior to modern building codes protecting structures against earthquake damage, severe property damage to public and private structures and infrastructure is likely to occur due to significant earthquakes. This is likely to include large numbers of uninhabitable housing units, and damage to older and not-yet-retrofitted county and city-owned structures, and infrastructure such as roads, electric distribution lines, telecommunications, water, and gas lines. Earthquake aftershocks often occur with additional and unforeseen damage to structures and infrastructure.

Disaster History

According to the Association of Bay Area Governments Resilience Program, "the San Andreas Fault was the source of the magnitude of 7.8 earthquake in 1906. Marin was sparsely inhabited at that time and experienced relatively moderate property loss and only two deaths. The epicenter was just two miles west of San Francisco and West Marin experienced some pronounced earthquake effects. This included a horizontal earth displacement of 21 feet near the head of Tomales Bay."

On October 17, 1989, a magnitude 7.1 earthquake occurred on the San Andreas Fault, the largest earthquake to occur in the San Francisco Bay Area since 1906. This earthquake was named the Loma Prieta Earthquake due to its calculated epicenter. The impact of the Loma Prieta Earthquake was most apparent in the northeast area of Santa Cruz. If the fault rupture location were closer, a strong shaking such as this could have caused severe damage within Marin County, including damage to life-line routes. The Loma Prieta earthquake was not "the big one," which is a common reference to an event with a magnitude of 8 or larger (such as the 1906 San Francisco quake).

Location

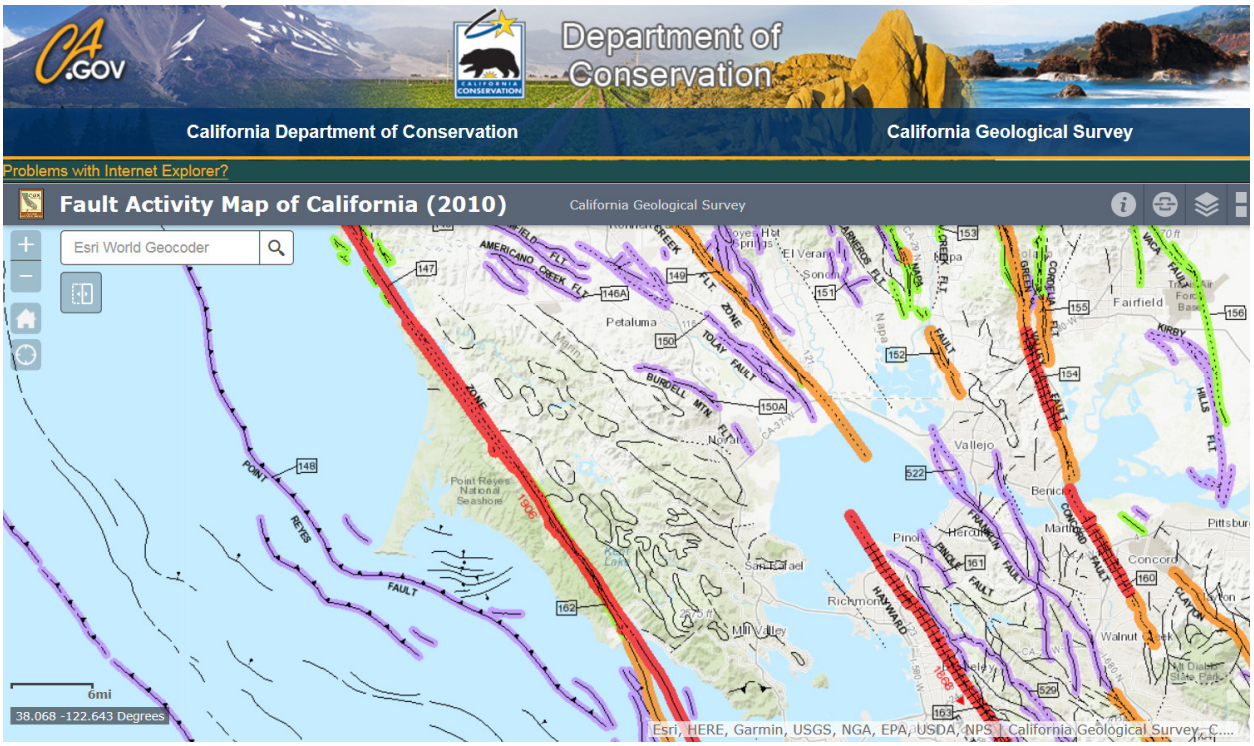
The potential for earthquake damage exists throughout Marin County because of a combination of the number of active faults within and near the County and the presence of soils vulnerable to liquefaction. These faults are shown on the California Geological Survey (CGS) Fault Activity Map of California (see Figure 3-1. Fault Activity Map below). Descriptions of the most significant active faults to Marin are provided below.

San Andreas fault: The San Andreas Fault traverses Marin County running north and south in the western quarter of the county. It enters Marin on the Pacific Coast near Bolinas, follows the path of Highway 1 and Tomales Bay, exiting Marin at sea just west of Dillon Beach.

Hayward fault: the eastern, more heavily populated part of Marin is less than ten miles from the northern section of the Hayward fault.

Rodgers Creek fault: The northern part of Marin is less than ten miles from the Rodgers Creek fault.

Figure 3-1. Fault Activity Map



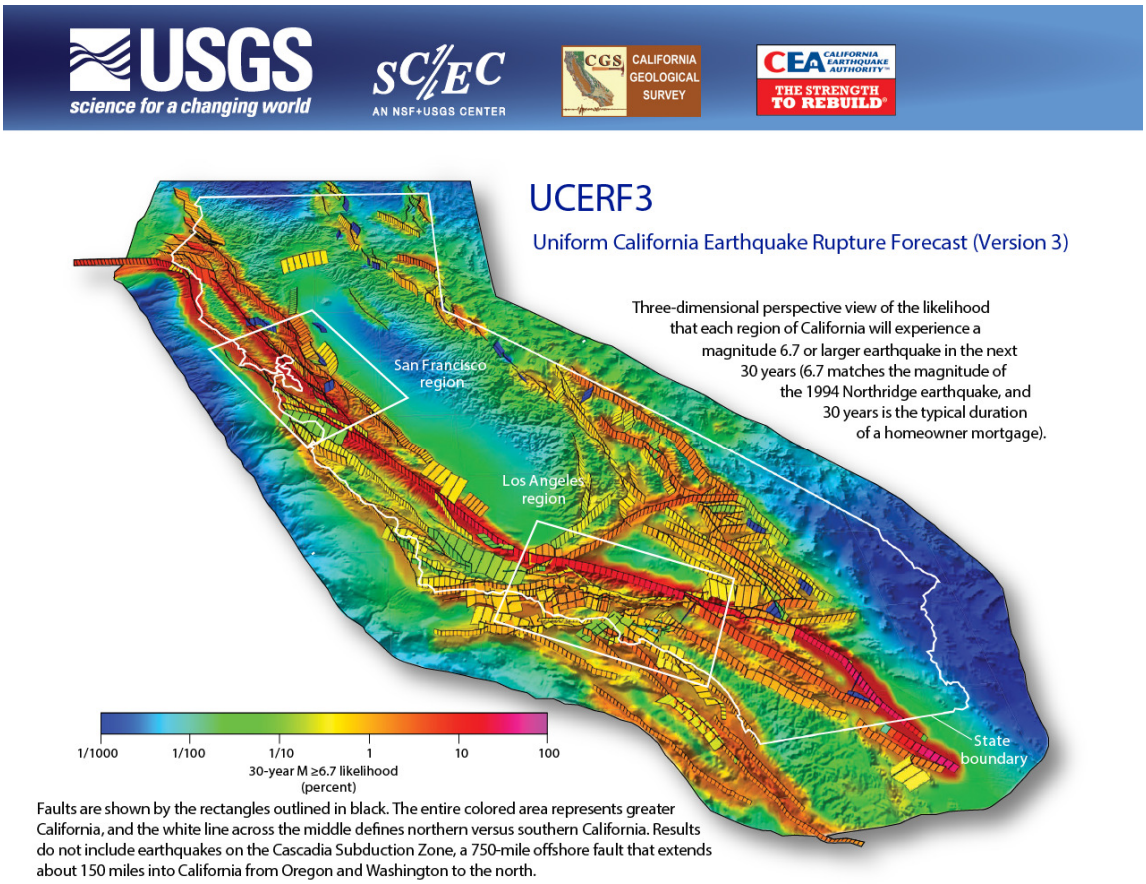
Probability of Future Events

According to a September 24, 2016 article in the Marin Independent Journal, "The Working Group on California Earthquake Probabilities has updated its earthquake forecast and determined there is a 72 percent probability - up from 63 percent - of at least one earthquake of magnitude 6.7 or greater striking somewhere in the Bay Area before 2043." The Association of Bay Area Governments (ABAG) Resilience Program projects a 52% chance of a 6.7 or greater earthquake

on one of the faults affecting Marin between now and 2036 (21% at San Andreas fault and 31% on Hayward/Rodgers Creek).

Supporting this article's assertions is the Uniform California Earthquake Rupture Forecast, Version 3 (UCERF3), which provides authoritative estimates of the magnitude, location, and time-averaged frequency of potentially damaging earthquakes in California (see Figure 3-2. Uniform California Earthquake Rupture Forecast below. The primary achievements have been to relax fault segmentation assumptions and to include multifault ruptures, both limitations of the previous model (UCERF2). [3]

Figure 3-2. Uniform California Earthquake Rupture Forecast



The September 24, 2016 article goes on to say "Marin sits smack dab (sic) in the middle of two major faults. To the east is the Rodgers Creek-Hayward fault just a few miles from Marin's shores through San Pablo Bay, which the U.S. Geological Survey estimates has a 33 percent likelihood of a 6.7-magnitude quake or greater in the next 30 years — the highest probability of any Bay Area fault to slip. But movement on those faults could be worse than originally thought.

[3] Field, E.H., Biasi, G.P., Bird, P., Dawson, T.E., Felzer, K.R., Jackson, D.D., Johnson, K.M., Jordan, T.H., Madden, C., Michael, A.J., Milner, K.R., Page, M.T., Parsons, T., Powers, P.M., Shaw, B.E., Thatcher, W.R., Weldon, R.J., II, and Zeng, Y., 2013, Uniform California earthquake rupture forecast, version 3 (UCERF3)—The time-independent model: U.S. Geological Survey Open-File Report 2013–1165, 97 p., California Geological Survey Special Report 228, and Southern California Earthquake Center Publication 1792, http://pubs.usgs.gov/of/2013/1165/

The Rodgers Creek-Hayward fault, thought to be two separate faults, actually may be linked and have the potential to cause more damage than previously determined, according to USGS research…

"The Rodgers Creek Fault runs from Sonoma County into San Pablo Bay near Marin's shore. The Hayward Fault runs through the western part of Alameda County into San Pablo Bay east of San Rafael and Novato. They were thought to be offset by about two miles under San Pablo Bay. But underwater exploration done in 2014 seems to link them. More study will occur to confirm those initial findings…

The majority of Marin County's single-family buildings with foundations to bedrock will perform well in a shake. Modern multi-story buildings with foundations to bedrock should not be subject to collapse, although some serious damage may occur. However, many heavier developed areas of Marin are built on soft alluvial soils or filled-in water ways. Due to liquefaction, these soils will significantly increase the shaking effects and will account for the majority of damaged and destroyed structures, regardless of their proximity to the fault line.

Liquefaction occurs when ground shaking causes loose, saturated soil to lose strength and act as a viscous fluid. When liquefaction occurs, it can result in the sidelong movement of large masses of soil, loss of strength in the soil supporting structures causing structures collapse, and/or consolidation due to soil settlement decreasing soil surface elevations.

Extent

The most vulnerable areas of Marin are on Bay Mud and current and former marshlands. Many of these areas have been artificially filled over the last century. Other areas with some risk of liquefaction include those along creeks due to fluvial and alluvial deposits. Unfortunately, much of Marin's residential areas and infrastructure are located on former marshes and along creeks. Tens of thousands of acres of residential areas, along with roads, airports, military facilities, retail centers, schools, hospitals, prisons, jails, government administration centers, convention centers, recreation areas, croplands/pasture are in areas vulnerable to liquefaction in Marin. The ABAG Resilience Program analysis shows risk of liquefaction in Corte Madera, Larkspur, Bel Marin Keys, Novato, Ross Valley along creeks (Ross, San Anselmo, Fairfax), San Geronimo, San Rafael, Santa Venetia, communities around Richardson Bay (Belvedere, Marin City, Mill Valley, Sausalito, Strawberry, Tam Valley, Tiburon), Stinson Beach, Tomales Bay-side communities, and the county-owned Gnoss Field Airport.

Impacts

Most structures in Marin were built before 1970, when major seismic design changes were made to the building code and are particularly vulnerable to earthquakes and liquefaction. Wood-framed homes, however, are light and flexible and can often survive earthquakes with minimal damage as long as the foundations are properly retrofitted (bolted and braced). The County of Marin and it's political subdivisions have adopted California Building, Plumbing, Electrical and Mechanical Codes whereby no building or structure is erected, constructed, enlarged, improved,

removed, or converted without a permit. Adherence to these codes currently allows the county to gather data on retrofitting and current building code compliance. It is important to note that these data continue to have limitations for assessing overall vulnerability in the county for all structures.

The county's topography includes large areas of steep slopes, adding to the vulnerability of earthquake induced disasters with the additional danger of Debris flow (landslides). Bluff erosion along the coastal areas also poses unique threats to coastal structures and roads during times of earthquake.

Vulnerability

For all three faults, many areas of the most severe vulnerability to earthquake coincide with the heavily populated Highway 101 corridor on the eastern side of the county. According to the ABAG Resilience Program, a 7.8 magnitude earthquake on the San Andreas fault would leave 3,100 homes in Marin uninhabitable, displace 6,200 households, and result in total building damage of $1,260 billion dollars. Because many people in the region do not have earthquake insurance, many homeowners will not be able to afford to rebuild their homes. Figure 4-2 from the ABAG Resilience Program shows building damage estimates for different earthquake scenarios.

In addition to damaging buildings, the San Andreas earthquake could close 77 roads in Marin due to faulting, liquefaction, debris flow/ landslide, shaking damage to bridges and interchanges, threat of building collapse, structural damage to highway and rail structures, small hazardous material releases, water and gas pipe leaks, and other miscellaneous reasons for closure.

3.3.2 Dam Failure

Reservoirs for water supply and the dams that impound them are integral parts of the municipal infrastructure in Marin County. Unlike most other counties in California, Marin does not import or export water through the Central Valley State and Federal water projects. The Marin Municipal Water District (MMWD) and the North Marin Municipal Water District (NMWD) operate and maintain eight major dams for municipal water supplies within their jurisdictions (see Table 3-2) MMWD dams include Alpine Dam, Bon Tempe Dam, Lagunitas Dam, Phoenix Dam, Peters Dam (Kent Lake), Nicasio Dam, and Soulajule Dam. NMWD maintains and operates one dam at Stafford Lake on Novato Creek for its smaller service area. None of these reservoirs generate hydroelectricity not are they actively managed for downstream flood control.

The California Water Code entrusts dam safety regulatory power to the California Department of Water Resources (DWR), Division of Safety of Dams (DSOD). Dams greater than 6-feet or holding 15 or more acre-feet are subject to DSOD jurisdiction. According to the California water code, owners of regulated dams are responsible for emergency preparedness with regard to potential loss of life or property. All regulated dams are inspected by DSOD annually. MMWD

inspection reports are available on their website. As of 2017 DSOD classifies the public safety risk of all jurisdictional dams.

Table 3-2 Marin Dams

Dam Name (Reservoir)	Owner	Type	Reservoir Capacity (acre-feet)	DSOD Downstream Hazard
Alpine	MMWD	Gravity (concrete)	8,892	Extremely High
Bon Tempe	MMWD	Earthen	4,300	High
Lagunitas	MMWD	Earthen	341	Significant
Novato Creek (Stafford)	NMWD	Earthen	4,430	Extremely High
Peters (Kent)	MMWD	Earthen	32,900	High
Phoenix	MMWD	Earthen	612	Extremely High
Seeger (Nicasio)	MMWD	Earthen	22,400	High
Soulajule	MMWD	Earthen	10,700	High

Hazard Profile

Significant, even catastrophic flooding can occur in valley areas downstream of major dams in the event of a complete or partial dam failure. Such events are extremely rare due to the stringent design and permitting requirements for dam construction and operation. However, in the active tectonic environment of the San Francisco Bay Area, the risk of a dam failure during a major earthquake remains a possibility. Dam failures can occur in response to full or partial structural collapse of the dam face (concrete arch dam) or embankment (earthfill dam) during a major earthquake. A dam could also partially rupture during an earthquake and fail completely sometime later due to leakage/seepage through the damaged embankment or dam face.

Given the design, construction, and maintenance protections in California, dam failure as a result of an earthquake is considered the most relevant.

Disaster History

In February 2017 California witnessed the failure of the spillway and emergency spillway at Lake Oroville leading to the evacuation of 188,000 people from the downstream inundation area. Situations like this, overtopping and erosion of a dam's face as a result of flows exceeding the capacity of spillway is another mechanism of dam failure, however reservoir inflows in Marin County do not have to accommodate the volatility of melting snowpack that occurs in the Sierra Nevada foothills.

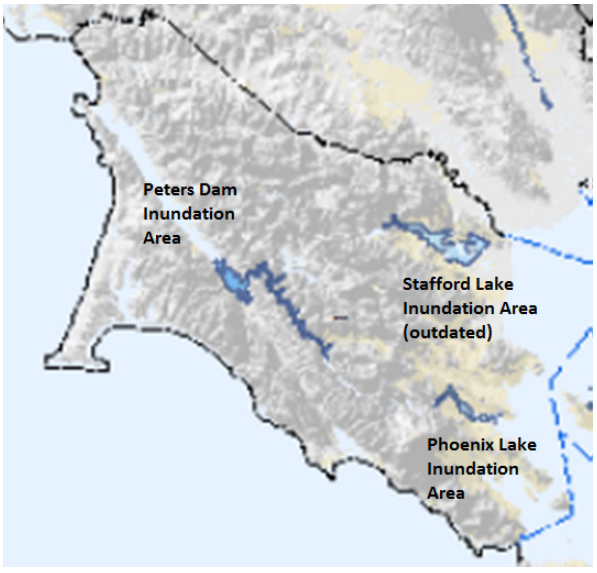
There is no record of a failure of any regulate dam located in Marin County.

Location

In the 1970s, State law required dam owners to develop maps depicting areas that might be inundated by dam failure. The law required that each map be produced only once, without any requirements for updating. The maps were developed using engineering hydrology principals and represent the best estimate of where the water would flow if the dam completely failed with a full reservoir, ie a worst case scenario. The inundation pathway is based on completely emptying the reservoir and does not include runoff from storms. Dam inundation maps do not indicate the depth of inundation nor do they indicate or infer the probability of such an event occurring.

Major dam inundation areas from the ABAG Resilience Program are shown in Figure 3-3 below. This does not appear to reflect the more recent analysis on the Stafford Dam, however, so an inundation depth grid from that analysis follows.

Figure 3-3. County-wide Dam Failure Inundation Map from ABAG Resilience Program



Probability of Future Events

Inundation maps from dam owners aren't required to be updated and are not required to depict the depth of inundation, so they generally represent just a rough estimate of what areas will be affected with no estimate of magnitude. The recent Stafford Dam analysis is of course an exception to this, where we have a depth grid showing a large portion of the City of Novato, including several key facilities there, flooded under several feet of water within several hours of a dam breach. The extent of damage from a dam failure at Stafford or Phoenix Lakes would be massive, however both would likely withstand an earthquake at least magnitude 8.2 on the San Andreas Fault, which is a rare magnitude to encounter (8.0 or greater earthquakes are expected once every 494 years in California according to USGS).

Extent

According to the 1988 Town of Ross General Plan Safety Element, "in 1974, a seismic stability analysis of Phoenix Lake Dam was conducted for the Marin Municipal Water District. The purpose of this study was to assess the risk of seismically induced flooding associated with failure of Phoenix Lake Dam. The earth dam was constructed just prior to the 1906 earthquake, which created a landslide on the inside portion of the dam embankment. The slope stability analysis conducted in 1974 concluded that the dam spillway could settle from 4 – 6 feet during an earthquake with a Richter magnitude of 8.5 generated along the San Andreas fault. The 1906 San Francisco earthquake had a Richter magnitude of 8.3…In response to this assessment, the Marin Municipal Water District has widened the spillway by 5 to 6 feet and has lowered the spillway by 6 feet. Accordingly, these improvements to the dam have reduced the flood risk to one flood in 30,000 years."

According to MMWD, "the dam has been modified several times in the last 100 years including increased height of fill, outlet works changes, an embankment buttress fill in the 1960s and a new spillway, designed for a spillway design flood with a recurrence interval of once in 10,000 years or so, and an increase in freeboard in the mid-1980s."

The Town of Ross's 2017 Local Hazard Mitigation Plan states "the dam is inspected yearly by the California Division of Safety of Dams and has been rated by that agency as acceptable for continued operation. Their rating for the facility is 3C, there is a potential for damage should the dam fail but that the dam is in good condition for its age…

"MMWD has a comprehensive Dam Safety Program to ensure all of the MMWD dams and spillways are safe and functioning properly. This program includes three main components: monitoring, routine inspections and maintenance, and emergency preparedness and response planning. The district also works closely with state and federal regulators and local emergency response partners to ensure public safety. MMWD produced a February 13, 2017 inspection report documenting the current conditions…

"The Phoenix Lake Dam is over 100 years old. According to ABAG, when a dam in known to have a failure potential, the water level is reduced to allow for partial collapse without loss of water as required by the State Division of Safety of Dams and by safety protocols established by dam owners. Thus, the probability of failure resulting in damage from the inundation is low."

According to the City of Novato's 2011 Local Hazard Mitigation Plan, a seismic stability analysis prepared for the North Marin Water District by Woodward-Clyde Consultants in 1992 confirmed the Stafford Dam was designed to withstand a magnitude 8.25 Richter earthquake on the San Andreas Fault, with a design epicenter located 10 miles from the dam.

Impacts

Failure of Phoenix dam would flood about 5 miles along Ross Creek down to the Town of Ross, part of San Anselmo where Ross Creek meets Corte Madera Creek, to unincorporated Kentfield and Greenbrae, and out into San Pablo Bay. The inundated portion of San Anselmo consists of small commercial buildings (some with housing units) and apartment buildings. Ross would be more severely affected with many homes and businesses, a couple major roads, and a fire station in the inundation zone. The unincorporated communities downstream also contain some major roads, many residences, a fire station, and a hospital in the inundation zone.

Lagunitas, Bon Tempe, Alpine and Peters dams are a series along Lagunitas Creek increasing in size going downstream.

Failure of the Peters or Alpine Dam could result in flooding in unincorporated areas in West Marin stretching about 10 miles from the reservoir down to Point Reyes Station at Highway 1 and into Tomales Bay. On its path it could flood around 5 miles of a major road, Sir Francis Drake Boulevard, which runs along Lagunitas Creek, and several dozen buildings along that road. It could flood Samuel P. Taylor State Park camping areas. The inundation area turns from Sir Francis Drake Boulevard down Platform Bridge Road towards Point Reyes Petaluma Road. Eventually the inundation area reaches Point Reyes Station, going right through the middle of this small town where there is a County fire station, elementary school, senior housing, and a healthcare facility.

The inundation area from Nicasio dam is largely coincident with the Peters Dam inundation area starting in the vicinity of Point Reyes Petaluma Road and Platform Bridge Road. The population that would affected by a failure of the Peters or Nicasio dams are very small relative to the Phoenix and Stafford dams.

Failure of the Stafford dam would affect an area that extends approximately 5 miles through incorporated and unincorporated parts of Novato and ending in San Pablo Bay at Bel Marin Keys. Although the probability is remote, the North Marin Water District and City of Novato take this threat very seriously and recently updated the inundation modeling and mapping, developed an emergency action plan, and conducted a tabletop exercise. The new analysis showed the San Marin residential area inundated with 1 foot of water in about half an hour, rising to 9 feet in some areas. In 1-2 hours central Novato is flooded with 1 foot of water, later rising up to 7 feet in some areas, affecting medical facilities, educational facilities, shopping centers, law enforcement, fire stations, and City Hall. Highway 101 is affected within 2-4 hours, with depths reaching more than 9 feet in some locations. Beyond Highway 101, the Novato Sanitary District floods after 2 hours, up to 5 feet. From 4 to 9 hours flooding passes Highway 37 and reaches Bel Marin Keys.

Vulnerability

Because of the catastrophic nature of the threat of dam inundation, dams tend to be built conservatively and the actual likelihood of either dam overflow or dam failure are extremely low. As stated above, the Stafford and Phoenix Lake dams are expected to withstand an earthquake at least magnitude 8.2 on the San Andreas Fault, which is a rare magnitude to encounter (8.0 or greater earthquakes are expected once every 494 years in California according to USGS).

3.3.3 Severe Storm

Hazard Profile

The climate on California's central coast is Mediterranean, in which summers are warm and dry and winters are cool and damp. A dominating factor in the weather of California is the semi-permanent high-pressure area of the North Pacific Ocean, sometimes called the Pacific High. This pressure center moves northward in summer, holding storm tracks well to the north, and as a result California receives little or no precipitation during that period. The Pacific High decreases in intensity in winter and moves farther south, permitting storms to move into and across the state and producing strong winds, widespread rain at low elevations, and snow at high elevations. From mid-autumn to mid-spring is the rainy season. During these months, storms may occur. In addition to strong winds and flooding, storms on rare occasions can bring hail and/or lightning to all areas of the County.

Disaster History

Marin County was included in the Presidential Disaster Declarations for Severe Winter Storms, Flooding, Mudslides on April 1, 2017; February 14, 2017; June 5, 2006; and February 3, 2006; making severe storms the most frequent cause of major disasters affecting Marin in the last 20 years.

A review of the National Oceanic and Atmospheric Administration's (NOAA's) National Climatic Data Center (NCDC) database reveals that, although most not considered disasters, 113 major severe storm events occurred in Marin County between 1996 and 2010. Of these events, 12 caused deaths or injuries, and 65 damaged property. According to NOAA, total property damage estimates (including crops) during this period were $278 million, with some of the most significant (over $50,000 in damage) events listed below in Table 3-3.

Table 3-3. Severe Winter Storm Events from NOAA's NCDC

Location	Event Type(s)	Year	Damage Est.*
Tomales	Tornado	1996	$205,000
Southern Marin	Flash Flood	1998	$2,000,000
Corte Madera	Heavy Rain	2002	$200,000
Coastal Marin	Coastal Flood	2005/2006	$340,000
Countywide	Flood	2005/2006	$219,000,000
Interior Valleys	Debris Flow	2006	$45,900,000
Coastal Marin	Strong Wind	2006	$500,000
Interior Valleys	Frost/Freeze	2007	$3,000,000
Corte Madera	Flash Flood	2008	$50,000
Interior Valleys and Mountains	Strong Wind	2009	$140,000
Countywide (Santa Venetia)	Flood/Wind	2009	$260,000
Interior Valleys	Strong Wind	2009	$85,000
Coastal Marin	Coastal Flood, Strong Wind, Flood	2010	$770,000
Countywide (Larkspur)	Heavy Rain/ Strong Wind	2010	$100,000
Countywide	Strong Wind	2010	$85,000
Coastal Marin	Strong Wind/Storm Surge	2011	$325,000
Interior Valleys	Strong Wind	2011	$50,000

Interior Valleys	Strong Wind	2011	$200,000
Interior Valleys	Strong Wind	2012	$60,000
Interior Valleys and Coast	Strong Wind	2012	$501,500
Interior Valleys	Strong Wind	2012	$150,000
Interior Valleys	Strong Wind	2012	$50,100
Countywide	Flood/Strong Wind	2012	$210,100
Mountains	Strong Wind	2013	$80,000
Countywide (Greenbrae, Novato, Marin City, Tamalpais Valley, Olema)	Flash Flood/Debris Flow	2014	$6,001,000
Interior Valleys/Coast	Strong Wind	2014	$115,600
Interior Valleys and Mountains	Strong Wind	2015	$23,500
Mill Valley AFS	Heavy Rain	2015	No data
Interior Valleys	Coastal Flood	2016	No data
Interior Valleys	Strong Wind	2016	No data
Alto	Flash Flood	2016	No data
San Rafael and Corte Madera	Flood	2017	No data
Kentfield	Flash Flood	2017	No data
Tomales	Flood	2017	No data
Corte Madera	Flood	2017	No data
Ignacio, Burdell, Marin City, Mountains	Strong Wind, Flash Flood, Flood	2017	No data
Interior Valleys	Strong Wind	2017	No data
Mountains	Strong Wind	2017	No data
Mountains and Coast	Strong Wind	2017	No data
Interior Valleys and Mountains	Strong Wind	2017	No data

Greenbrae and Mountains	Strong Wind, Flood	2017	No data
Interior Valleys and Coast	Strong Wind	2017	No data
Corte Madera	Flood	2018	No data

*Damages as listed on NOAA website are in some cases less than local estimates. For example, in 2014 it was estimated in a December 29, 2014 news release from the Marin County Office of Emergency Services that there was approximately $13.3 million in damages countywide.

Not included in the available dataset is $8,760,000 in damages reported to the Marin County Board of Supervisors on March 14, 2017 related to disasters declared in January and February of 2017. Damage consisted of 10 debris flows (landslides), 3 badly eroded levees, damage to various storm water pumps and generators, and many sites of downed trees and other debris.

Location

Many events in the NCDC database described above affected all of Marin County. Indeed, the entire county is susceptible to storms and damage from wind. The coastal and mountainous areas are particularly susceptible to wind, although wind has caused damages throughout the county. Coastal areas are susceptible to storm surge and high tides. Flash flood primarily affects interior valleys, although there are some flashy coastal streams. Localized stormwater ponding and clogged drainage occurs in countless areas throughout Marin during storms and although it can be hazardous, particularly to vehicles when the depth of water is greater than 6" in the road, it is not considered a major hazard for the purpose of this plan as there is not a significant threat to critical structures.

Probability of Future Events

Based on recent history, severe winter storms occur every year, but those leading to federally declared disasters seem to occur about every 10 years – often in clusters and associated with high tides and/or atmospheric rivers. More details on probability of hazards associated with storms are contained in the following sections detailing debris flows, flooding, and wind.

Extent

A storm can cause heavy rains, flash flooding, tidal flooding, and wind speeds of up to 70 miles per hour. More details on extent of hazards associated with storms are contained in the following sections detailing debris flows, flooding, and wind.

Impacts

Details on impacts on structures, infrastructure, and systems due debris flows, flooding, and wind are outlined in the following sections.

Vulnerability

Vulnerability to debris flows, flooding, and wind are outlined in the following sections.

3.3.4 Debris Flow (Landslides)

Hazard Profile

Landslide is a general term for the dislodging and fall of a mass of soil or rocks along a sloped surface or the dislodged mass itself. The term is used for varying phenomena, including mudflows, mudslides, debris flows, rock falls, rock slides, debris avalanches, debris slides, and slump-earth flows.

Landslides can be earthquake-induced or non-earthquake induced. Earthquake-induced landslides occur as a result of ground shaking. The most common earthquake-induced landslides include shallow rock falls, disrupted rock slides, and disrupted slides of earth and debris. Non-earthquake induced landslides may involve a wide range of combinations of natural rock, soil, or artificial fill. The susceptibility of hillside and mountainous areas to non-earthquake induced landslides depends on variations in geology, topography, vegetation, and weather. They may also occur due to indiscriminate development of sloping ground or the creation of cut-and-fill slopes in areas of unstable or inadequately stable geologic conditions. Non-earthquake-induced landslides can often occur as a result of intense or prolonged precipitation that can saturate slopes and cause failures. Another example of a non-earthquake-induced landslide is that which results from physical undermining of a slope. Most commonly this can occur as a result of high volume and/or high velocity water flows of a creek which lead to scour at the toe of a sloped creek bank. This phenomenon can also occur as a result of man-made excavations where a slope is destabilized as a result of improperly removing soil at the toe of a slope which over time leads to failure of that slope. Prolonged and/or heavy precipitation leads to increases in landslide events in Marin County more often than other natural phenomena referenced above; therefore, it

is being addressed as a subset of Severe Storm hazards. There is more about debris flow in the wildfire section (3.3.9 Post-Fire Debris Flow).

Disaster History

Marin County has sustained significant damage as a result of several natural disasters in recent years. Most notable were the Winter and Spring storms of 2006 (DR-1628 and DR-1646) which resulted in hundreds of locations in Marin County where damage occurred; many of those being landslides, rock fall, or other infrastructure damage related to slope instability. Most recently, severe damage occurred during the January and February Winter storms of 2017 (DR-4305 and DR-4308) resulting in over 100 locations in Marin County where damage occurred.

Landslides are a part of natural geologic processes and have impacted both private and public property in various areas throughout Marin County since development began. Much of Marin County was developed in the early 20th century prior to the implementation of grading requirements and road design standards. During this time, many of the roads in Marin County were benched or cut into steep hillsides without sufficient compaction of the roadbed. Furthermore, the use of earth retaining structures was not common in roadway construction and/or retaining structures were built using wood materials that have since deteriorated.

Marin County is largely undeveloped and has a widespread natural environment where creeks and rivers adjoin both private and public infrastructure. During times of intense rainfall, creeks rise and the resulting high flows can erode roadway supporting earthen embankments leading to landslides and sometimes property damage.

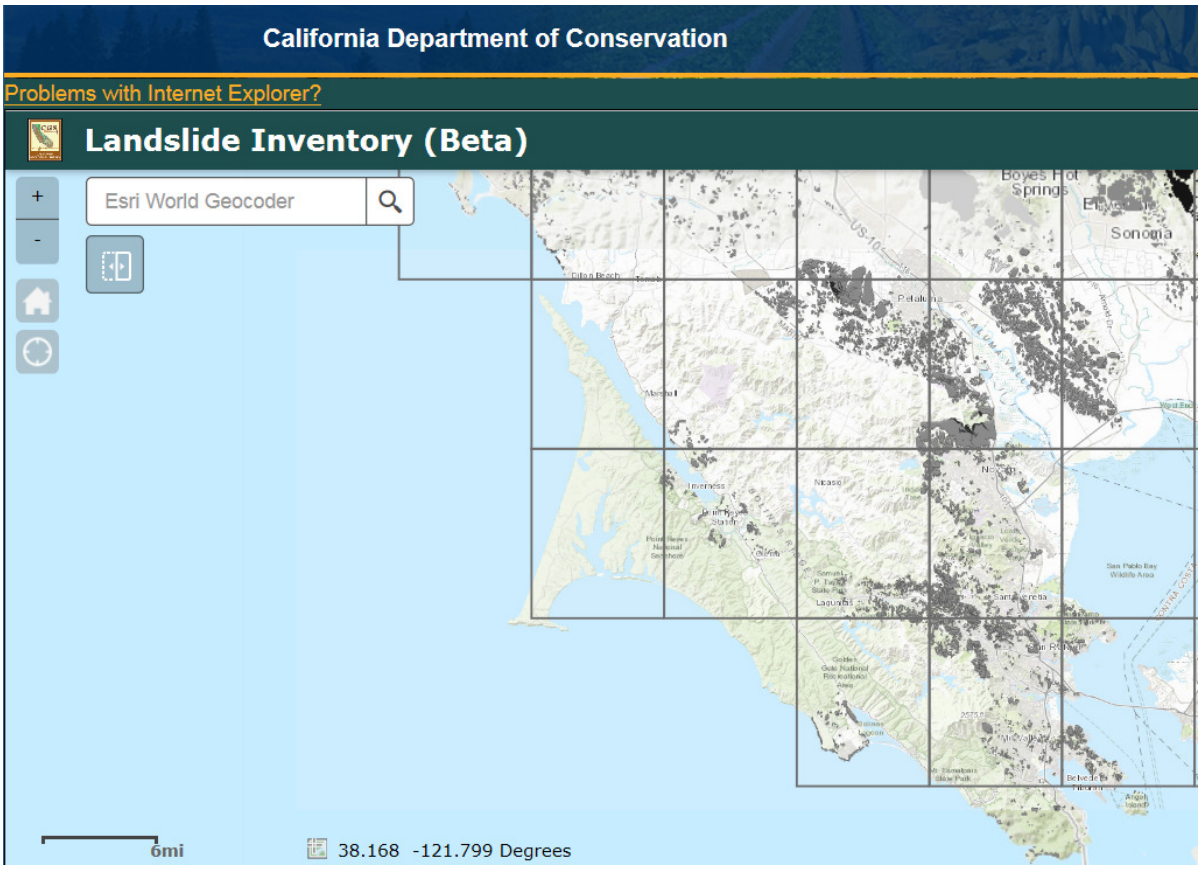
An example from the history of debris flow in the county is the bluff along the Bolinas Mesa in the unincorporated town of Bolinas has been associated with a variety of landslide activity. The major cause of earth movement in this area is the extensive presence of weak cohesion-less (sandy) soils combined with undermining wave action at the toe of the bluff. As wave action removes toe-supporting soils, the outer face of the bluff slumps or creeps downwards causing settlement and landslides at the top of the Mesa. In 2011, a $1.5M emergency slide repair was constructed at the intersection of Terrace Avenue and Overlook Drive on the Bolinas Mesa to repair recent drastic settlement (up to 8-feet) such that access for emergency vehicles and resident egress could be maintained. As much as 20,000 cubic yards of material was excavated and re-compacted in lifts with earth reinforcing fabric to affect the repair.

Location

California Geological Survey has an interactive landslide inventory map available on their website (http://maps.conservation.ca.gov/cgs/lsi/) that shows records associated with past landslide events in Marin County. A snapshot is in Figure 3-4 below. The inventory shows extensive areas of prior landslides around the county particularly in developed areas. Affected areas notably include many landslides near Bolinas Lagoon, Inverness and Bolinas (Point Reyes Station) ridges on the west coast; throughout Ross Valley including Sleepy Hollow, Fairfax and San Anselmo; San Rafael just outside downtown at Lincoln, Lock Lomond affecting many

residences, San Quentin potentially affecting a wastewater treatment plant, and Bret Harte potentially affecting Highway 101; Santa Venetia affecting N. San Pedro Rd; Novato at Little Mountain and Mount Burdell affecting major roads such as Center Road, San Marin Drive and Novato Blvd and their nearby residential areas; Paradise Cay and Reed residential areas near Tiburon; and Mill Valley at Homestead Valley. Smaller scale, and/or more isolated slides occur throughout the county where there are slopes. These are typically of concern if there are roads or structures affected.

Figure 3-4. California Department of Conservation Landslide Inventory



Probability of Future Events

Slope instability throughout much of Marin County is related to many factors, including, but not limited to; type(s) of soil involved and various geologic factors (presence of faults or other weakened soil planes), steepness of the slope and surrounding topography, intensity and duration of rainfall, presence of underground springs or groundwater, adequacy of surface water management, and proper erosion protection. While landslides occur in any given year, the frequency and number of landslides has been observed to be directly proportionate to the frequency and duration of rainfall events.

Landslides are less likely to occur during the fall months (October-November) when the ground is sufficiently dry and can absorb the moderate rain events typically observed during this time of year. Landslides are more often observed between December and May when rain events are usually more intense and/or frequent. Under these circumstances, the ground has been saturated, becomes heavier, and the presence of water within the soil increases the pore pressure thereby reducing the friction between soil particles – which leads to sliding. Proper drainage management to maintain existing sufficient drainage patterns (on both private and public lands) is essential to limiting potential future landslide events. In Marin County, renewed and potentially widespread landslide activity will most likely occur during or after future periods of prolonged or intense rainfall.

Extent

Debris flows can cause irreparable damage to any structures overlying or in the path of the soil where they take place. They can cause roads to close until expensive and time consuming stabilization and/or repair projects can take place and can be deadly to occupants of homes. Less serious effects can also result, such as breaking underground pipes.

Impacts

Impacts include structures, infrastructure, and systems.

Vulnerability

The following tables represent vulnerability to debris flow (data from Marin County Department of Public Works sources)

Existing Structures

Commercial	Industrial	Single-Family	Multi-Family
96	3	10,346	1,897

Transportation

Miles of Roads	Miles of Railroad	Number of Ferry Terminals
562	0	0

Communication

MERA Towers
1

Power

Transmission Tower	Substation	Natural Gas Substation	Miles of Electric Transmission Lines	Miles of Natural Gas Pipeline
4	2	0	25	5

Water/Sewerage

Wastewater Treatment Plants	Pump Station
0	0

Critical Facilities Impacted. Assess dependencies on infrastructure. Cultural Resources – inventory cultural and historic assets that are unique or irreplaceable. Museums, unique geological sites, concert halls, parks, stadiums, etc.

Schools	Police & Fire	Medical	Airports/Heli	Cultural Resources
2	6	0	0	4

3.3.5 Flooding

Hazard Profile

A flood occurs when the existing channel of a stream, river, canyon, or other watercourse cannot contain excess runoff from rainfall or snowmelt, resulting in overflow onto adjacent lands. In coastal areas, flooding may occur when strong winds or tides result in a surge of seawater into areas that are above the normal high tide line.

Other types of flooding in Marin include isolated ponding and stormwater overflow. Isolated ponding is when pools form on the ground and can occur in any area that doesn't drain effectively – for example, in a natural depression in the landscape. Stormwater overflow is when storm drains back up. Stormwater drainage systems quickly convey rainwater through underground pipes to creeks and the Bay. When the stormdrains are obstructed or broken or when the water-bodies to which they lead to are already full, water backs up onto the streets.

Although stormwater overflow and isolated ponding also occur throughout the County, the effects are typically not widespread or significantly damaging.

A floodplain is the area adjacent to a watercourse or other body of water that is subject to recurring floods. Floodplains may change over time from natural processes, changes in the characteristics of a watershed, or human activity such as construction of bridges or channels. In areas where flow contains high sediment load, such as Easkoot Creek in Stinson Beach (due to an active landslide upstream), the flow carrying capacity of the channel may be reduced dramatically during a single flood event. Coastal floodplains may also change over time as waves and currents alter the coastline (especially wetlands) and sea levels rise.

Physical damage from floods includes the following:

- Inundation of structures, causing water damage to structural elements and contents.
- Erosion or scouring of stream banks, roadway embankments, foundations, footings for bridge piers, and other features.
- Impact damage to structures, roads, bridges, culverts, and other features from high velocity flow
- Deposition of debris carried by floodwaters to roads, structures, crossings, etc. Such debris may also accumulate on bridge piers and in culverts, increasing loads on these features or causing overtopping or backwater effects.
- Destruction of crops, erosion of topsoil, and deposition of debris and sediment on croplands.
- Release of sewage and hazardous or toxic materials when wastewater treatment plants are inundated, storage tanks are damaged, and pipelines severed.

Floods also cause economic losses through permanent or temporary closures of businesses, homes, local/state roadways, and government facilities; disrupt communications; disrupt the provision of utilities such as water and sewer; result in excessive expenditures for emergency response and may limit the access of emergency responders; and generally disrupt the normal function of a community.

In areas such as Marin County that do not have extended periods of below-freezing temperatures or significant snowfall, floods usually occur during the season of highest precipitation or during heavy rainfalls after prolonged dry periods. Marin County is dry during the late spring, summer, and early fall and receives most of its rain during the winter months. The rainfall season extends from November through April, with most rainfall occurring during this period. Due to varying microclimates within the County, rainfall in water year 2016-2017 where there are Marin County Flood Control & Water Conservation District-owned gages ranged inland from as low as 47 inches in Novato to over 82 inches in Kentfield. Along the coast, rainfall ranged from 36 inches at Oceana Marin to 45 inches at Point Reyes Station.

In should be noted winter 2016-2017 was an unusually wet year. An average of 56 inches of rain falls each year at the summit of Mount Tamalpais, at 2,572 feet elevation. The rain collects in several channels, flowing down steep slopes and onto broad, flat valleys, many of which are populated. The valleys usually only receive on average 32 inches of rain per year, thus flows

from the uplands contribute greatly to flows on the valley floor. During most rainfall events, waterways remain within their channels or underground pipes until they reach a bay or the ocean.

Riverine flooding is caused by creek overflow when their banks spill. Naturally, waterways regularly overflowed onto an adjacent floodplain. Buildings are now often located on these flood plains. The size and slope of a channel, blockages, proximity to the bay, and constrictions obstructing flow such as bridges, utility pipes, or adjacent buildings influence riverine flooding.

Prior to development, Marin's flat lowlands flooded frequently. When rain fell on Marin, it infiltrated into the ground and moved slowly toward the creek channel. The ground acted like a sponge, storing water and releasing it slowly. While water moved underground, it was naturally cleansed by physical and biological processes. Annual floods brought life-giving water to parched floodplains, nourishing them with fresh sediment. They recharged aquifers and allowed fish to swim over normally dry land that was rich with food. Tides flooded biologically rich marshes along the bay perimeter twice a day. When humans began to develop the land, we created conflicts between what we built and the natural tendency of creeks to flood. Much of the development in Marin was built in flood-prone areas which put it at risk of inundation. Roads, parking lots, roofs, and other impervious surfaces prevent water from infiltrating the ground. Instead, it moves quickly across the landscape into pipes and creeks further increasing flood risk downstream. Homes, commercial areas, schools, hospitals, police and fire stations, roads and highways, sanitary sewers and waterlines, sewage treatment plants, pump stations are all located in floodplains in Marin.

All of Marin's watersheds are small and largely prone to flash flooding. Flash floods are particularly dangerous. The National Weather Service (NWS) defines a flash flood as one in which the peak flow travels the length of a watershed within a 6-hour period. These floods arise when storms produce a high volume of rainfall in a short period over a watershed where runoff collects quickly. They often affect populated areas of Marin's cities and towns. They often strike with little warning and are accompanied by high velocity flow.

Several Marin Communities, such as Tamalpais Valley, Santa Venetia, Corte Madera, Belvedere, and parts of Strawberry, Novato, and Ross Valley are protected by levees. Levees are typically earthen embankments designed to contain, control, or divert the flow of water to provide some level of protection from flooding. No levee system provides full protection from all flooding events to the people and structures located behind it. Some level of flood risk exists in the levee-affected areas. Except for one levee system in Novato-Hamilton, none of the County's levees are FEMA-accredited. Many were built many decades ago (non-engineered) by farmers or developers and material may have been added over the years.

Levee failure is the overtopping, breach or collapse of the levee. Levees can fail in the event of an earthquake, internal erosion, poor engineering/construction or landslides, but levees most commonly fail as a result of significant rainfall or very high tides. During a period of heavy rainfall, the water on the water-body side of the levee can build up and either flow over the top ("overtopping") or put pressure on the structure causing quickening seepage and subsequent erosion of the earth. The overflow of water washes away the top portion of the levee, creating deep grooves. Eventually the levee weakens, resulting in a breach or collapse of the levee wall and the release of uncontrollable amounts of water.

Disaster History

Since the middle of the last century, the winter/spring storms of 1950, 1955*, 1958*, 1963, 1964*, 1969*, 1970*, 1973*, 1978, 1980, 1982*, 1983*, 1986*, 1995*, 1996, 1997*, 1998*, 2002, 2005/2006*, 2006*, 2008, 2014, and 2017* caused significant damage.

*Major Federal Disasters declared for flood.

Typically storms in which high tides coincide with peak stormwater flow are the most damaging. The New Year's Eve 2005-2006 flood was the last major riverine flooding event that caused widespread damage in Marin. Localized flooding occurred in almost all areas of the County in the 2006 winter storm. San Anselmo, Ross, Fairfax, and Mill Valley were the most heavily impacted. Power outages peaked at 10,000 customers in January. Nine schools closed due to mud, water and road damages and over 20 major roads were closed during the early part of the storm. Corte Madera Creek in San Anselmo, Ross and Fairfax; Novato Creek; Easkoot Creek in Stinson Beach; and Arroyo Corte Madera del Presidio in Mill Valley overflowed their banks. West Creek in Tiburon would also have overflowed its banks but was prevented by a water-inflated property protection bag. Per Table 4-3, at least $219 million in damage was reported in Marin due to this storm, including $94 million in the Ross Valley (Corte Madera Creek) Watershed alone. Over a thousand homes, apartments and businesses were damaged or destroyed. Prior to 2006, the last flood of similar magnitudes occurred in 1982 and 1983. Many improvements were made to flood facilities since then, particularly in Novato.

Novato Creek in the northern part of the county historically caused damage to large numbers of homes, particularly in the 1960's, until the Novato Flood Control Project was completed in eight construction phases starting in the 1980's and continuing through 2006. Novato still experiences some damage during significant winter storms despite the completed Novato Creek Flood Control project. For example, over a million dollars-worth of levee damage occurred in 2014 and 2017 and a heavy burden on stormwater pumping systems caused additional damage to pumping system components. Power outages are also a frequent problem for one of the major pump stations in the area.

Although the current Corte Madera Creek Flood Control project is partially complete (Unit 4 in the Town of Ross is yet to be constructed), flooding will still occur for storms greater than about a 5-year recurrence flood event. Potentially all nine southerly and some centrally located communities of Marin County on this creek are impacted by high tides and heavy rains in above average winter storms. The north-east part of the county, densely populated around the floodplain zones, is threatened every winter and still experiences some damage during winter storms despite the completed Novato Creek Flood Control project.

Flood of 1925: Ross business district. (Photo: Courtesy of Marin History Museum)

Flood of 1982: San Anselmo. (Photo: Courtesy of San Anselmo History Museum)

Flood of 1983: Santa Venetia (Photo: Marin County Department of Public Works)

Flood of December 31, 2005: San Anselmo. (Photo: Marin County Department of Public Works)

Location

Major county watersheds where significant numbers of structures are at risk from riverine flooding include Coyote Creek, Arroyo Corte Madera del Presidio, East and West Creek watersheds, Corte Madera Creek, Novato and Rush Creeks, Miller Creek, Easkoot Creek (Stinson Beach), Gallinas Creek. Additionally, many locations along Richardson Bay, Tomales Bay, lower Las Gallinas Creek, the San Rafael Canal, East San Rafael and Novato shores, and the outer Pacific coastline are vulnerable to coastal flooding.

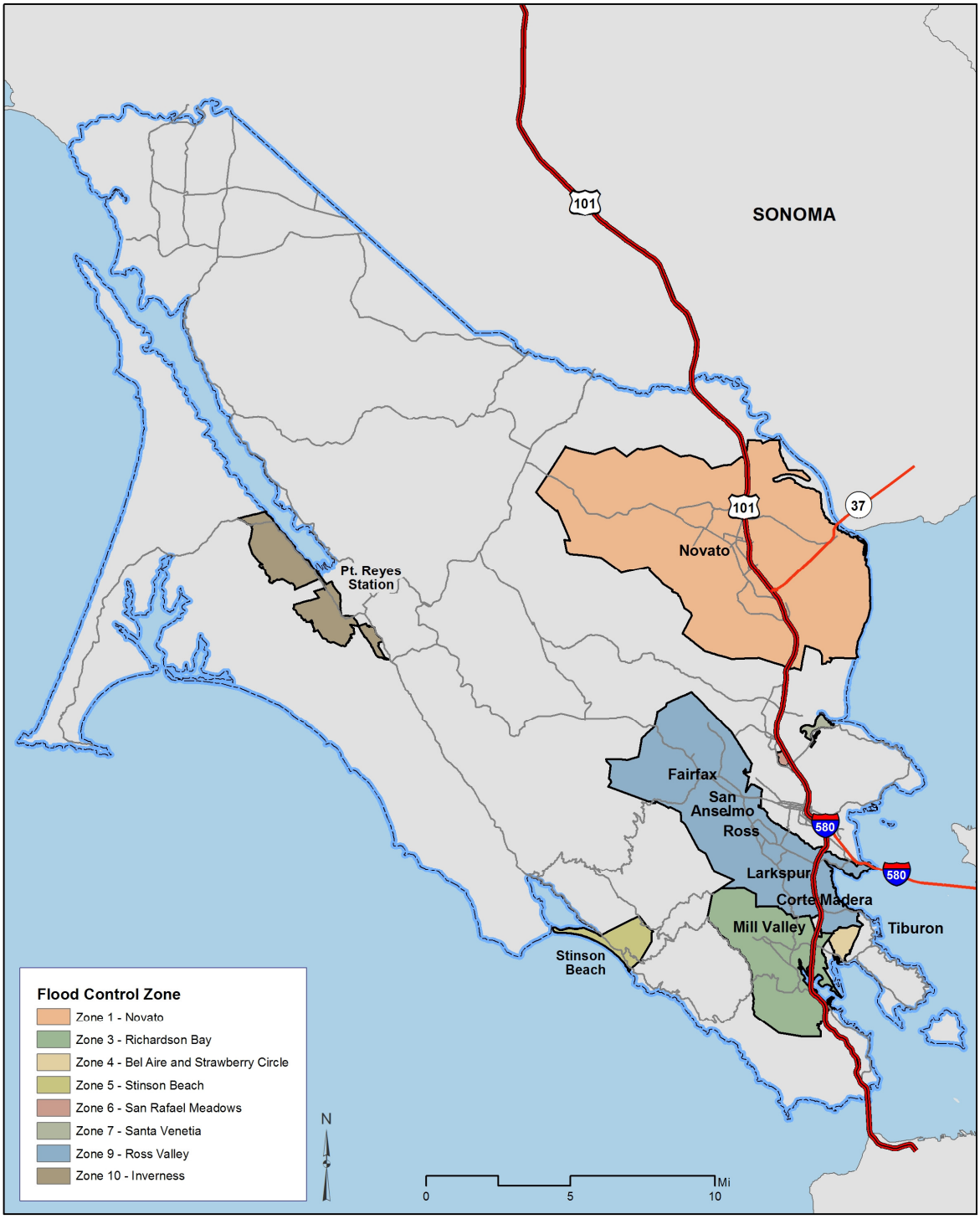
In many cases, where there is a significant history of flooding there is a Marin County Flood Control & Water Conservation District "Flood Zone" established. There are 8 County Flood Zones located in the following areas as described in Table 3-4 and mapped in Figure 3-5.

Table 3-4. Marin County Flood Control & Water Conservation District "Flood Zones"

Zone No.	Name	Location
1	Novato	Northern Marin: Most of City of Novato and some surrounding areas within the Novato Creek watershed.
3	Richardson Bay	Southern Marin: Marin City watershed, Coyote Creek watershed (includes Tamalpais Valley and Almonte); Arroyo Corte Madera del Presidio watershed and Ryan Creek watershed (both include much of the City of Mill Valley), a watershed including Sutton Manor/Alto/part of Strawberry.
4	Bel Aire	Southern Marin: East and West Creek watersheds which run through the Bel Aire neighborhood of the Town of Tiburon and part of (unincorporated) Strawberry.

5	Stinson Beach	West Marin: Part of the lower Easkoot Creek watershed at Stinson Beach.
6	San Rafael Meadows	Central Marin: A part of the Las Gallinas Creek watershed in the City of San Rafael across from the County Civic Center.
7	Santa Venetia	Central Marin: The unincorporated community of Santa Venetia along Las Gallinas Creek.
9	Ross Valley	Central Marin: The Corte Madera Creek watershed, including the towns of Fairfax, San Anselmo, Ross, and Larkspur, as well as unincorporated parts of San Anselmo, Fairfax, Kentfield and Greenbrae.
10	Inverness	West Marin: Inverness, along the west shore of Tomales Bay and the East flank of Inverness Ridge.

Figure 3-5. Marin County Flood Control & Water Conservation District "Zones"



Flood Control Zones

County of Marin
Department of Public Works

www.marinwatersheds.org

All incorporated cities and towns in Marin have flood risk – and are in fact participants in the National Flood Insurance Program. Even those that are not in a Marin County Flood Control & Water Conservation District "Flood Zone," have robust maintenance and capital improvement programs that help manage and mitigate flood risk. These cities without District Flood Zones include most of San Rafael and Tiburon, and all of Corte Madera, Sausalito, and Belvedere. Additionally, San Anselmo, Ross, Larkspur, Fairfax, Mill Valley and Novato have flood mitigation programs that operate largely independently of the Flood District, although extensive coordination of activities and collaboration with the Flood District is facilitated through the Marin County Watershed Program (part of the County Department of Public Works).

Every city and town, and many unincorporated communities in Marin contain FEMA Special Flood Hazard Areas (SFHA), meaning they have at least a 1% chance of flooding in a given year. They all participate in the National Flood Insurance Program and many of the structures in the SFHA carry FEMA flood insurance or private flood insurance.

Marin County and its cities participate in the NFIP. The NFIP makes Federally-backed flood insurance available to homeowners, renters, and business owners in communities that adopt and enforce floodplain management ordinances to reduce future flood damage. Table 3-5 lists the date of the initially mapped FIRM, the emergency/regular program entrance date into the NFIP, and the number of policies in force.

Table 3-5. Date of Initially Mapped FIRM and Emergency/Regular Program Entrance Date into NFIP for Marin County and Cities

County/Community Name	Date of Initially Mapped FIRM	Emergency/Regular Program Entrance Date into NFIP	Number of Policies in Force
Marin County	3/1/82	3/1/82	2040
City of Sausalito	9/30/80	9/30/82	78
Town of Tiburon	5/16/77	5/16/77	142
Town of Belvedere	5/2/77	5/2/77	283
City of Mill Valley	1/3/79	1/3/79	725
City of Novato	1/19/78	1/19/78	1472
City of San Rafael	5/1/84	5/1/84	1565
Town of San Anselmo	12/1/77	12/1/77	558
Town of Ross	2/4/81	2/4/81	194
City of Larkspur	3/15/84	3/15/84	580
Town of Fairfax	1/5/78	1/5/78	204
Town of Corte Madera	12/15/77	12/15/77	588

Source: FEMA NFIP, effective 11/30/17

Probability of Future Events

The County of Marin has several major floodplains which are mapped by FEMA in the most recent Flood Insurance Rate Maps (FIRM), several of which were recently updated in 2016 and 2017. MarinMap.org references of the floodplains for various areas of the County follow, along with symbols showing the locations of critical facilities like Fire Stations, Medical Facilities, and Law Enforcement. The bulk of the floodplains are located in some of the County's most heavily populated areas along the eastern shoreline: notably portions of Novato, San Rafael, and Mill Valley.

These floodplains vary in size, probability and severity of inundation, underlying causes (riverine, tidal, etc.), and potential impacts to the communities in them. The areas of most concern are located in what is designated by FEMA as a 100-year flood zone or Special Flood Hazard Area (SFHA). Due to the increased probabilities of flooding (1% chance in any given year), these properties face high insurance premiums and major restrictions on further development. Summaries of neighborhoods in FEMA floodplains follow (please see MarinMap for details on these locations).

Inverness along Tomales Bay 100-year AE floodplain. *Access to and from Elementary School and Library potentially threatened by flooding. Inverness Post Office at edge of SFHA. Hazard rating "low" due to limited extent. Note: Inverness has several creeks that flow to Tomales Bay. The creeks have potential to overflow and flood properties, but this is not modeled. Landslides and excessive sediment deposition in creeks have resulted from historical floods.*

Point Reyes Station 100-year (A, AE) floodplain and floodway. *Potential access issues due to flooding near roadways. Hazard rating "low" due to limited extent.*

Bolinas and Stinson 100-year (VE) floodplain. *Potential access issues due to flooding near roadways. Beach and other recreation areas, community facilities and residential structures located in SFHA. Hazard rating "low" due to limited extent.*

Muir Beach 100-year (VE, A) floodplain. *Potential access issues due to flooding near roadways. Beach and possibly other community facilities, including volunteer fire facility, located in SFHA. Hazard rating "low" due to limited extent.*

Tamalpais Valley/Coyote Creek 100-year (AE) floodplain and floodway. *Potential access issues due to flooding near roadways such as State Highway 1. Many residential and stormwater*

pumping structures in SFHA. Hazard rating "moderate" due to high number of structures and critical roadway potentially affected.

Marin City and Waldo Point 100-year (AE) floodplain. *Access issues due to flooding near roadways such as State Highway 101 and Donohue Street, which are critical access points to Marin City. Hazard rating "moderate" due to severity of access issues posed by flooding.*

Sausalito and Waldo Point 100-year floodplain. *Access issues due to flooding of primary roadways through the city. Hazard rating "moderate" due to severity of access issues posed by flooding.*

Mill Valley 100-year (AE) floodplain and floodway. *Access issues due to flooding of primary roadways through the city. Schools and fire stations at risk. Hazard rating "moderate" due to severity of access issues and vulnerability of some critical facilities by flooding.*

Strawberry and Greenwood Cove 100-year (AE) floodplain. *Access issues due to flooding of primary roadways through community, including SR 131. Many residential structures at risk. Hazard rating "moderate" due to severity of access issues and vulnerability of several residential structures to flooding.*

Belvedere and Tiburon 100-year floodplain. *Access issues due to flooding of primary roadways through communities. Many residential structures at risk, along with fire station, library, post office and other community facilities. Hazard rating "moderate" due to severity of access issues and vulnerability of community and critical facilities to flooding.*

Along the Pacific Ocean there are a number of homes in Stinson Beach which are mapped as being in a VE zone. A VE zone is a 100-year flood zone where tsunamis or other forms of wave action threaten low lying coastal areas.

For some of the developments along the San Francisco Bay, such as Santa Venetia and Tamalpais Valley, the main issues concern poor drainage due to flat terrain and/or differential settlement, low elevation relative to the tides, and the reliance on a system of pumps and levees to keep floodwaters from inundating homes. Runoff collecting in this area can be especially difficult to remove during high tides.

Other more inland areas, such as areas along Corte Madera Creek and its tributaries, have higher elevations yet still contain properties located in 100-year flood zones. This is mainly due to threats caused by local creeks which have a tendency to overflow their banks when rainfall reaches critical levels. Properties along Novato Creek and its tributaries face similar threats. The main stems of these creeks and many of their tributaries are constrained by development on the banks.

Extent

The diversity and dispersion of Marin County's flood hazards, in addition to the tendency for floods to be flashy in nature, make response to emergencies more difficult and increase the need for planning and community awareness in areas of increased flood risk. While property damage to structures within 100-year flood zones is a major concern, damage to roads, utilities, and other supporting infrastructure located in these zones can potentially impact areas of the community outside of the flood zones as well.

Dealing with flooding from rain and upstream runoff is already complicated. Sea level rise will make it even more complicated by increasing the frequency and duration of flooding. When water temperature increases, water expands and takes up more space than cold water. As the planet warms, the water in the ocean warms, expands, and elevates sea levels. The changing climate has also melted parts of the ice caps at the North and South Poles. As this ice melts and flows into the ocean, it increases the amount of water in the ocean and raises sea levels even more. Sea levels in San Francisco Bay have risen seven inches over the past century. Predictions of future sea level rise vary from 12 inches by 2030 to 60 inches by 2100. The Bay Conservation and Development Commission (BCDC) recommends using 36 inches of sea level rise for planning purposes. Rising sea levels increase the upstream extent of tidal flooding, worsen creek overflow due to backwater effects of elevated high tides, and create larger, stronger waves which erode the shoreline and destroy sensitive marshes. Coastal flooding will have a large impact on cities and habitat.

A 36-inch increase in sea levels will greatly impact people's lives throughout Marin. Daily high tides will inundate major thoroughfares, schools, retirement communities, private homes, shopping areas, bike paths, and stormwater detention ponds. Valuable marsh and mudflat habitat will be permanently flooded. Infrastructure will need to be armored, abandoned, or relocated. Shorelines will be eroded by increased wave erosion, threatening even more infrastructure.

With sea level rise it is projected that more land along Marin's coastline and bayside will be permanently inundated or subject to more regular flooding, while the frequency and intensity of storm events are anticipated to increase with climate change. Greater riparian flooding may also occur with sea level rise and future storm events, though modeling is necessary to better understand the extent of such hazards. As previously discussed best available sea level rise and future flood models indicate that by 2100 around 7,000 acres, 9,000 parcels, 10,000 buildings and 120 miles of roads throughout Marin County may be exposed flooding due to future sea level rise and 100-year storm events.[4]

Arroyo Corte Madera del Presidio is at risk of overtopping due to less than a 5-year flow. On average Corte Madera Creek and Easkoot Creek are at risk of overflowing their banks due to 5-10 year flow events. Novato Creek overflows in some locations due to 10-year flow. Coyote Creek and Gallinas Creek are more vulnerable to overtopping due to tidal elevations and may be able to carry 100-year riverine flows at low tides.

[4] County of Marin, Marin Bay Waterfront Adaptation and Vulnerability Evaluation (BayWAVE), (June 20, 2017) at 25, http://www.marincounty.org/main/baywave/vulnerability-assessment; County of Marin, Marin Ocean Coast Sea Level Rise Vulnerability Report (CSMART), (September 2015

The probability of future levee failures in Marin County is largely unknown but may result from a large winter storm or seismic event. Where more is known about the risks associated with levee failure, we have generally completed Local Levee Evaluations in partnership with the CA Department of Water Resources (DWR). Areas where these studies have been completed include Santa Venetia/Gallinas Creek (further studied in partnership with the U.S. Army Corps of Engineers or "USACE") and Coyote Creek. Levee Evaluations are underway for levees along lower Novato Creek and Corte Madera Creek (also in partnership with USACE).

Impacts

Impacts include structures, infrastructure, and systems.

Vulnerability

The following tables represent vulnerability to debris flow (data from Marin County Department of Public Works sources)

Existing Structures

Commercial	Industrial	Single-Family	Multi-Family
1,309	288	9,562	3,625

Transportation

Miles of Roads	Miles of Railroad	Number of Ferry Terminals
374	19	4

Communication

MERA Towers
0

Power

Transmission Tower	Substation	Natural Gas Substation	Miles of Electric Transmission Lines	Miles of Natural Gas Pipeline
37	5	1	27	8

Water/Sewerage

Wastewater Treatment Plants	Pump Station
3	22

3.3.6 Wind

Description

Based on the NOAA data presented in Table 3-3, most severe winter storms in Marin come with strong winds and many of them cause damage. This can lead to power outages and/or road closures, clog creeks and culverts, damage to structures and cars due to fallen trees, and damage resulting from wind-driven wave erosion.

Previous Occurrences

Based on Table 3-3, winds were reported as high as 72 knots. Storms with strong winds knock down trees and power lines nearly every year and continue to slowly erode vulnerable coastal areas and critical inland ponds (i.e. reservoirs/dams, berms/levees around stormwater detention ponds, wastewater treatment/storage ponds). One event was characterized as a tornado, in Tomales in west Marin, but this weather phenomenon is extremely rare in this part of California.

Location

Table 3-3 shows significant damage due to strong winds affecting all areas of Marin – coastal, mountainous, inland valleys, and southern Marin. Locations where there are power lines, roads, and creeks/bridges, and ponded water for infrastructure (stormwater, wastewater, drinking water purposes) are particularly vulnerable to disruption due to wind damage, as are private structures with nearby trees.

Probability of Future Events

Wind events and associated damages are expected to continue to occur several times per year. County, city and town public works staff and their contractors remove dead, sick or fallen trees in their right-of-way as needed and as funding allows, but there is no feasible way to prevent this hazard.

Extent

Marin's damaging wind events tend to range between 7 and 11 on the Beaufort scale, or 30 to 60 knots. These wind strengths are characterized as high wind to violent storm. Thus, most years whole trees are put in motion and the ocean heaps up and white foam and spindrift form. Slight structural damage and uprooted trees can result occasionally.

Impacts

Although the entire county is affected by wind, coastal areas tend to be impacted more frequently by the strongest winds (9+ on the Beaufort scale) than inland areas. Marin's coastal areas have small resident populations but large visiting populations, such as Muir Beach, Stinson Beach, and Bolinas that can be impacted by strong winds. Beachgoers and boaters would be particularly impacted by wind hazards. Tourism is a key part of the economy in Marin, particularly in coastal communities, and thus there are potentially significant economic impacts of wind events. Some communities, such as Oceana Marin and Olema, rely on water and wastewater infrastructure that has potential to be impacted by coastal erosion, wind driving up wave elevations, and erosion from waves forming due to wind over treatment and storage ponds. Inland critical ponds are also impacted by wind-driven wave erosion such as dams on drinking water reservoirs, and levees/berms containing stormwater retention and detention ponds. Across the county powerlines are potentially impacted by wind, potentially affecting commercial, industrial, and residential areas, and most years downed trees lead to temporary road closures.

Vulnerability

Impacts of wind events may be frequent but the results of those frequent events tend to be short-lived, such as downed trees and powerlines. The systems that are most vulnerable are those that wouldn't be able to be fully repaired quickly should there be a catastrophic failure during an extreme wind event, such as a breach of a levee or dam due to wave erosion. Some examples of vulnerable facilities include:

- Bridgeway Promenade in Sausalito, an economically significant lifeline route, a portion of which runs along the San Francisco Bay shoreline and is vulnerable to wind-driven waves. The route is frequented by visiting tourists and shoppers that are a key part of Sausalito's economy. The impacts are expected to increase with climate change and sea level rise.
- Oceana Marin Force Main Pump Station is 60 feet from the edge of a coastal bluff. Coastal erosion rates up to 4.4 feet/year were anticipated in the Dillon Beach area (where Oceana Marin is located) according to a 2003 Cliff and Erosion Technical Background report prepared to support a Marin County Local Coastal Program update. Although only a small community would be affected by the failure, it would be a long time before the

critical water supply facility could be replaced. Additionally, the community has a sewer line potentially vulnerable to coastal erosion.

- Wind driven waves could flood the Olema Domestic Water Pump Station which would cause electrical and water supply failure to 43 residents, 3 hotels, a church, and a campground.
- Stafford Dam's (earthen) upstream face is subject to wind and wave action which has been eroding the gunite and welded wire reinforcement. A catastrophic failure could lead to inundation of the City of Novato (see the subsection on Dam Failure for vulnerability analysis).

3.3.7 Tsunami

Hazard Profile

Tsunamis consist of waves generated by large disturbances of the sea floor, which are caused by volcanic eruptions, landslides or earthquakes. Shallow earthquakes along dip slip faults are more likely to be sources of tsunami than those along strike slip faults. The West Coast/Alaska Tsunami Warning Center (WC/ATWC) is responsible for tsunami warnings. Tsunamis are often incorrectly referred to as tidal waves. They are actually a series of waves that can travel at speeds averaging 450 (and up to 600) miles per hour with unusual wave heights. Tsunamis can reach the beach before warnings are issued. Associated risks include flooding, contamination of drinking water, ruptured tanks or gas lines, and the loss of vital community infrastructure.

Some Marin County communities may be vulnerable to tsunamis because of the location and quality of the built environment. The principal exposure will be people, buildings, and infrastructure located in the low-lying potential inundation area. Especially at risk are visitors, hikers, campers, and non-residents who might be on the shore when the tsunami strikes.

Disaster History

Prior to the 2011 tsunami impacting Japan, tsunamis have caused loss of life and damaged property in Hawaii, Alaska and the West Coast over the last hundred years. The Alaskan earthquake of 1964 generated tsunami waves affecting the entire California coastline resulting in twelve lives lost and an estimated $17 Million in damages. Marin County was not severely affected and there is no history of any significant damage caused by tsunami.

Over 80 tsunamis have been observed or recorded along the coast of California in the past 150 years. Since 1946, there have been seven tsunamis known to have caused damage to ports and harbors in California. In 1964, a tsunami caused by a M9.2 earthquake offshore from Alaska

resulted in 12 deaths in California and destroyed portions of downtown Crescent City. More recently, a 2006 tsunami (originating in the Kurile Islands region) caused approximately $20 million in damage to Crescent City harbor. A 2010 tsunami (originating offshore from Chile) caused several million dollars in damage to ports and harbors in the state. A tsunami in 2011 (caused by a M9.0 earthquake offshore of Japan) killed one person at the mouth of the Klamath River and caused up to $100 million damage to 27 ports, harbors, and marinas throughout the state. The most damage occurred in Crescent City, Santa Cruz and Moss Landing harbors and a federal disaster was declared in Del Norte, Santa Cruz, and Monterey Counties.

Location

Tsunami inundation maps and information specific to Tsunami run up scenarios in Marin were updated in 2012. As part of this project, signage indicating evacuation routes and safety zones has been installed along the coast and informational pamphlets specific to areas of the county have been distributed. Informational pamphlets covering the vulnerable areas of west Marin are available from the Marin County Sheriff's Office OES.

The following is a list of tsunami inundation areas for various communities in Marin (please see MarinMap for details on these locations).

- Almonte Tsunami Inundation Area. Highways 1 and 101 and residential and commercial areas potentially impacted.
- Belvedere and Tiburon Tsunami Inundation Area. Residential and commercial areas near Belvedere Lagoon potentially impacted in Belvedere. Tiburon Boulevard, Tiburon City Hall, a fire station and commercial areas potentially impacted in Tiburon.
- Black Point Tsunami Inundation Area. Residential areas potentially impacted.
- Dillon Beach Tsunami Inundation Area.
- Kentfield Tsunami Inundation Area. Some residential and educational areas potentially impacted. Bridge to hospital potentially impacted.
- Mill Valley Tsunami Inundation Area. Some residential, commercial, and educational areas potentially impacted.
- Muir Beach Tsunami Inundation Area.
- Paradise Cay Tsunami Inundation Area. Residential area and marina potentially affected.
- Point San Pedro Tsunami Inundation Area.
- San Quentin Tsunami Inundation Area. Potentially affects State Prison and nearby facilities.
- San Rafael Tsunami Inundation Area. Potentially affects marinas, commercial areas, and medical clinic.

- Sausalito Tsunami Inundation Area. Potentially affects marinas, commercial areas, schools, and the primary road through town.
- Stinson Beach Tsunami Inundation Area. Potentially affects fire stations, residential areas, commercial areas, and a National Park
- Strawberry Tsunami Inundation Area. Potentially affects marinas, commercial areas, schools, and the primary road through town.

Probability of Future Events

The greatest threat associated with tsunami is the impact on coastal structure property and threat to human lives. The State of California Coastal Management Program (CCMP) under the California Coastal Act requires cities and counties lying wholly or partly within the coastal zone to prepare a Local Coastal Plan (LCP) that must be certified by the Coastal Commission as consistent with policies of the Coastal Act. (Public Resources Code, Division 20). The U.S. National Tsunami Hazard Mitigation Program (NTHMP) is a State/Federal partnership created to reduce tsunami hazards along United States coastlines.

NTHMP coordinates the efforts of five Pacific States including California. Focal points of future efforts include:

- The Tsunami Inundation Mapping Effort (TIME)
- Tsunami Warning Guidance for Tsunami Warning Centers
- Improve Seismic Networks
- Installation of real-time broadband seismic stations
- Telemetry upgrades to warning centers
- Shortening information dissemination time to emergency services agencies
- Deploy Tsunami Detection Buoys
- Improve Statewide Coordination and Technical Support for Tsunami Warnings

The support of local populations for a variety of mitigation products and programs are essential for mitigation success. To that end, the National Oceanic and Atmospheric Administration (NOAA) has developed the TsunamiReady™ program. To be recognized as TsunamiReady, here are some of the criteria that a community must meet:

- Establish a 24-hour warning point and emergency operations center
- Have more than one way to receive tsunami warnings and to alert the public
- Promote public readiness through community education and the distribution of information
- Develop a formal tsunami plan, which includes holding emergency exercises.

- Comply with TsunamiReady guidelines (which include Communications and Coordination, Warning Reception, Warning Dissemination, Community Preparedness, and Administrative guidance)

Marin County, and the communities of Dillon Beach, Belvedere and Tiburon, are now recognized by the NOAA as TsunamiReady, significantly improving public safety before, during, and after tsunami emergencies.

Extent

Tsunamis can travel at speeds of over 600 miles per hour in the open ocean and can grow to over 50 feet in height when they approach a shallow shoreline, causing severe damage to coastal development. Recent studies of the continental shelf off the California coast indicate a potential for underwater landslides capable of generating damaging tsunamis that could threaten coastal communities.

The National Geodetic Data Center (NGDC) provides a database cataloging all tsunami occurrences. The database can be used to evaluate past tsunami events at a particular site.

Impacts

Community exposure to tsunamis in California varies considerably—some communities may experience great losses that reflect only a small part of their community and others may experience relatively small losses that devastate them. Among the incorporated communities and the unincorporated areas of the county are communities that have the highest number of people and businesses in the tsunami-inundation zone. The communities of Belvedere and Sausalito have the highest percentages of people and businesses in this zone. To download the Community Exposure to Tsunami Hazards in California report visit the USGS website: http://pubs.usgs.gov/sir/2012/5222/

Vulnerability

Existing Structures

Commercial	Industrial	Single-Family	Multi-Family
360	75	2,890	1,070

Transportation

Miles of Roads	Miles of Railroad	Number of Ferry Terminals
124	2	4

Communication

MERA Towers
0

Power

Transmission Tower	Substation	Natural Gas Substation	Miles of Electric Transmission Lines	Miles of Natural Gas Pipeline
2	1	1	8	1

Water/Sewerage

Wastewater Treatment Plants	Pump Station
2	12

Critical Facilities Impacted. Assess dependencies on infrastructure. Cultural Resources – inventory cultural and historic assets that are unique or irreplaceable. Museums, unique geological sites, concert halls, parks, stadiums, etc.

Schools	Police & Fire	Medical	Airports/Heli	Cultural Resources
8	6	1	0	3

3.3.8 Wildfire

The Marin County Fire Department in collaboration with FIRESafe Marin finalized the Community Wildfire Protection Plan (CWPP) in July 2016. The full CWPP is incorporated by reference into this multi-jurisdictional LHMP and most of the information that follows comes directly from the CWPP.

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

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

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

A science-based hazard, asset, risk assessment was performed using up-to-date, high resolution topography and fuels information combined with local fuel moisture and weather data. The assessment was focused on identifying areas of concern throughout the county and beginning to prioritize areas where wildfire threat is greatest. Hazard mitigation efforts can then be focused to address specific issues in the areas of greatest concern (see Sections 4 and 5 of the CWPP). Marin County will reduce wildland fire hazard using a collaborative and integrated approach that includes the following strategies (see Section 8 of the CWPP):

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

The CWPP provides a framework for future collaboration that can be used to identify, prioritize, implement, and monitor hazard reduction activities throughout the county. It is intended to be a living document that will be updated periodically by FIRESafe MARIN and the Marin County Fire Department (MCFD) in collaboration with a broader group of county stakeholders. The CWPP is also intended to support the California Fire Plan and CAL FIRE's Unit Strategic Fire

Plan. While this CWPP broadly covers the entire county, it supports and encourages more focused plans for wildfire protection at the city, community, and neighborhood scales.

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

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

See page 5 of the CWPP for a summary of the 13 fire departments and districts within Marin County. Figure 3-6 indicates their jurisdictional areas.

Figure 3-6. Map of the federal responsibility areas, state responsibility areas and local responsibility areas in Marin County

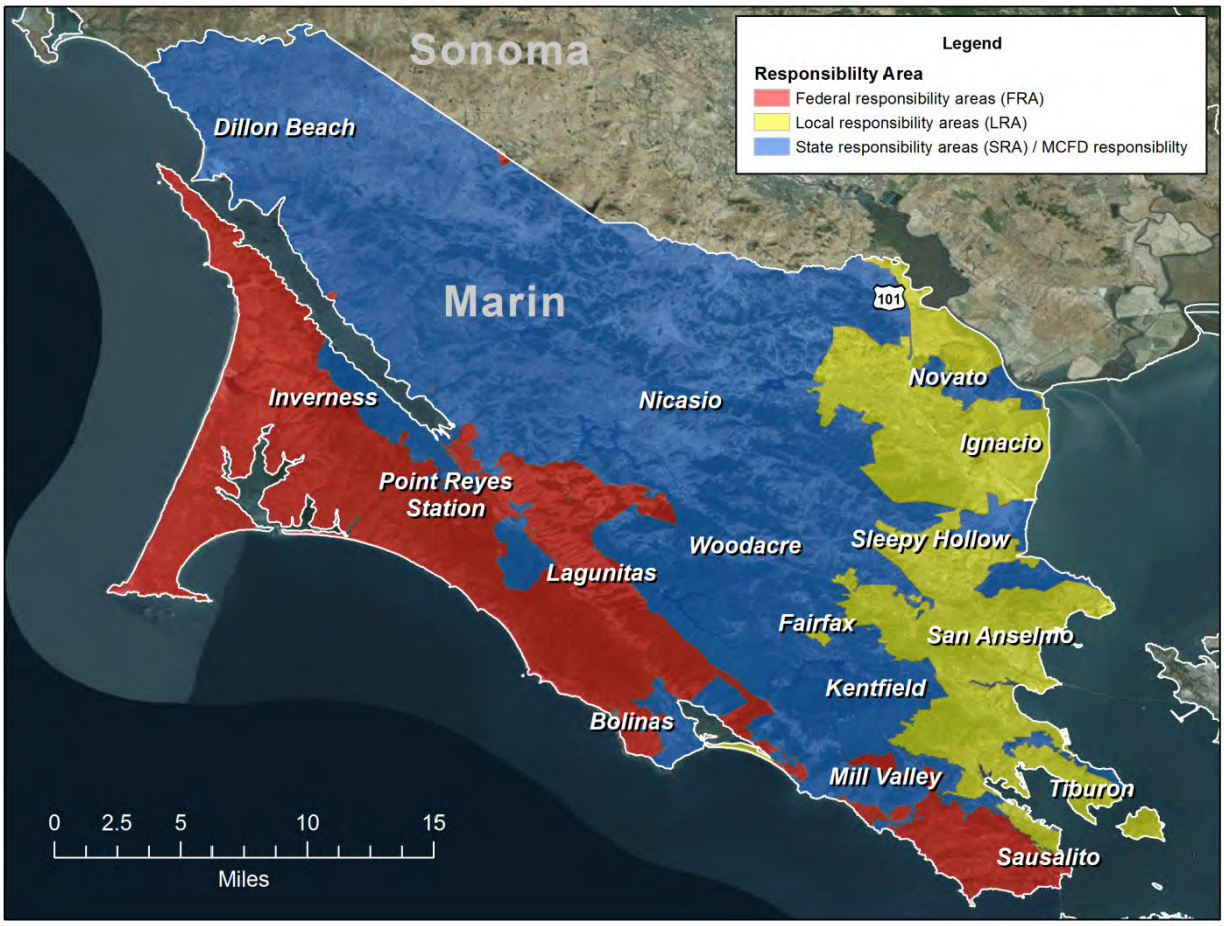
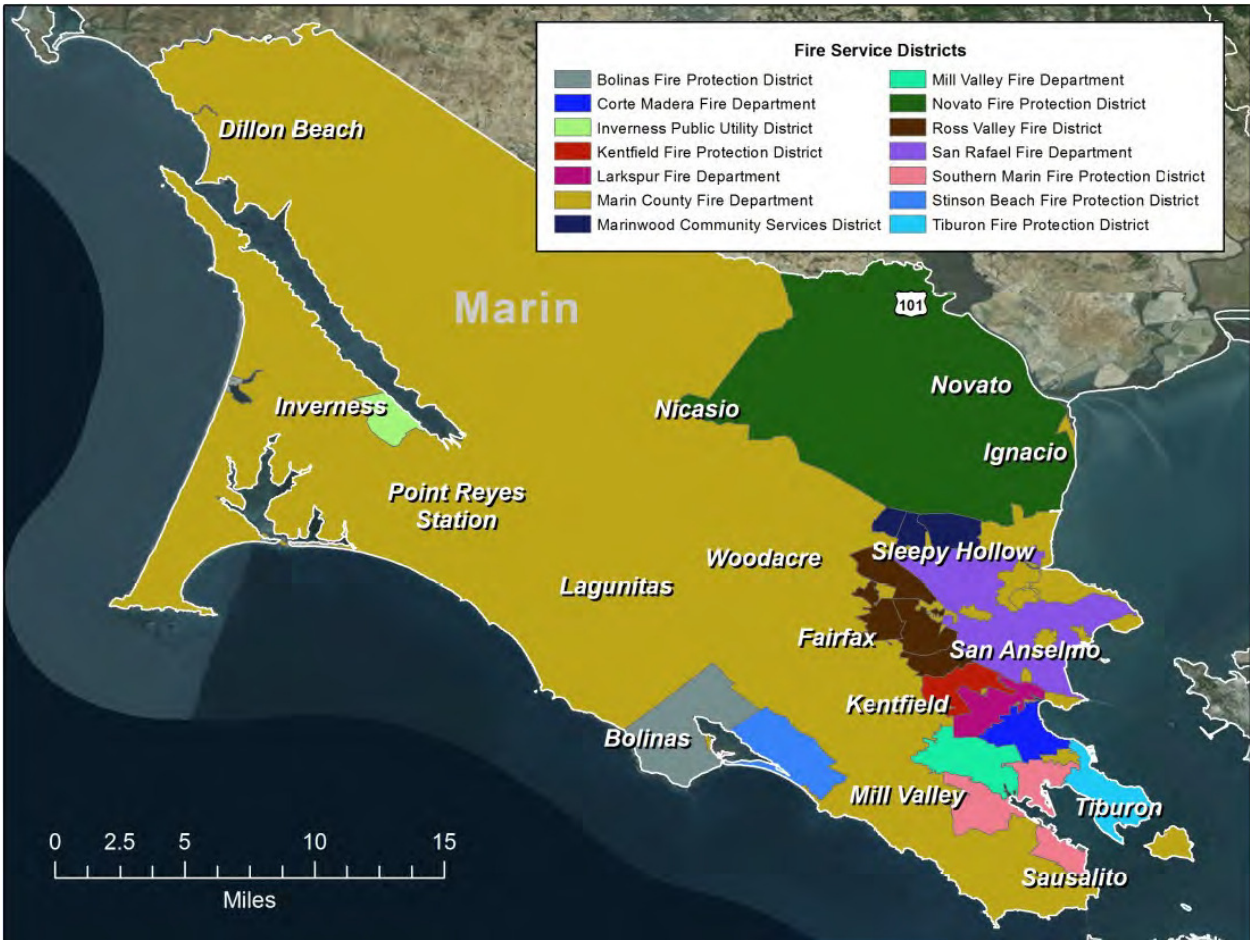


Figure 3-7. Map of Marin County professional fire service agency jurisdictions



Hazard Profile

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

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

annual variability of weather patterns, and less frequent and transient weather patterns are important to fire conditions.

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

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

Occasionally in the summer and more often in the fall, the Pacific High moves inland and centers over Oregon and Idaho, while low pressure moves from the Central Valley of California to southern California and Arizona. The resulting north-to-south pressure gradient can be strong enough to retard the typical sea breeze and can even result in winds blowing from the land to the ocean (offshore winds). As the offshore winds move air from the Great Basin to the coastal areas of California, the air descends and compresses, which greatly warms and dries the air. Under these “Diablo” wind conditions, temperatures in Marin County can reach 100°F in the inland areas and even 80°F at the coast, and relative humidity can be very low. In addition, wind speeds can be high (20 to 40 mph) and gusty and are often much faster over the mountains and ridge tops such as Mt. Tamalpais, Loma Alta, and Mt. Burdell compared to low-lying areas. Wind speeds can be high over the ridges and mountains at all times of day under this “offshore” wind pattern and are often much slower or even calm at night in low-lying areas because nighttime cooling decouples the aloft winds from the surface winds. It is during these Diablo wind events that there is a high potential for large, wind-driven fires should there be an ignition. Historically, the largest and most destructive fires have occurred during these offshore (also known as Foehn) wind events including the Angel Island and the Vision fires.

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

Beginning in late November and lasting through the end of March, the Pacific High moves south and weakens, allowing storms that originate in the Gulf of Alaska to move over California. These storms bring precipitation and, at times, strong winds out of the south. Each storm usually

results in one fourth inch to several inches of rain over a day or so. Near Mt. Tamalpais, rainfall amounts are enhanced by orographic lifting, resulting in higher rain amounts in the Kentfield and Fairfax areas compared to the rest of the county. Typically, after the first rain in November, the cool weather and occasional storm keeps the ground wet through late Spring. However, in some years, significant rain does not occur until later in the year (e.g., early-to-late December) and there can be several weeks without any storms and rain. During storms, temperatures are usually mild.

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

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

Vegetation, which is also known as fuel, plays a major role in fire behavior and potential fire hazards. A fuel's composition, including moisture level, chemical make-up, and density, determines its degree of flammability. Of these, fuel moisture level is the most important consideration. Generally, live trees contain a great deal of moisture while dead logs contain very little. The moisture content and distribution of fuels define how quickly a fire can spread and how intense or hot it may become. High moisture content will slow the burning process since heat from the fire must first eliminate moisture.

In addition to moisture, a fuel's chemical makeup determines how readily it will burn. Some plants, shrubs, and trees such as chamise and eucalyptus (both present in Marin County) contain oils or resins that promote combustion, causing them to burn more easily, quickly, and intensely.

Finally, the density of a fuel influences its flammability; when fuels are close together but not too dense, they will ignite each other, causing the fuel to spread readily. However, if fuels are so close that air cannot circulate easily, the fuel will not burn freely.

Marin County has extensive topographic diversity that supports a variety of vegetation types.

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

Grasslands with a mixture of native and nonnative annual and perennial plant species occur most often in the northern and western parts of the county due to a combination of soil type, lower rainfall, and a long history of ranching. The southern and western facing slopes tend to have a higher percentage of grasslands, which in turn have the potential to experience higher rates of fire spread. Grassland fires are dangerous even without extreme fire weather scenarios due to the rapid rate of fire spread; in some cases, fires spread so quickly that large areas can burn before response resources are able to arrive.

In the west portion of the county closer to the coast, where precipitation is higher and marine influence is greater, most areas are densely forested with conifer species (i.e., Bishop pine, Douglas-fir, and coast redwood) and associated hardwood species. Chaparral vegetation also occurs in parts of the county, especially on steeper south and west facing slopes. This mix of densely forested areas mixed with chaparral results in higher fuel loads and potentially higher fire intensity. Expansion of the residential community into areas of heavier vegetation has resulted in homes existing in close proximity to dense natural foliage; these homes are often completely surrounded by highly combustible or tall vegetation, increasing the potential that wildland fires could impact them.

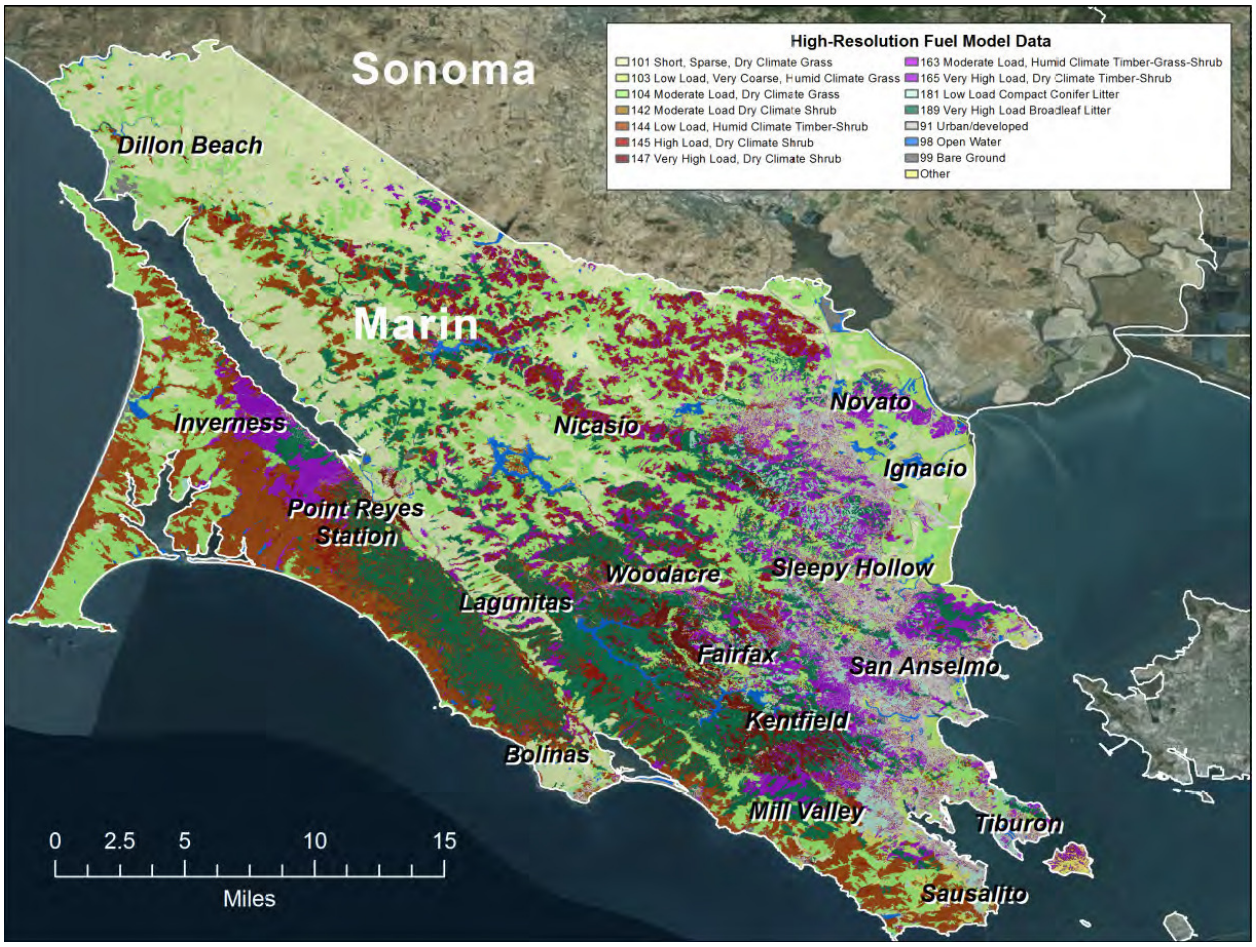
As part of the development of the CWPP, an updated vegetation map layer was created using the most recent vegetation information available from a variety of state and local data sources. Vegetation distribution in Marin County is characterized by approximately 20 different types of vegetation which have been classified into 15 fire behavior fuel models. Table 7 on page 21 of the CWPP lists the fuel model types for Marin County, while Figure 5 shows a fuel model map; the data shown were developed to support this CWPP and represent the most up-to-date and highest-resolution vegetation coverage information for the county. The methods used to develop the data set are described in Appendix A of the CWPP.

Insect infestations and plant diseases, such as California oak mortality syndrome (sudden oak death), are increasing and threaten to change the structure and overall health of native plant communities in Marin County. Sudden oak death has no known cure and is the biggest concern; this syndrome is caused by the fungus-like Phytophthora ramorum, which has led to widespread mortality of several tree species in California since the mid-1990s; the tanoak (Lithocarpus densiflorus) in particular appears to have little or no resistance to the disease. Sudden oak death has resulted in stands of essentially dead trees with very low fuel moistures.

Studies examining the impacts of sudden oak death on fire behavior indicate that while predicted surface fire behavior in sudden oak death stands seems to conform to a common fuel model already in use for hardwood stands, the very low moisture content of dead tanoak leaves may lead to crown ignitions more often during fires of "normal" intensity.

Two other plant diseases prevalent in Marin County are pitch canker (which affects conifers such as Bishop pine and other pine species), and madrone twig dieback (which affects Pacific madrones). Pitch canker is caused by the fungus Fusarium circinatum (F. subglutinans, F. sp. pini), which enters the tree through wounds caused by insects. While some trees do recover, most infected trees are eventually killed by the fungus. Management of this disease largely focuses on containment to reduce the fungus spreading to other trees. Pitch canker is a particular issue in the NPS lands of Pt. Reyes National Seashore, where many acres of young Bishop Pines that were seeded on the Inverness Ridge by the Mount Vision Fire of 1995 have been infected.

Figure 3-8. Fuel model map for Marin County



These dead and dying trees have created large swaths of land with dense and dry fuel loads.

Madrone twig dieback is caused by the native fungus Botryosphaeria dothidea and appears to be getting worse throughout the county due to drought effects on Pacific madrones. Three additional threats to trees common to Marin County include:

• Bark and ambrosia beetles (Monarthrum dentiger and monarthrum scutellare), which target oak and tanoak trees. Sudden oak death may be exacerbating the effects of beetle

infestations which prey on trees already weakened by this disease.

• Root rot, caused by oak root fungus (Armillaria mellea), is primarily associated with oaks and other hardwoods but also attacks conifers. These fungal infestations cause canopy thinning and branch dieback and can kill mature trees. As with the beetle infestations, sudden oak death may be exacerbating the effects of root rot fungus in the county forests.

• Velvet-top fungus (Phaeolus schweinitzii) is a root rot fungus affecting Douglas-fir and other conifers, with the infection typically occurring through a wound.

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

Marin County is topographically diverse, with rolling hills, valleys and ridges that trend from northwest to southeast. Elevation throughout the county varies considerably, with Mt. Tamalpais' peak resting at 2,574 feet above sea level and many communities at or near sea level. Correspondingly, there is considerable diversity in slope percentages. The San Geronimo Valley slopes run from level (in the valley itself) to near 70%. Mt. Barnabe has slopes that run from 20 to70%, and Throckmorton ridge has slopes that range in steepness from 40 – 100%. These slope change s can make fighting fires extremely difficult.

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

The dispersion of burning embers from wildfires is the most likely cause of home ignitions. When embers land near or on a structure, they can ignite near-by vegetation or accumulated debris on the roof or in the gutter. Embers can also enter the structure through openings such as

an open window or vent and could ignite the interior of the structure or debris in the attic. Wildfire can further ignite structures through direct flame contact and/or radiant heat. For this reason, it is important that structures and property in the WUI are less prone to ignition by ember dispersion, direct flame contact, and radiant heat.

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

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

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

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

The county has amended the 2013 California Fire Code (CFC) Chapter 49 requirements for defensible space around existing homes (note that the 2013 CFC Chapter 49 requirements are identical to the Public Resource Code and Government Code requirements). The MCFD amendment modifies the language of PRC 4291 such that the property line no longer limits the amount of defensible space required around structures. If the 100-foot defensible space/fuel modification zone extends from private to public lands, the defensible space stops at the property boundary. However, fuel modification/clearance may be permitted after an evaluation and issuance of approval from the public land management agency.

Disaster History

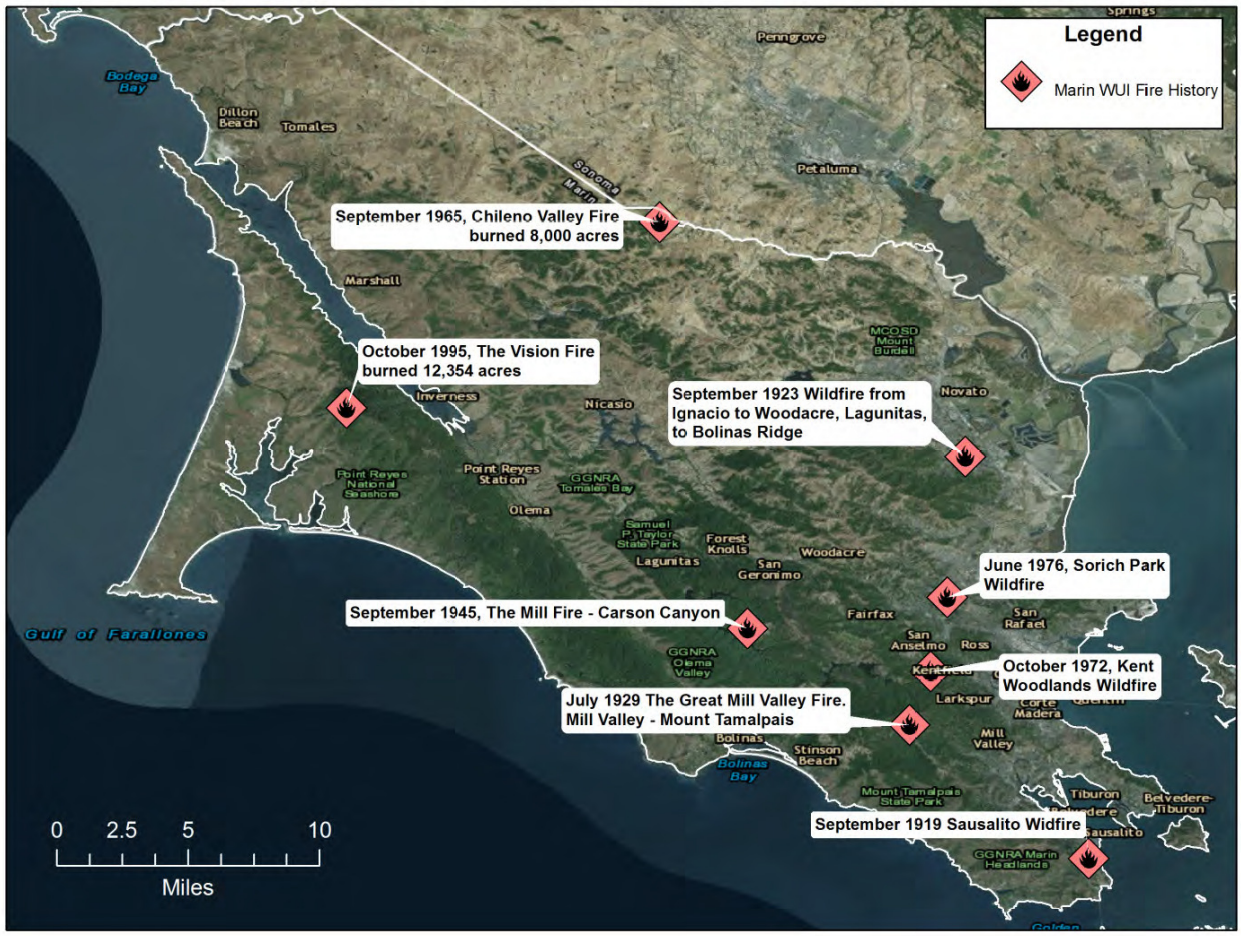
In the time before the county was settled, fire was a natural part of the ecosystem. Much of the vegetation in what is now the wildlands of Marin County depended on fire to renew itself by

removing old, dead fuel in order to make room for healthy new vegetation and promote the growth of native plant species. Once the land was settled, business operators, landowners, and homeowners had an interest in protecting the natural assets of Marin County and their own investments. Uncontrolled fires had already burned large tracts in the past and valuable lumber, structures, and field crops had been destroyed. A series of fires that occurred in the late 1800s prompted the organization of the first fire departments in Marin County around the turn of the century.

Since then, national fire suppression policies and practices (among other factors) have contributed to the continuous growth (and overgrowth) of vegetation resulting in dangerous fuel density, or fuel loads. Combined with this fuel accumulation, the public have been building homes closer and closer to wildlands, which is creating the WUI fire issues that are now present in many parts of Marin County and the country.

Throughout its history, Marin County has experienced many wildland fires. Figure 3-9 shows a map of large fires that have occurred in Marin's WUI.

Figure 3-9. Map of large fires that have occurred in Marin County's WUI

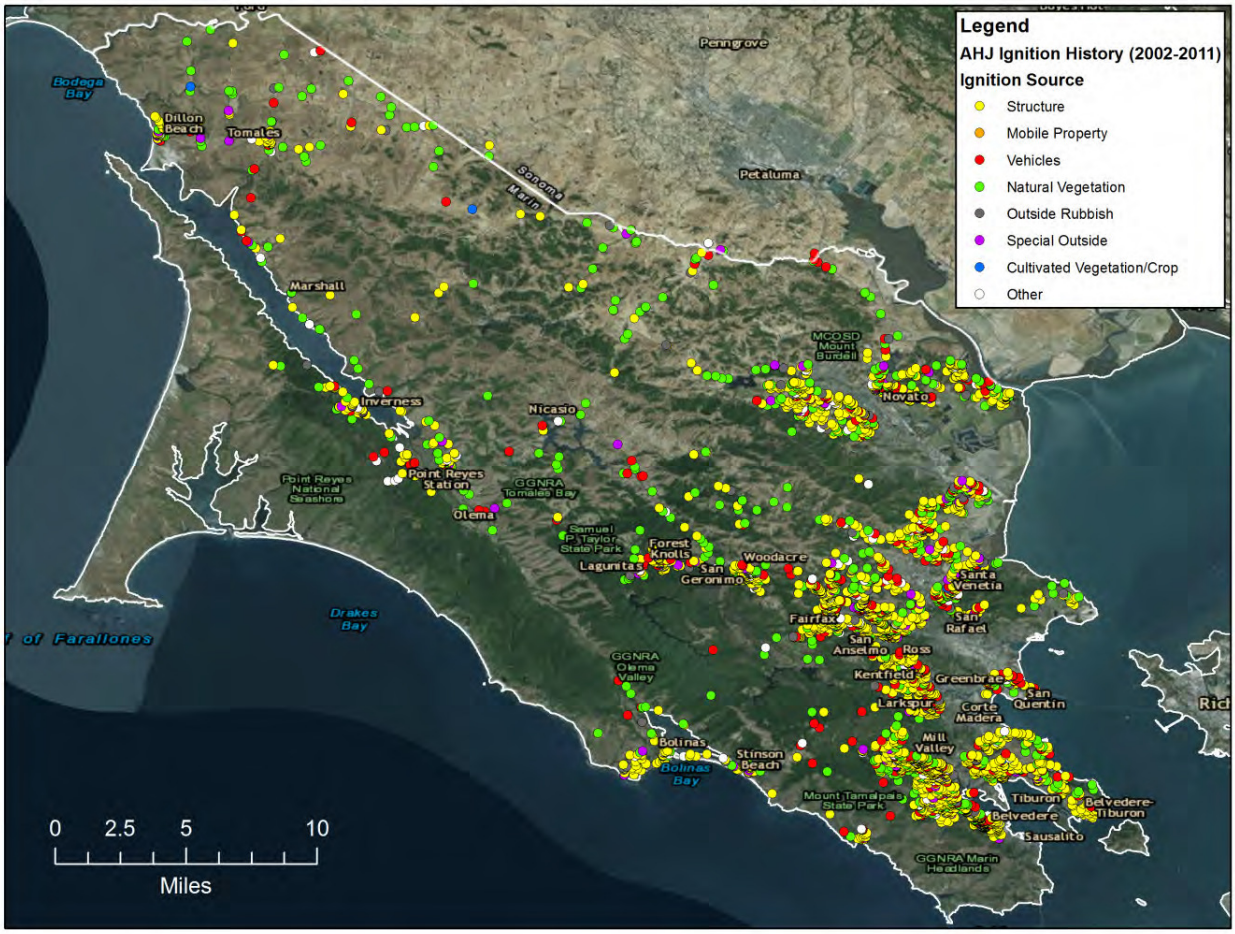


The most recent Marin County fire that resulted in significant structure loss was the Vision Fire in 1995, which destroyed 48 structures in the community of Inverness. In 1929, the base of Mt.

Tamalpais—specifically the community of Mill Valley—experienced a significant fire known as the Great Mill Valley Fire. That fire's footprint is now developed with more than 1,100 homes (valued at $1.3 billion) which have significantly altered the natural vegetation through urban and suburban development.

As part of the CWPP, Ignition data for all authorities having jurisdiction (AHJ) were acquired and analyzed for 2002 through 2011 to evaluate ignition trends within the county. Table 8 of the CWPP presents the ignition history for all AHJs classified by ignition category. Figure 3-10 below shows a map of the ignition history for all AHJs classified by ignition category.

Figure 3-10. Map of ignition history data for all authorities having jurisdiction in Marin County from 2002 to 2011.



Location

The WUI zone map used throughout this CWPP was assembled using geographic information system (GIS) data layers acquired from the Marin County GIS web portal, MarinMap. The WUI zone helps inform decisions on where to focus vegetation management and fuel reduction projects. The WUI zone determination is also a major component of MCFD's Strategic Fire Plan (Marin County Fire Department, 2015), which in turn is part of CAL FIRE's Strategic Fire Plan.

Homes and structures located anywhere in and around the WUI are at a higher risk for exposure to wildland fire. Fire can spread rapidly throughout WUI areas through adjacent structures and/or vegetation, or by ember dispersion. Property owners in the WUI have a responsibility to prepare their property for structure defense by providing adequate defensible space and complying with WUI building codes and ordinances (see Section 7 of the CWPP). The WUI boundaries for Marin County were determined based on areas with high structure density and proximity to areas with a high density of burnable fuels.

Approximately 60,000 acres—18% of the county's land area—falls within the wildland urban interface (WUI) where residences (i.e., homes and structures) are intermixed with open space and wildland vegetation. Within Marin County, there are 96,195 parcels and 106,679 living units; of these living units, an estimated 69,000 units are located in the WUI. A recent assessment by the Marin County Fire Department (MCFD) revealed that these living units within the WUI are valued at $59 billion (Marin County Fire Department, 2015). Because of the mix and density of structure and natural fuels combined with limited access and egress routes, fire management becomes more complex in WUI environments. In Marin County specifically, many of the access roads within the WUI are narrow and winding and are often on hillsides with overgrown vegetation, making it even more difficult and costly to reduce fire hazards, fight wildfires, and protect homes and lives in these areas.

Figure 3-11. Map of Marin County and the wildland urban interface (colored red)

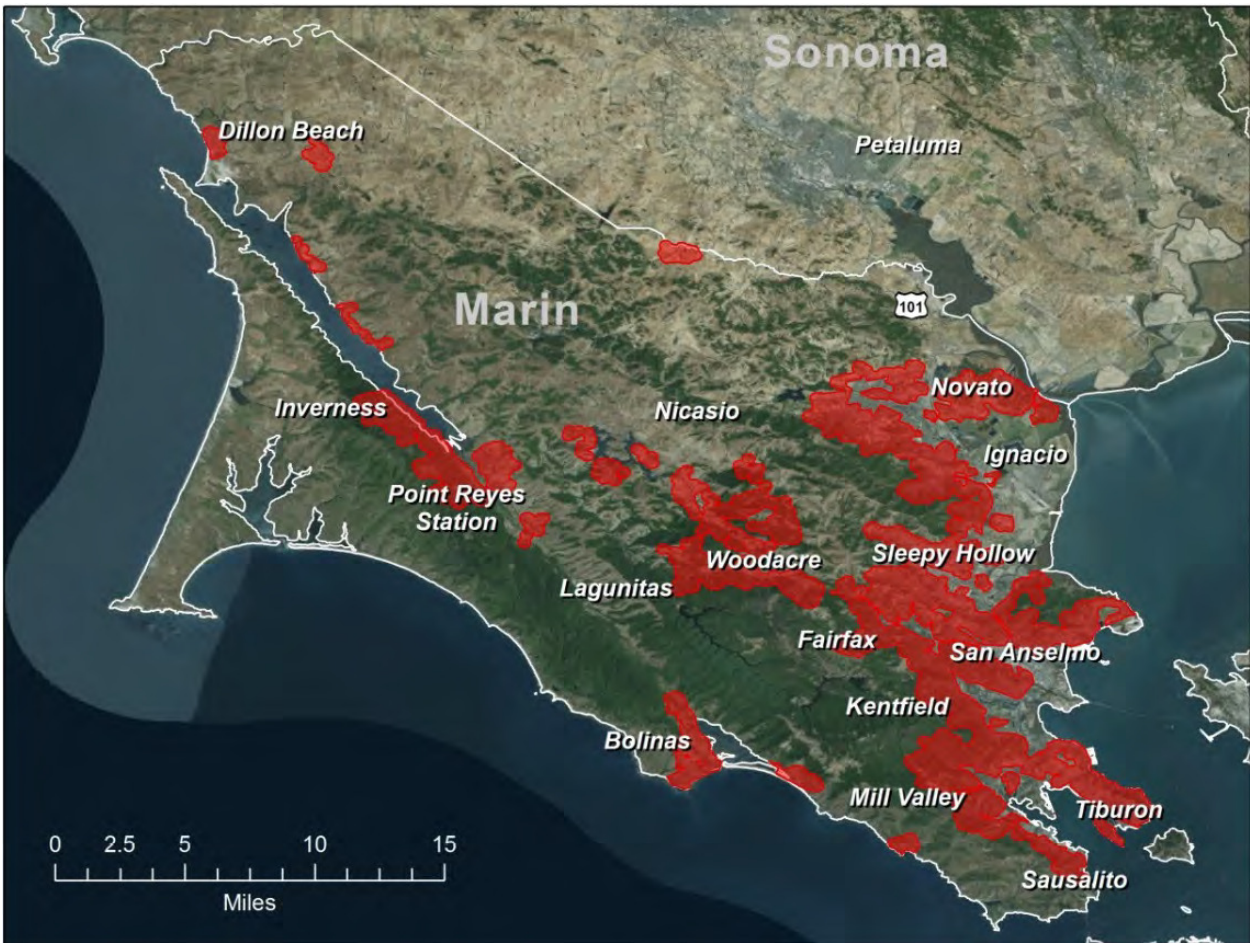


Figure 3-12. Marin County's WUI boundaries overlaid with population density

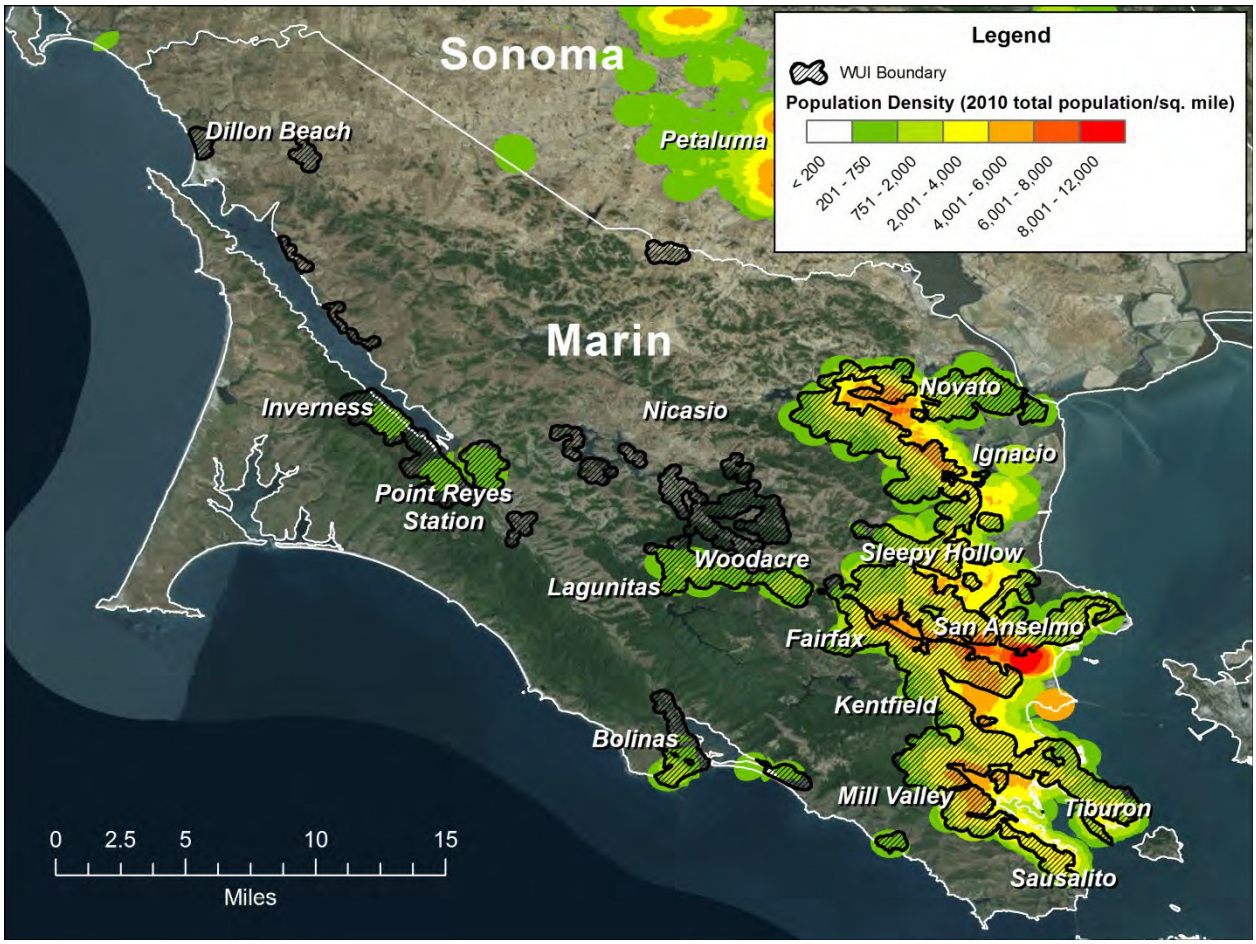
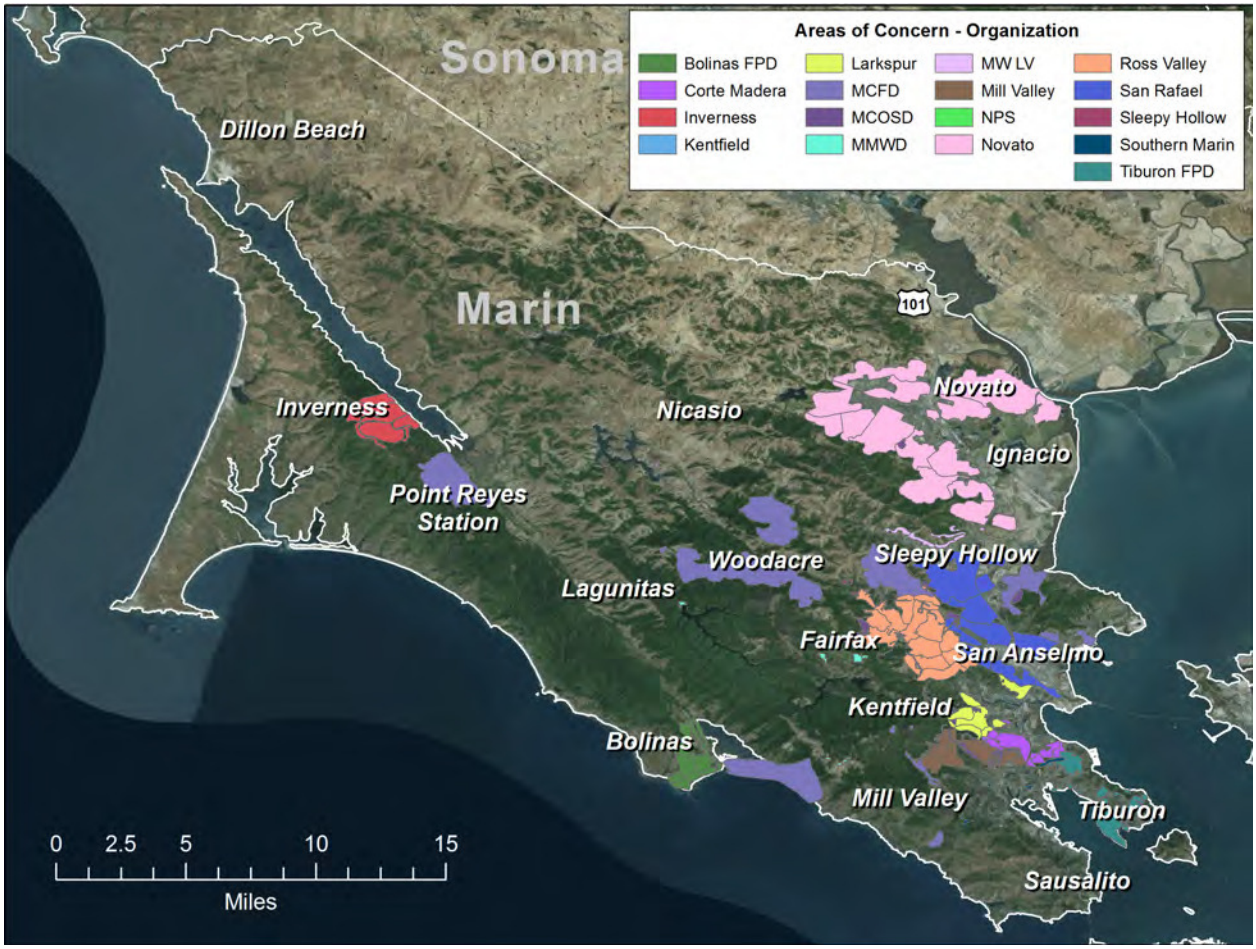


Table 3-6. Marin County communities at risk and fire district jurisdiction

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

Figure 3-13. Map of areas of concern identified by CWPP stakeholder agencies in Marin



Extent and Probability Future Events

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

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

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

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

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

The Mt. Tamalpais watershed supplies central and southern Marin County with 75% of their fresh water. Given the area's seasonal rainfall, any major wildfire impacting the heavily forested watershed will result in major silting and subsequent degradation of water quantity and quality in the watershed. This watershed—as well as the lands managed by MCOSD, state parks, and NPS—are largely contiguous. They harbor several endangered, threatened, and special-status species, including the coho salmon and northern spotted owl.

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

Finally, Marin County's agricultural land base includes nearly 137,000 acres of privately owned agriculturally zoned land and 32,000 acres of federally-owned land that is leased to agricultural operators. Agricultural operations include livestock and livestock products; aquaculture; field crops; fruit, vegetable, and nursery crops. The gross value of all agricultural production was approximately $101 million in 2014 (Marin County Department of Agriculture, 2014). To help protect people and property from potential catastrophic wildfire, the National Fire Plan identifies communities that are at high risk of damage from wildfire. These high-risk communities identified within the WUI were published in the Federal Register in 2001. In California, CAL FIRE has the responsibility for managing the list. With California's extensive WUI situation, the list of communities extends beyond just those adjacent to Federal lands; there are 1,329 communities currently on the California Communities at Risk List. Marin County has 23 of these at-risk communities, as shown in Table 12 in the CWPP. A countywide assessment of the wildland fire threat undertaken by CAL FIRE revealed that nearly 313,000 acres (approximately 82% of the total land area of the county) are ranked as having moderate to very high fire hazard severity zone ratings.

Using the methodology described in Section 4.2 of the CWPP, a series of models of the hazards, assets, and risks were completed. One model was the average fire season flame length, with lengths above 8 feet possibly exhibiting the more extreme fire behavior and be relatively more hazardous from a fire suppression perspective. Rate of spread is defined as the rate of forward spread of the fire head expressed in feet per minute. The higher the rate of spread, the more difficult a fire is to suppress. A composite map of the flame length, rate of spread, and population density for the average fire season scenario is shown in Figure 3-14; orange and red show areas where more extreme fire behavior is likely given an ignition.

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

Figure 3-14. Composite map of population density, flame length, and rate of spread for the average fire season model scenario

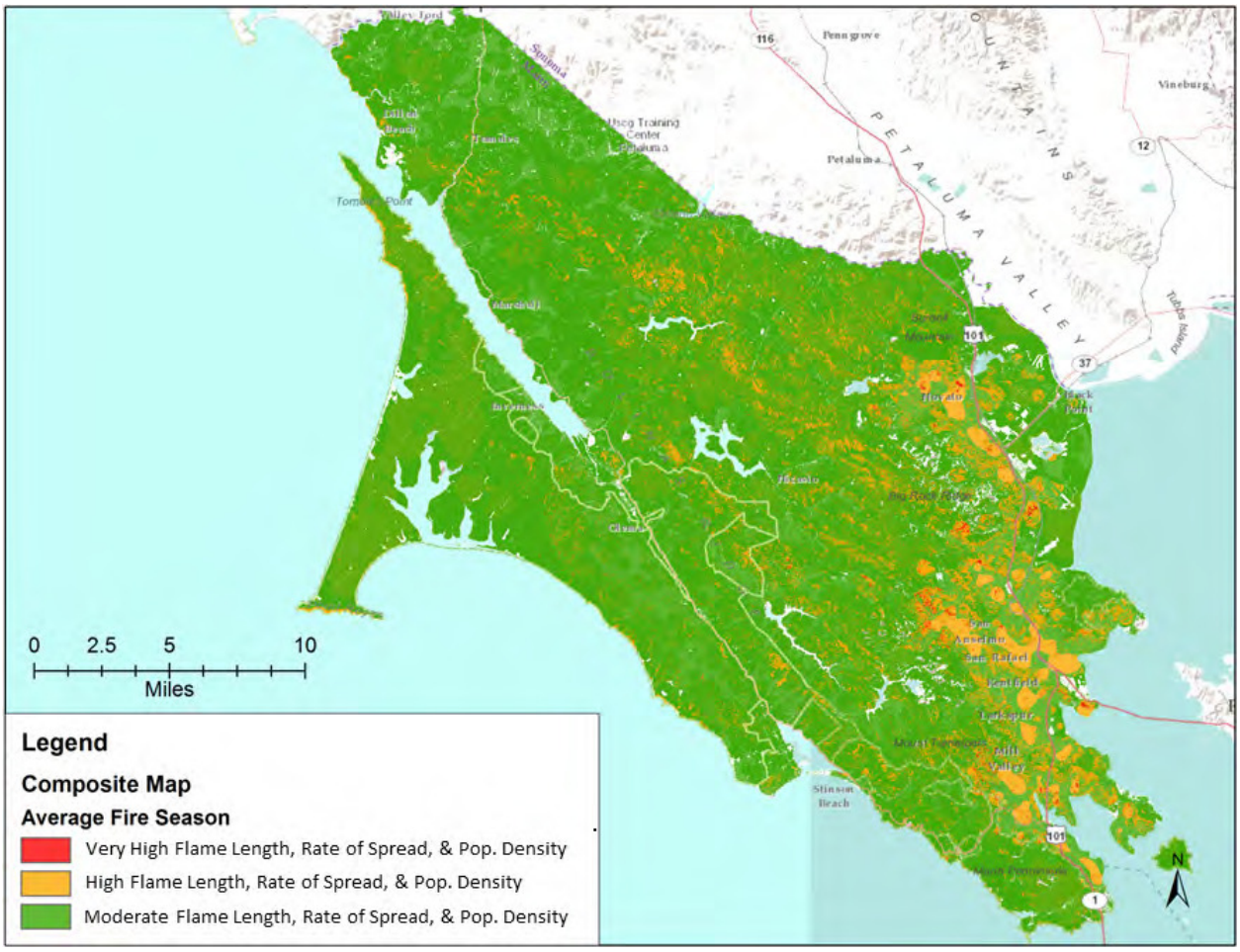


Figure 3-15. Composite map of population density, flame length, and rate of spread for the average fire season model scenario

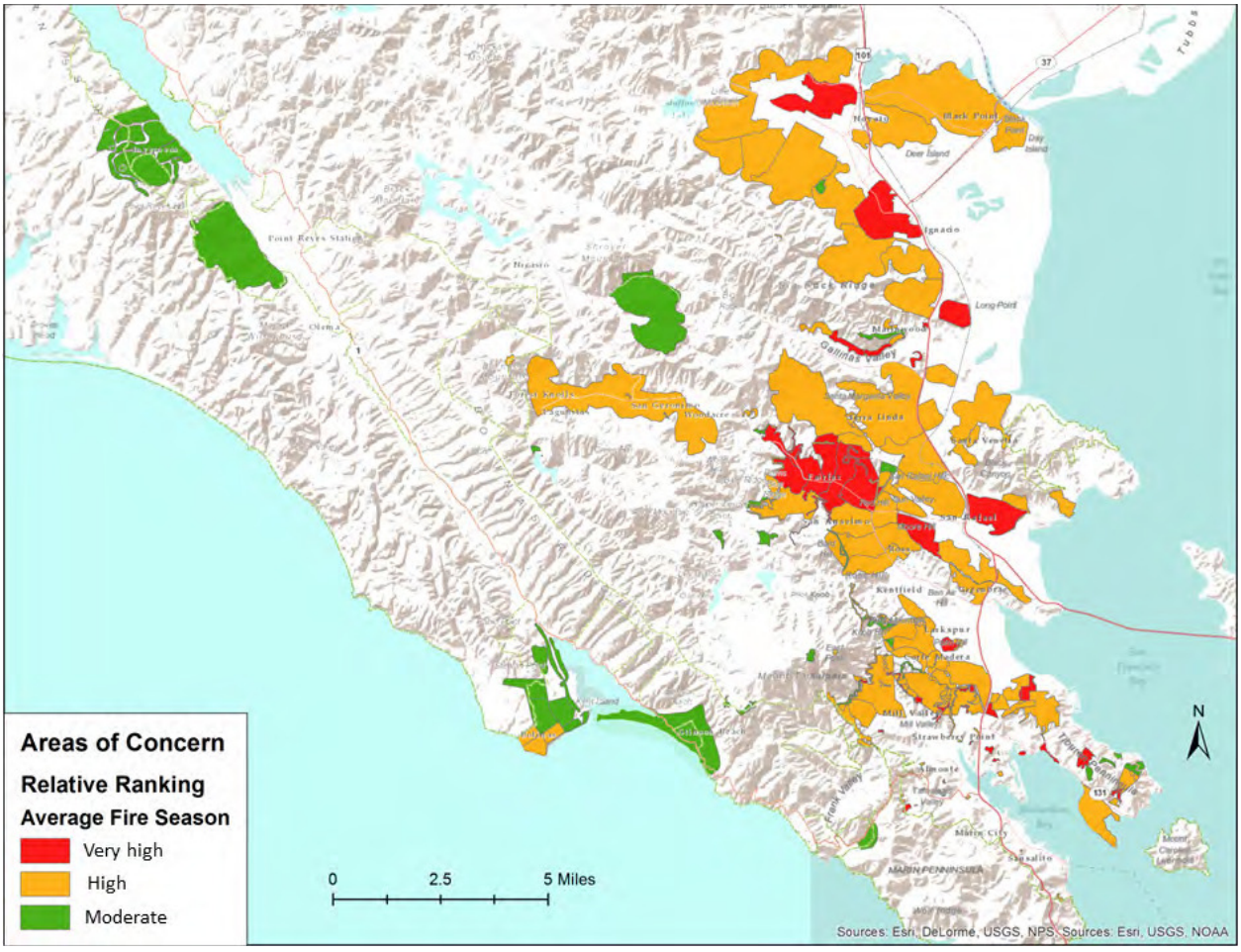
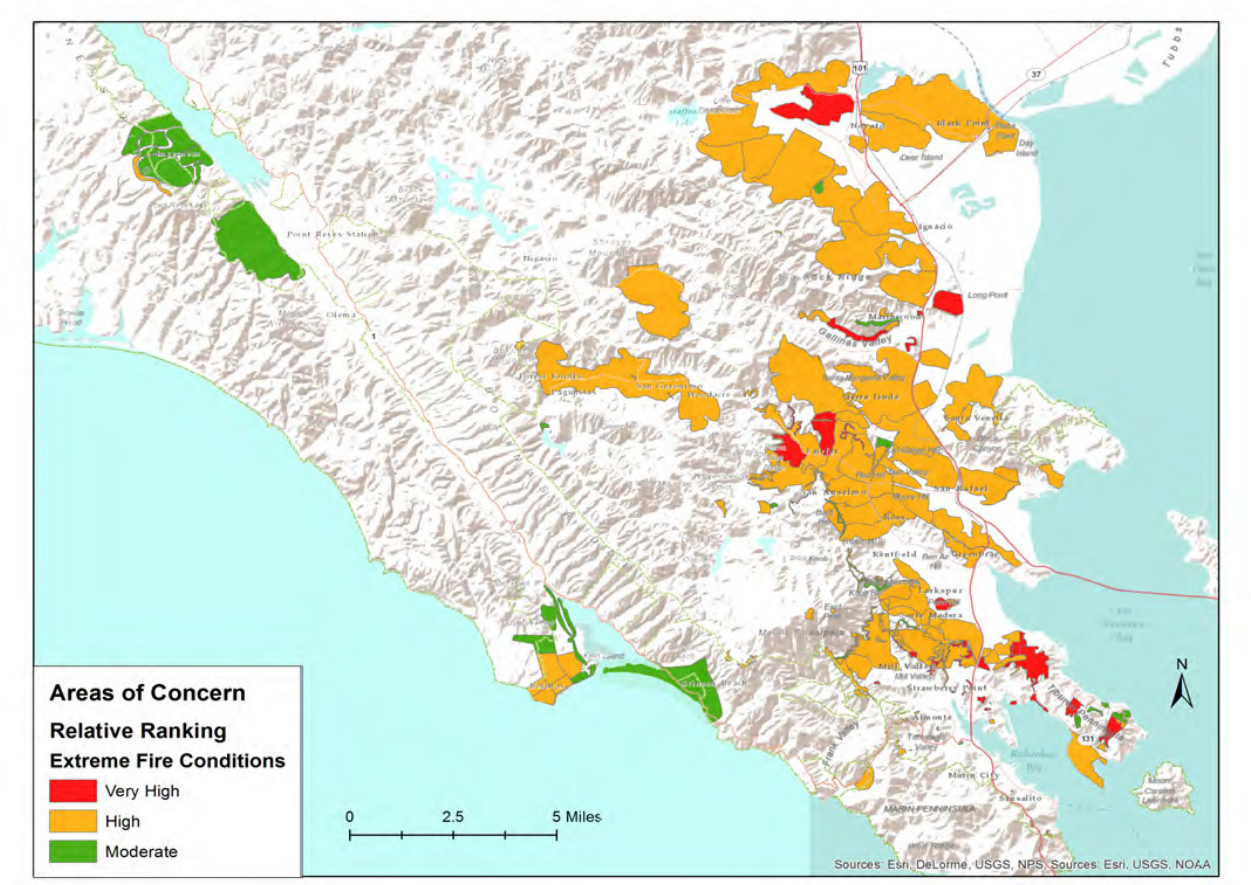


Figure 3-16. Composite map of population density, flame length, and rate of spread for the extreme fire conditions model scenario



Communities at Risk and Areas of Concern	Relative Ranking
Bolinas (water system expansion/improvement	Very High/High
Corte Madera and Larkspur (Tiburon Ridge, Ring Mountain, Palm Hill WUI)	Very High
Corte Madera (Marin Estates, Madrono-Pleasant [Town], Madera del Presidio Phase II, Chapman, Park/Meadowsweet, Christmas Tree Hill, Blithdale Ridge, Palm Hill/Blue Rock, Madera del Presidio Phase I)	High
Inverness (watershed and residential areas)	High/Moderate
Kentfield (Evergreen Fire Trail; Rancheria Road; Crown Road from 123 Crown Road to Phoenix Road and continuing on Indian Fire Road to the Blithedale Ridge/Eldridge Grade intersection; King Mountain Loop project (Larkspur) to 76 Ridgecrest Road; 12 Ridgecrest Road to 76 Ridgecrest Road, including all of BlueRidge Road southwest facing slope; the area of Goodhill Road and Crown Road, including the area of Harry Allen Trail; 351 Evergreen Road to 414 Crown Road to 12 Ridgecrest Road, south and southeast facing slope)	High
Larkspur (North Magnolia WUI; Greenbrae Hills WUI; Marina Vista	High

Area WUI; Baltimore Canyon WUI; Marina Vista/SE Baltimore Canyon; King Mountain/NW Baltimore Canyon)	
Mill Valley (MMWD land and open space areas)	Very High
Mill Valley (Scott Valley, Cascade, PG&E property, Summit, City property, open space, City right-of-way, private property, Warner Canyon/Scott Highlands, MMWD/private/City right-of-way)	High
Marin County Fire Department (Hill Ranch, Los Ranchitos, Summit, Bay View, San Pedro, Mount Tam Lookout, Sleepy Hollow WUI, Throckmorton/Panoramic WUI, Dickson Lookout, Woodacre/Lagunitas/Forest Knolls WUI, Mount Tam Middle Peak infrastructure, Rancho Santa Margarita WUI, Inverness WUI, Green Gulch, Stinson Beach WUI)	High
Marin County Open Space District Lands (areas in and adjacent to neighborhoods)	Very High/High
Marin Municipal Water District (Rock Spring, Pine Mountain south gate, Sky Oaks Meadow, Deer Park Road, Sky Oaks Headquarters, Peters Dam)	High/Moderate
Marinwood/Lucas Valley (Limestone Hill area, CSA 13, Horse Hill area, Berry area, Miller Creek Road Area, Valleystone Project, Lucas Valley Estates)	Very High/High
Novato (Marin Valley, Novato North, Anderson Rowe)	Very High
Novato (San Marin, Hilltop, Loma Verde, Wilson West, Cherry Hill, Pacheco Valley, Little Mountain, Indian Valley, Wildhorse Valley, Wilson East, Ignacio Valley, Atherton, Blackpoint)	High
Ross Valley (Fairfax, Hawthorne Hills, San Francisco Boulevard, Alameda, Morningside, upper San Anselmo Avenue)	Very High
Ross Valley (Ross [east/central/south], San Anselmo [downtown], Cascade Canyon, Sleepy Hollow)	High
San Rafael (San Pedro Ridge, Dominican, Glenwood, Peacock Gap, Gerstle Park and Cal Park neighborhoods)	Very High
San Rafael (Smith Ranch areas, West End from San Rafael Hill to Ridgewood Avenue Bret Harte, Los Ranchitos areas, Terra Linda neighborhoods)	High
Sleepy Hollow (Loma Alta area)	High
Southern Marin (Meda project, Milland, Ricardo open space, So. Morning Sun/Tennessee, Hawkhill, Autumn Lane)	Very High
Southern Marin (Rodeo water tank, U.S. Route 101/Wolfback Ridge, Seminary, Edwards/Marion, Lattie Lane/Highway 1, Blackfield,	High

Laguna/Forest, Cabin Drive, Homestead Valley, Fairview Ring Mountain Area, Aqua Hotel Hill, Highway 1 to Erica/Friars)	
Tiburon (Middle Ridge, South Knoll Playground, Blackie's Pasture, Greenwood Beach)	Very High
Tiburon (Ring Mountain, Old St. Hilary's Open Space Preserve, Tiburon Marsh, Belvedere Lane and right of ways, Tom Price Park, Sugarloaf Drive to Paradise Drive, Middle Ridge open space, Romberg Tiburon Center, Paradise State Park)	High

Unincorporated rural areas within the county include the coastal communities of Muir Beach, Stinson Beach, and Bolinas; communities near Tomales Bay including Olema, Point Reyes Station, Inverness, Inverness Park, Marshall, Tomales, and Dillon Beach; and rural areas in the interior valleys including Nicasio, Lagunitas, Forest Knolls, San Geronimo, and Woodacre. These communities are primarily situated within or adjacent to the WUI, with moderate to dense concentrations of structures. Marin County has approximately 60,000 acres of WUI adjacent to 200,000 acres of watershed. Response times in these communities present significant challenges to keeping fires from directly impacting the communities and sub divisions (especially those within the SRA) as emergency fire access and evacuation egress is limited by narrow, winding roads lined with dense vegetation.

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

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

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

3.3.9 Post-Fire Debris Flow

Hazard Profile

According to the U.S. Geological Service (USGS), "Wildfire can significantly alter the hydrologic response of a watershed to the extent that even modest rainstorms can produce

dangerous flash floods and debris flows. The USGS conducts post-fire debris-flow hazard assessments for select fires in the Western U.S. We use geospatial data related to basin morphometry, burn severity, soil properties, and rainfall characteristics to estimate the probability and volume of debris flows that may occur in response to a design storm." There have been no major wildfires in the County since 2013, although nearby Sonoma and Napa counties currently face a significant threat of post-fire debris flow due to the October 2017 wildfires.

Disaster History

The MCM LHMP team has not found examples in recent history of post-fire debris flow in Marin.

Location

USGS analysis does not show any existing significant post-fire debris flow threats in Marin. However, any summer or fall wildfires that occur in the next 5 years could lead to post-fire debris flows originating from the burn areas during the following rainy season. Thus, the location of this hazard coincides with watershed locations with the greatest wildfire and flood threats.

Extent and Probability of Future Events

Without recently burned watersheds the extent and probability of future events can't be analyzed. However, precautions should always be taken after a burn to ensure that soil stability is maintained to the extent feasible.

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SECTION 4 VULNERABILITY ANALYSIS

4.1 OVERVIEW

A vulnerability analysis predicts the extent of exposure that may result from a hazard event of a given intensity in a given area. The analysis provides quantitative data that may be used to identify and prioritize potential mitigation measures by allowing communities to focus attention on areas with the greatest risk of damage.

Per the local mitigation planning requirements, this vulnerability analysis consists of the following seven steps:

Asset inventory

Methodology

Data limitations

Exposure analysis

Repetitive Loss and Severe Repetitive Loss properties

Summary of impacts

Additionally, the impacts of the hazards on future development areas, natural and beneficial function, and life/safety warning/evacuation procedures are discussed at the end of this section to meet the compliance requirements for CRS Activity Worksheet 510.

Tables that support the asset inventory, exposure analysis and summary of impacts are provided in each local-participant-specific appendix (Appendix G through Appendix S).

4.2 ASSET INVENTORY

Assets that were included in this MCM LHMP's vulnerability analysis are as follows:

- Population (for the unincorporated area of Marin County and the cities and towns)
- Residential building stock (for the unincorporated area of Marin County and the cities and towns)
- RL properties (for the County of Marin and the cities and towns)
- Critical facilities and infrastructure:
- Government facilities for Marin County and the cities and towns
- Community facilities, including libraries, community centers, and parks
- County Jail

- Emergency response facilities, including police and fire stations
- Public hospitals and medical clinics
- Public utilities, including pump stations, electric substations, potable water facilities, wastewater facilities, wells, dams, reservoirs, debris basins hydro stations, meter stations, and stream and precipitation gages (including those used for emergency warnings)
- Educational facilities, including school buildings and district offices
- Transportation infrastructure, including airports, transit stations, and County-maintained bridges

The total assets inventoried for each local participant are located within the first table of each local-participant-specific appendix (Appendix G through Appendix S).

4.3 METHODOLOGY

A conservative exposure-level analysis was conducted to assess the risks associated with the identified hazards. This analysis is a simplified assessment of the potential effects of the hazards on values at risk without consideration of the probability or level of damage.

Population and residential building information was derived from HAZUS data at the census block level. HAZUS stands for HAZards United States, and is a geographic information system-based natural hazard loss estimation software package developed and distributed by FEMA. Counts and values per census block come from the 2000 Census. In cases in which the census blocks did not exactly match with city boundaries, a manual process was used to better match population and residential buildings to each city. Population and residential building vulnerability was determined through a combination of spatial overlay, and proportional analysis if only part of the census block was affected by the hazard.

The list of critical facilities and infrastructure came from a combination of HAZUS-provided facilities and infrastructure and participant-provided facilities information. The only HAZUS-provided critical facilities and infrastructure used were ones that are directly relevant to the plan. Some of the HAZUS data were modified using an aerial photo to improve the accuracy of their locations. Participant-provided facilities and infrastructure were submitted with either a full street address, latitude and longitude coordinates, or with a verbal description of the location of the facility (e.g., ½ mile west of an intersection). Facilities and infrastructure with a full street address were located through address matching (geocoding) in GIS. Addresses that didn't match were located through Google Earth and then imported into the GIS database. The accuracy of the point location for a critical facility or infrastructure will vary depending on the method used. For example, the latitude and longitude coordinates are very precise, while the address match is less precise. Critical facility point locations were overlaid onto each hazard to determine vulnerability.

If the location representing the asset fell within a hazard area, it was counted as impacted. Estimated replacement values were provided by each local participant, if available. If not

available, the estimated replacement value was taken from HAZUS for the type or category of facility.

For each physical asset located within a hazard area, exposure was calculated by assuming the worst-case scenario (that is, the asset would be completely destroyed and would have to be replaced). The aggregate exposure, in terms of replacement value or insurance coverage, for each category of structure or facility was calculated. A similar analysis was used to evaluate the proportion of the population at risk. However, the analysis simply represents the number of people at risk; no estimate of the number of potential injuries or deaths was prepared.

4.4 DATA LIMITATIONS

The vulnerability estimates provided herein use the best data currently available, and the methodologies applied result in an approximation of risk. These estimates may be used to understand relative risk from hazards and potential losses. However, uncertainties are inherent in any loss estimation methodology, arising in part from incomplete scientific knowledge concerning hazards and their effects on the built environment as well as the use of approximations and simplifications that are necessary for a comprehensive analysis.

It is also important to note that the quantitative vulnerability assessment results are limited to the exposure of people, buildings, and assets to the identified hazards. It was beyond the scope of this MCM LHMP update to develop a more detailed or comprehensive assessment of risk (including annualized losses, people injured or killed, shelter requirements, loss of facility/system function, and economic losses). Such impacts may be addressed with future updates of the MCM LHMP or disaster recovery focused planning efforts.

4.5 EXPOSURE ANALYSIS

Vulnerable population and existing structures, including residential buildings and critical facilities and infrastructure, at risk to each identified hazard are located in each local-participant-specific appendix (Appendix G through Appendix S). For Marin County and the participating cities, the exposure analysis was prepared for population, residential buildings, RL properties and critical facilities and infrastructure. The analysis included some Special District critical facilities and/or infrastructure owned or maintained by the Special District.

The estimated potential dollar losses for residential buildings and critical facilities and infrastructure at risk to each identified hazard are shown in each local-participant-specific appendix (Appendix G through Appendix S). As noted previously, estimated values were provided by the local jurisdiction or HAZUS software, if available. The methodology used to prepare the estimate is described in Section 4.3.

4.6 REPETITIVE LOSS PROPERTIES

According to FEMA BureauNet 2018 there are 216 Repetitive Loss (RL) properties in Marin County, including all the jurisdictions. Ten of those properties are considered to have suffered severe repetitive loss. The vast majority, 183, are residential properties. There are also 28 commercial properties and 5 industrial that are RL.

Information about RL properties by jurisdiction is located in Table 4-1. Most RL properties are located within Unincorporated Marin, incorporated cities of Novato and San Rafael. For privacy reasons, we are not including maps or addresses of the RLs.

Table 4-1. Repetitive Loss and Severe Repetitive Loss Properties

Jurisdiction	# Repetitive Loss Properties	# Severe Repetitive Loss Properties	Residential	Commercial	Industrial
Belvedere	2	0	2	0	0
Corte Madera	10	1	7	2	1
Fairfax	6	0	6	0	0
Larkspur	7	1	4	2	1
Marin County	87	4	81	6	0
Mill Valley	5	0	3	2	0
Novato	38		38	0	0
Ross	14	2	13	1	0
San Anselmo	1	0	1	0	0
San Rafael	37	1	24	12	1
Sausalito	5	1	1	2	2
Tiburon	4	0	3	1	0

Source: FEMA BureauNet 2018

4.7 SUMMARY OF IMPACTS

The summary of impacts (i.e., percentage at risk) for the population, residential buildings, and critical facilities and infrastructure at risk to each identified hazard are shown in each local-participant specific appendix (Appendix G through Appendix S) for Marin County and each participating city. For special districts, the analysis only includes the critical facilities owned or maintained by the Special District.

Based on the MCM LHMP's hazard analysis and vulnerability analysis as well previous State and Presidential Disaster Declarations in Marin County, the County is most vulnerable to earthquakes, coastal and riverine flood hazards, landslides, and wildfire hazards.

Nearly the entire County is located within high and extreme shaking hazard areas. As a result, the intense shaking that the County could experience may compromise modern buildings and infrastructure.

Riverine and coastal flooding is prevalent within Marin County watershedsand along the county's coastline.

4.8 FUTURE DEVELOPMENT

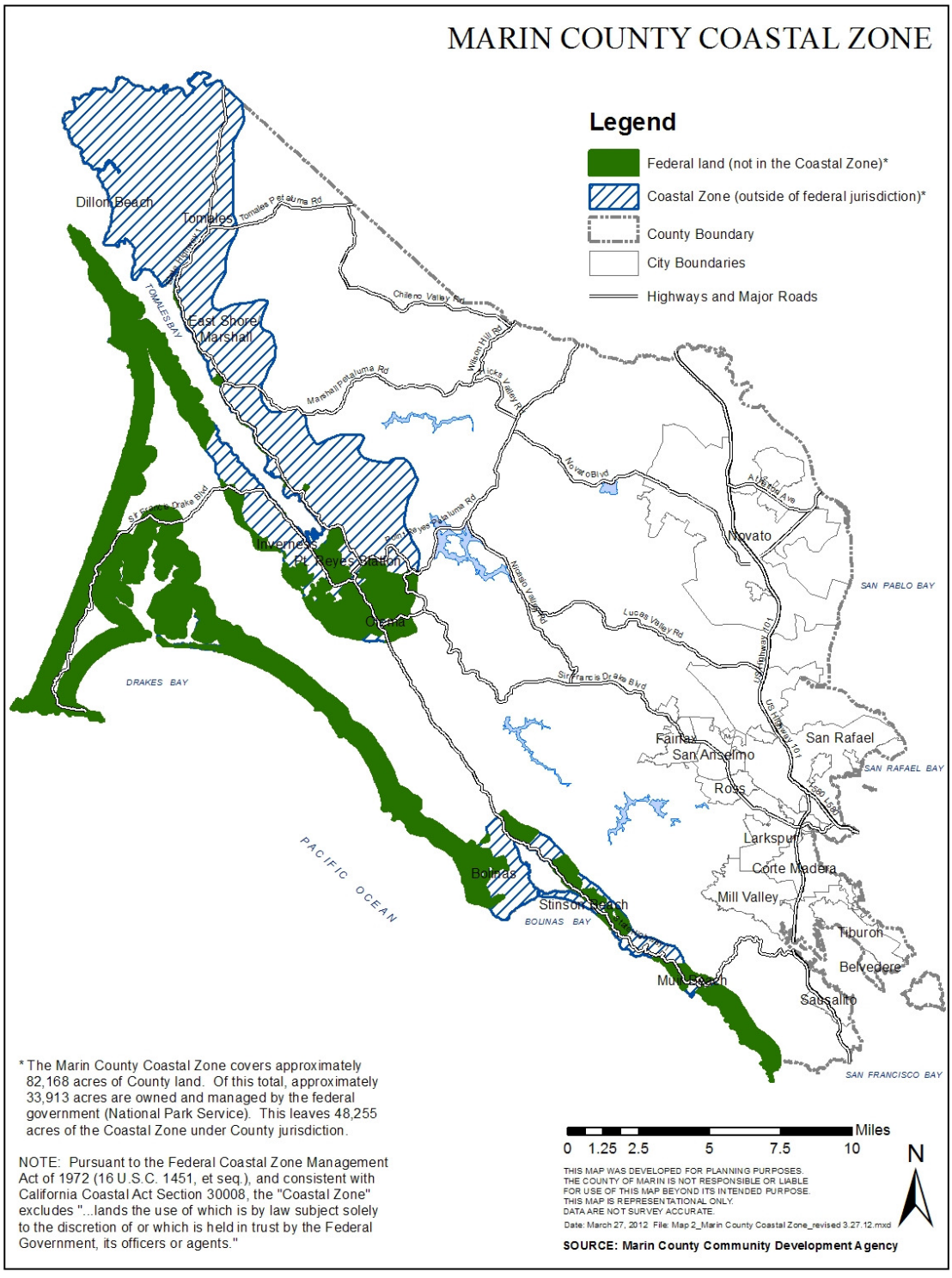
Marin County's abundance of natural, recreational, and scenic resources has supported a long history of open space preservation. Its rolling hills, expansive ranchlands, beaches, coastlines, and more are appreciated by both visitors and locals alike. This quote, from the Marin Independent Journal 1934 Editorial captures this sentiment:

"No community on earth is more favored than Marin with the wealth and beauty of potential playgrounds. If we don't acquire some of these lands, the opportunity will surely slip away from us."

In the 1960s, housing/transportation development proposals were underway throughout Marin County including for the Marin Headlands, outer coast, Tomales Bay area and more. Such proposals threatened Marin's rural character and long heritage of family farming, sparking citizen activism which drew national attention. These efforts led to the employment of land use planning tools to ensure the County's natural and agricultural areas remain protected in perpetuity. Establishment of the Point Reyes National Seashore in 1962, and a handful of other Federal/State Park units, ensured the protection of a large amount of the County's most cherished lands as publicly accessible open space. Additionally, the Marin Agricultural Land Trust, established in 1980, has placed agricultural conservation easements on over 60,000 acres of farmland, to ensure protection from development in perpetuity.

Furthermore in 1972 the California Coastal Commission was established as a regulatory agency whose mission is "To protect, conserve, restore, and enhance the environment of the California coastline". Pursuant to the California Coastal Act of 1976, the agency is tasked with the protection of a variety of resources including public access, habitat, water quality and visual. The Commission issues Coastal Development Permits, until a local agency has a certified Local Coastal Program (LCP), with a land use plan and implementation plan.

West Marin's coastal zone covers approximately 82,168 acres. Of this approximately 33,913 acres are owned and managed by the National Park Service, leaving 48.255 acres under County Jurisdiction subject to the LCP. This encompasses a handful of small communities along the Pacific Coast and Tomales Bay shorelines including Muir Beach, Stinson Beach, Bolinas, Inverness, Point Reyes Station, East Shore and Dillon Beach. New growth in these communities is limited by a variety of factors including few remaining undeveloped parcels; land use policies and plans which protect public access and natural resources; and environmental features such as the coast itself, Tomales Bay, and steep bluffs which naturally restrain development.



Marin County has focused on sea level rise planning and climate action for several years. Currently, the LCP is being updated to reflect the changing risks to coastal areas and develop appropriate policies and actions to avoid and minimize the risk of disaster and harm to its residents, infrastructure and coastal resources. Coastal Act policies Sections 30210, 30240, and 30251 dictate that new development shall be safe from hazards and recognize that shoreline

protective devices such as seawalls may be appropriate in certain instances to serve coastal-dependent uses or to protect existing structures or public beaches in danger from erosion. However, shoreline protective devices must be designed to eliminate or mitigate the adverse impacts on the sand supply of surrounding natural shorelines. Other development-limiting Coastal Act policies include:

Section: 30210: Development shall not interfere with the public's right of access to the sea including the use of beaches

Section 30240: Environmentally Sensitive Habitat Areas (ESHA) shall be protected

Section 30251: The scenic and visual qualities of coastal areas shall be considered and protected as resources of public importance.

The 2040 population projection for Marin County is 277,087 (Department of Finance). In order to accommodate population growth over the next several years, Marin County and its incorporated cities have implemented a number of land use plans and development policies to direct growth away from hazardous conditions. For example, as required by state law, the County and each incorporated city have a general plan with a safety element that identifies hazards affecting the County and incorporated cities. Likewise, the County and the incorporated cities have a number of planning policies, such as floodplain ordinances and building codes, restricting new development in hazard areas and/or increasing construction requirements in hazard areas.

In addition to steering away growth from hazard areas, Marin County and its incorporated cities have a history of aggressive growth management that seeks to limit growth overall and to direct it within the incorporated cities and urban areas of the unincorporated County.

The 2007 Marin Countywide Plan was last updated in 2015 to reflect the theme of planning for sustainable communities. Twelve principles support this theme including the preservation of natural assets and the protection of agricultural assets in order to minimize development in open space. The plan is divided into specific elements, each with goals, policies, and implementation programs. The Plan's land use pattern reflects existing development potential shifted to a degree from environmentally constrained sites to more appropriate locations. Specific Countywide Plan policies which limit urban development through the protection of open space resources include:

- Biological Resources 1.1 Protect Wetland, Habitats for Special-Status Species, Sensitive Natural Communities, and Important Wildlife Nursery Areas and Movement Corridors.
- Biological Resources 1.2 Acquire Habitat
- Biological Resources 2.1 Include Resource Preservation in Environmental Review
- Biological Resources 2.2 Limit Development Impacts
- Biological Resources 3.1 Protect Wetlands
- Biological Resources 4.1 Restrict Land Use in Stream Conservation Areas
- Biological resources 5.1 Protect the Baylands Corridor
- Biological Resources 5.2 Limit Development and Access

- Biological Resources 5.3 Leave Tidelands in Their Natural State
- Air 4.m Focus Development in Urban Corridors
- Open Space 2.2 Continue to Acquire or Otherwise Preserve Open Space Countywide
- Open Space 2.4 Support Open Space Efforts Along Streams
- Open Space 2.5 Support Open Space Efforts in the Inland Rural Corridor
- Open Space 2.6 Support Open Space Efforts in the Coastal Corridor
- Agriculture 1.1 Limit Residential Use
- Agriculture 1.2 Encourage Contractual Protection
- Agriculture 1.3 Preserve Agricultural Zoning
- Agriculture 1.4 Limit Non-Agricultural Zoning
- Agricultural 1.5 Restrict Subdivision of Agricultural Lands Within the Coastal, Inland Rural and Baylands Corridors
- Agriculture 1.6 Limit Non-Agricultural Development
- Additionally, the Plan includes policies to limit development in hazardous areas, including:
- Environmental Hazards 3.a Regulate Development in Flood and inundation Areas
- Environmental Hazards 3.e Restrict Development in Flood Prone Areas
- Environmental Hazards 4.1 Limit Fire Risks to Structures

Implementation tools such as the County Development Code are used to carry out Countywide Plan goals. Some of the policies and programs in the Countywide Plan will require rezoning of individual properties for consistency with land use designations and policies. Furthermore, many unincorporated communities are guided by community plans with may include customized building and site design standards, ridgeline and view corridor protection mechanisms, home size regulations and more.

Natural and Beneficial Functions

The County's floodplains drain into five wetlands, described below. A wetland is an area of land whose soil is saturated with moisture either permanently or seasonally. Such areas may also be covered partially or completely by shallow pools of water. Wetlands include swamps, marshes, and bogs and the water found in wetlands can be saltwater, freshwater, or a mixture of both.recreation of habitat types; habitat protective fencing; and trail soil stabilization.

4.9 LIFE/SAFETY WARNING/EVACUATION SYSTEMS

There are several life/safety warning/evacuation systems in Marin County, including the Emergency Alert System, AlertMarin "Reverse 911" System, Nixle, Tsunami Watch and Warning Messages, various local warning sirens and horns, and law enforcement/fire agency evacuation procedures. A description of each of these systems and a discussion of the impact of hazards on each system is discussed below.

Emergency Alert System: The Emergency Alert System is a network of all radio, TV broadcast stations, and cable TV networks in the county. Messages normally "enter" the system at two points: (1) Marin's Emergency Operations Center (EOC), and (2) the NWS headquarters in Monterey, CA. Messages are received by local radio broadcast stations and then relayed to all other radio, TV broadcast stations, and cable companies within the county. Any message transmitted from either the EOC or NWS will be broadcast countywide via all of the stations and cable companies within the county. Messages transmitted through the Emergency Alert System utilize power lines and telephone lines. Thus, the Emergency Alert System could be impacted by an earthquake, landslide, debris flow, or wildfire. An earthquake could cause the power lines or telephone lines to go down and lose functionality. A landslide or debris flow could cause the poles supporting the power lines and telephone lines to collapse, and a wildfire could cause the poles supporting the power lines and telephone lines to burn down. Once the poles are down, the lines could go down and lose functionality.

AlertMarin "Reverse 911" System: Emergency officials use the AlertMarin Emergency Notification System to deliver incident-specific information or potentially life-saving instruction to the precise geographic area(s) affected. Messages are sent to recipients' cell phone or VoIP (voice over internet protocol) phone to receive emergency alerts sent by call, text, email, or smartphone application from the County of Marin

Nixle: Nixle is a Community Information Service dedicated to helping you stay connected to the information that matters most to you, depending on your physical location. You stay connected to your local police department ensuring that you receive trusted and immediate, geographically relevant information. Information is immediately available over your cell phone by text message, by email, and over the web. Members of the public may self-register by texting their zip code to 888777. The system typically alerts via SMS / text, though email & smartphone app. Alerting can be geographically focused from a single zip code to entire county. There are multiple agencies in Marin County that use Nixle including the Marin County Sheriff's Office.

There are four types of messages; Alerts (many would refer to this as an emergency type alert), Advisories (less urgent need-to-know information), Community Information (day-to-day neighborhood to community-level information), Traffic (very localized traffic information).

Tsunami Watch and Warning Messages: Tsunami "Watch" (a tsunami may have been generated) and "Warning" (a tsunami has been generated) messages are issued for Marin County by the West Coast and Alaska Tsunami Warning Center located in Alaska, with the Pacific Tsunami Warning Center, located in Hawaii, serving as a backup. Both centers also transmit "Information" messages when significant seismic events occur under the sea floor, even when the seismic events do not the potential to generate a tsunami. Watch and Warning messages are transmitted by the respective Warning Centers over the NOAA Weather Wire system directly to each other, Coastal NWS Forecast Offices and their Area of Responsibility's State Warning Centers. The local NWS Office is located in Monterey serves Marin County. CalOES operates California's State Warning Center in Sacramento. Some messages are transmitted automatically based upon seismic event magnitude and location, and followed shortly by amplifying information (after review by scientists at the Tsunami Warning Centers). Generally, a message is generated within five minutes of the seismic event. Messages are recorded for transmission of the Emergency Alert System and local National Weather Radio Sites. There is no fixed, audible warning system that covers the entire 42 miles of the County's coastline. Emergency vehicle (and helicopter) public address systems and sirens may be used to alert residents of the need to evacuate. Warnings may not be possible in the event of a tsunami generated by a local seismic event, and will not be available if a tsunami is generated by a local nonseismic event (subaerial or subsea landslide).

Local Warning Sirens and Horns: Various entities within the county utilize local, short range sirens and horns for the purpose of alerting small segments of the population to impending hazards. These systems are currently under review and more information will be provided on them in future iterations of this plan.

Law Enforcement/Fire Agency Evacuation Procedures: Law Enforcement Officers and Firefighters may drive through neighborhoods with sirens activated announcing evacuations and/or emergency directions over their loud speakers. Sheriff's Air Patrol may also fly overhead announcing the same information

SECTION 5 MITIGATION STRATEGY

5.1 OVERVIEW

A mitigation strategy includes the identification of mitigation goals and actions that will reduce the risks of each hazard and vulnerability to the local population and built environment for each local participant.

Per the local mitigation planning requirements, this mitigation strategy consists of the following four steps:

1. Local hazard mitigation goals
2. Identification and analysis of mitigation actions
3. Implementation of mitigation actions
4. Identification and analysis of mitigation actions for NFIP compliance

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5.2 MITIGATION GOALS

Mitigation goals are defined as general guidelines that explain what a community wants to achieve in terms of hazard and loss prevention. Goal statements are typically long-range, policy-oriented statements representing community-wide vision. For the MCM LHMP, the Planning Committee developed one goal for each identified hazard. As shown in Table 5-1, these goals are 1) earthquake and liquefaction, 2) dam failure, 3) severe storm (wind, flooding, and debris flow), 4) tsunami, 5) wildfire, and 6) post-fire debris flow.

Table 5-1. Mitigation Goals

Goal Number	Goal Description
1	Reduce the possibility of damages and losses due to earthquakes and liquefaction.
2	Reduce the possibility of damages and losses due to dam failure.
3	Reduce the possibility of damages and losses due to severe storms, including wind, flooding, and debris flow.
4	Reduce the possibility of damages and losses due to tsunami.
5	Reduce the possibility of damages and losses due to wildfire and post-fire debris flow.

5.3 IDENTIFICATION AND ANALYSIS OF MITIGATION ACTIONS

Mitigation actions are activities, measures, and/or projects that help achieve the goals of a mitigation plan. Mitigation actions are usually grouped into six broad categories: prevention, property protection, public education and awareness, natural resource protection, emergency services, and structural projects.

The Planning Committee developed overarching mitigation actions to be applied throughout the county referred to as "common actions". In addition, each local participant identified other jurisdiction-specific mitigation actions by reviewing existing resources, identifying past success stories and best management practices, and soliciting input from pertinent departments including planning, public works, and emergency management staff. As a result of both mitigation action identification processes, each local participant developed several dozen mitigation actions. During the MCM LHMP update process, the Planning Committee reviewed the mitigation strategy of prior LHMPs. This process revealed that the majority of the mitigation actions identified in the in prior LHMPs were not suitable to be included in the MCM LHMP for the following reasons:

- Mitigation actions were ineligible for FEMA funding
- Mitigation actions were emergency response, preparedness, and/or recovery focused rather than mitigation focused
- Mitigation actions were not well defined
- Mitigation actions were not stand-alone projects
- Mitigation actions were continued-compliance and/or maintenance focused

As such, for the MCM LHMP Planning Committee developed a handful of mitigation actions based on the MCM LHMP's hazard analysis, vulnerability analysis, and capability assessments. The list of potential mitigation actions in the MCM LHMP was condensed so local participants would focus their attention and effort on projects that would likely be implemented over the next 5 years (the lifespan of the MCM LHMP). Criteria considered for the development of the new mitigation actions included the following:

- Mitigation action must be mitigation-focused (as opposed to response, recovery, and preparedness-driven)
- Mitigation action must meet the 2015 HMA Guidance project criteria eligibility
- Mitigation action must address the DMA 2000 requirements for the identification and analysis of mitigation actions
- Mitigation actions must address the MCM LHMP vulnerability analysis results

In addition to the potential mitigation actions developed for the local participants, local agencies have their own specific actions in Appendix G – S.

As shown below, for each potential mitigation action, the following information is listed: mitigation action description; mitigation action category; hazard(s) addressed; and type of development affected by mitigation action. Additional mitigation actions reselected and/or added by a local participant and supporting staff are located in his/her local-participant-specific appendix (Appendix G through Appendix S).

Table 5-2. Potential Common Mitigation Actions

No.	Description	Hazard and Goal Addressed	Existing Local Mechanism to Implement	Timeline	HMA Eligible Activity Type (and New or Existing Construction)	Fundin
1	Integrate the MCM LHMP into all jurisdictions general plan safety elements.	All	General Plan updates		Hazard Mitigation Planning Related Activity - New/existing	HMGP
2	Assess vulnerability of critical facilities and public buildings to damage in natural disaster. Make recommendations to staff and governing board on priorities for mitigation, identify funding mechanisms, conduct improvements.	All	Needed	Short term	Hazard Mitigation Planning Related Activity - Existing	HMGP,
3	Adopt, amend as needed, and enforce updated versions of state and federal regulations for Building and Fire Codes so that optimal standards are used in construction and renovation projects of public and private buildings and infrastructure.	All	Existing construction codes	Ongoing	Hazard Mitigation Planning Related Activity - New/existing	Buildin
4	Develop/ enforce regulations requiring replacement of above-ground utilities with underground utilities. Require underground utilities be effectively sealed to prevent backflow of floodwaters into buildings.	All	Varies by jurisdiction?	Ongoing	Hazard Mitigation Planning Related Activity - New/existing	HMGP
5	Provide information to residents, property owners and merchants about the availability of hazard maps such as MarinMap and private mitigation resources. Do this as part of Hazard Mitigation Planning to be eligible for FMA funding.	All	Through existing public outreach methods, newsletters, social media	Ongoing	Hazard Mitigation Planning Related Activity (information dissemination as part of) - Existing	HMGP
6	Work with utility system providers and other lifeline infrastructure and	All	No formal	Ongoing	Hazard Mitigation Planning Related	HMGP

Table 5-2. Potential Common Mitigation Actions

No.	Description	Hazard and Goal Addressed	Existing Local Mechanism to Implement	Timeline	HMA Eligible Activity Type (and New or Existing Construction)	Fundin
	municipal partners to develop strong and effective mitigation strategies as part of multi-jurisdictional hazard mitigation planning..		mechanism		Activity - New/existing	
7	Train staff in emergency response and hazard mitigation by hosting trainings and by encouraging attendance at conferences and workshops as part of multi-jurisdictional hazard mitigation planning..	All			Hazard Mitigation Planning Related Activity - New/existing	HMGP
8	Support CERT and other neighborhood/civilian initiatives as part of multi-jurisdictional hazard mitigation planning.	All			Hazard Mitigation Planning Related Activity - existing	HMGP
9	Use partnerships to protect as open space or parks, those areas susceptible to extreme hazards (such as through land acquisition, zoning, and designation as priority conservation areas).	All	General plan land use/open space elements	Long-term, as opportunities arise	Hazard Mitigation Planning Related Activity - New/existing And Property Acquisition and Structure Demolition/Relocation – Existing	HMGP, (if prote
10	Energy storage plan and backup generators?	All			Generators – existing	HMGP initiativ
11	Use inventories to require private building owners to inform tenants that they live or work in a susceptible building and may need to live/work elsewhere for a period of time following a major earthquake.	Earthquake			Hazard Mitigation Planning Related Activity - Existing	HMGP
12	Use incentives for mitigation of privately owned at-risk or seismically deficient structures (soft story / unreinforced masonry/old bridges).	Earthquake			Structural Retrofitting of Existing Buildings - Existing	HUD C HMGP PDM
13	Adopt applicable standards for voluntary or mandatory retrofits of seismically vulnerable buildings.	Earthquake			Hazard Mitigation Planning Related Activity - Existing	HMGP

Table 5-2. Potential Common Mitigation Actions

No.	Description	Hazard and Goal Addressed	Existing Local Mechanism to Implement	Timeline	HMA Eligible Activity Type (and New or Existing Construction)	Fundin
14	Upgrade deficient ramps and bridges.	Earthquake			Infrastructure Retrofit - Existing	HMGP,
15	Require engineered plan sets for seismic retrofits of homes on steep hillsides, soft-story homes, and other split-level or vulnerable homes not covered by standard plan set A	Earthquake and Debris Flow			Hazard Mitigation Planning Related Activity - New	HMGP
16	Continued participation and enforcement of NFIP floodplain and State Phase II stormwater management regulations	Flood			Hazard Mitigation Planning Related – New/Existing	HMGP
17	Improve FEMA Community Rating System (CRS) score by managing beyond minimum requirements as appropriate for local conditions.	Flood			Hazard Mitigation Planning Related Activity - New/Existing	HMGP
18	Foster partnerships and coordination with Flood Control District, FEMA Region IX, County and neighboring jurisdictions. .	Flood			Hazard Mitigation Planning Related Activity - Existing	HMGP
19	Incorporate flood planning into local planning. .	Flood			Hazard Mitigation Planning Related Activity - New/Existing	HMGP
20	Periodically inspect and maintain creeks and drainage infrastructure. .	Flood			Hazard Mitigation Planning Related Activity - Existing	HMGP
21	Protect natural flood mitigation functions.				Hazard Mitigation Planning Related Activity - Existing	
22	Conduct education & outreach-develop homeowners guide to flood preparedness.				Hazard Mitigation Planning Related Activity - Existing	HMGP Initiativ
23	Maintain and improve berms, levees, & infrastructure such as catch basins, pipes, pump stations.				Localized Flood Risk Reduction Projects - Existing	
24	Acquire, relocate, elevate Repetitive Loss structures.				Property Acquisition and Structure Demolition/Relocation and Structure Elevation - Existing	FMA
	Continue to support the San	Flooding,		0-5 years	Non-localized Flood	Partially

Table 5-2. Potential Common Mitigation Actions

No.	Description	Hazard and Goal Addressed	Existing Local Mechanism to Implement	Timeline	HMA Eligible Activity Type (and New or Existing Construction)	Fundin
	Francisco Bay Area Advanced Quantitative Precipitation Information System project to provide both improved observing capabilities and a suite of numerical forecast models to produce accurate and timely information for a variety of user needs, including improved precipitation and hydrologic information to assist the region in mitigating flood hazards, maximize water supply, and enhance ecosystem services. The primary emphasis will be to improve short-term (48 hour) monitoring and prediction of high-impact rainfall events. The secondary emphasis will focus on improved medium-range precipitation forecasts (out to 10 days) for water supply.	drought			Risk Reduction Project? - New construction Also, Miscellaneous/ Other project that addresses climate change adaptation and encourages resiliency. Mitigation project adapts to new challenges posed by more powerful storms, frequent heavy precipitation, prolonged droughts, extreme flooding, and other weather events.	Californ Departm Rutilies Integrat Manage Sonoma Water A Potentia funding include addition agencie water, s agencie region, the nort Francis
	Conduct multi-jurisdictional repetitive loss area analysis for full county as part of multi-jurisdictional local hazard mitigation planning	Flood			Hazard Mitigation Planning Related Activity - Existing	
25	Acquire, relocate, elevate structures in floodplain.	Flood			Property Acquisition and Structure Demolition/Relocation and Structure Elevation - Existing	HMGP
26	Reinforce and/or elevate ramps, bridges, and roads as needed.	Flood, Debris flow, and Earthquake			Infrastructure Retrofit	
27	Ensure one member of City/Town staff is a Certified Floodplain Manager.	Severe Storm/ Flood			Hazard Mitigation Planning Related Activity – New/Existing	
28	Conduct two new fire-related assessments taking into account lessons learned from the 2017 North-Bay wildfires. The new data points needed in order to support improved fire hazard mitigation				Hazard Mitigation Planning Related Activity – New/Existing	

Table 5-2. Potential Common Mitigation Actions

No.	Description	Hazard and Goal Addressed	Existing Local Mechanism to Implement	Timeline	HMA Eligible Activity Type (and New or Existing Construction)	Fundin
	include 1) assessing vulnerability of public and private structures in the wildland-urban interface zones based on building material and roof type, and 2) identifying areas with aging population and/or access and functional needs. This analysis could support new mitigation strategies that would make Marin more resilient to the type of disaster that occurred in our northern neighboring county.					
	Prepare powerful graphics for the 2023 MCM LHMP that show how one or both of fire and/or flood hazards affects the vast majority of populated areas. The goal is to encourage communities to work together towards a common goal of minimizing hazard risk for all.	Flood/SLR and Wildfire			Hazard identification or mapping for the implementation of mitigation activities Public awareness or education campaigns about mitigation	5 Perce
29	Consider landslide or wildfire hazard concerns, including roads leading to development, when new construction or major remodels are proposed in hillside areas discourage construction or add mitigation measures as appropriate.	Debris flow and wildfire			Hazard Mitigation Planning Related Activity – New/Existing	
30	Increase efforts to reduce landslides and erosion in existing and future development by improving appropriate code enforcement and use of applicable standards for private property, such as those appearing in the California Building Code, California Geological Survey Special Report 117 – Guidelines for Evaluating and Mitigating Seismic Hazards in California, American Society of Civil Engineers (ASCE) report Recommended Procedures for Implementation of DMG Special Publication 117: Guidelines for Analyzing and Mitigating Landslide Hazards in California,	Debris flow			Hazard Mitigation Planning Related Activity – New/Existing	

Table 5-2. Potential Common Mitigation Actions

No.	Description	Hazard and Goal Addressed	Existing Local Mechanism to Implement	Timeline	HMA Eligible Activity Type (and New or Existing Construction)	Fundin
	and the California Board for Geologists and Geophysicists Guidelines for Engineering Geologic Reports. Such standards should cover excavation, fill placement, cut-fill transitions, slope stability, drainage and erosion control, slope setbacks, expansive soils, collapsible soils, environmental issues, geological and geotechnical investigations, grading plans and specifications, protection of adjacent properties, and review and permit issuance.					
31	Prevent impacts to roadways.	Debris flow (landslide)			Soil Stabilization and Infrastructure Retrofit - Existing	
32	Stabilize susceptible areas.	Debris flow (landslide)			Soil Stabilization - Existing	
33	Develop a plan for appropriate access and evacuation in hillside wildland-urban interface areas, For example creation of no parking areas, signage, and early warning and evacuation.	Wildfire			Hazard Mitigation Planning Related Activity	
34	Develop a method of regulating and/or enforcing defensible spaces.	Wildfire			Hazard Mitigation Planning Activity	
35	Encourage Fire Departments to expand vegetation management programs in wildland-urban-interface areas to more effectively manage the fuel load through various methods including, but not limited to, roadside collection and chipping, mechanical fuel reduction equipment, selected harvesting, use of goats or other organic methods of fuel reduction.	Wildfire			Wildfire Mitigation (Creation of Defensible Space, Hazardous Fuels Reduction)	
36	Work to ensure a reliable source of water for fire suppression through the cooperative efforts of water districts, fire districts, residents and commercial property owners.	Wildfire			Hazard Mitigation Planning Related Activity	
37	Fuel Reduction program targeting invasive and exotic plants that	Wildfire			Wildfire Mitigation (Hazardous Fuels	

Table 5-2. Potential Common Mitigation Actions

No.	Description	Hazard and Goal Addressed	Existing Local Mechanism to Implement	Timeline	HMA Eligible Activity Type (and New or Existing Construction)	Fundin
	contribute to fire (and flooding) hazards such as eucalyptus, broom, and cordgrass.				Reduction)	
38	Veg management program for elderly/disabled.	Wildfire			Wildfire Mitigation (Creation of Defensible Space, Hazardous Fuels Reduction)	
39	Post-fire soil stabilization.	Post-fire debris flow			Soil stabilization	
40	Residential fuel modification program.	Wildfire			Wildfire Mitigation (Creation of Defensible Space, Hazardous Fuels Reduction)	
41	Participate in C-Smart and BayWAVE vulnerability assessments and implement strategies resulting from Phase 2	Sea Level Rise			Hazard Mitigation Planning Related Activities	
42	encourage integration of SLR and climate change into planning documents, systems, operations, and maintenance	Sea Level Rise			Hazard Mitigation Planning Related Activities	
43	SLR-1 Use C-SMART / BayWAVE assessments	Sea Level Rise			Hazard Mitigation Planning Related Activities	
44	SLR-2 Manage development in high-risk areas	Sea Level Rise			Hazard Mitigation Planning Related Activities	
45	SLR-3 Prevent infrastructure expansion in high-risk areas	Sea Level Rise			Hazard Mitigation Planning Related Activities	
46	SLR-4 Protect buildings and infrastructure	Sea Level Rise			Localized flood risk reduction projects	
47	SLR-5 Preserve high-hazard areas as open space	Sea Level Rise			Hazard Mitigation Planning Related Activities	
48	SLR-6 Protect and restore natural buffers	Sea Level Rise			Hazard Mitigation Planning Related Activities	
49	TSU-6 Continue participation in	Tsunami			Hazard Mitigation Planning Related	

Table 5-2. Potential Common Mitigation Actions

No.	Description	Hazard and Goal Addressed	Existing Local Mechanism to Implement	Timeline	HMA Eligible Activity Type (and New or Existing Construction)	Fundin
	NOAA TsunamiReady program				Activities	
50	Encourage property owners in dam inundation areas to purchase insurance	Dam inundation			Public awareness or education campaigns about mitigation	5 Perce

5.4 IMPLEMENTATION OF MITIGATION ACTIONS

After the list of potential mitigation actions had been developed, each plan participant, along with staff from other relevant departments/agencies within his/her jurisdiction, evaluated and prioritized the potential mitigation actions to determine which mitigation actions would be included in his/her local-participant-specific mitigation action plan. Only mitigation actions that met at least four or more of prioritization criteria listed below was included in the mitigation action plan. Criteria considered for this evaluation process included:

- Current or potential support from the plan participant
- Plan participant department or agency champion
- Ability to be implemented during the 5-year lifespan of the MCM LHMP
- Ability to reduce expected future damages and losses (cost-benefit)
- Mitigates a high-risk hazard or multiple hazards

Each local participant's mitigation action plan is included in the local-participant-specific appendix (Appendix G through Appendix S). Each mitigation action plan includes: a description of each mitigation action; prioritization criteria selected (numbers 1-5, as shown above); potential facility to be mitigated (if known); responsible department or agency; potential funding source; and implementation timeframe.

5.5 IDENTIFICATION AND ANALYSIS OF MITIGATION ACTIONS: NFIP COMPLIANCE

As noted in Section 4.3, Marin County and all of its cities participate in the NFIP. Table 4-3 lists the following for each NFIP participant: date of initially mapped FIRM; emergency/regular NFIP entrance date; number of flood policies in force. Additionally, Marin County and several cities are participants of the Community Rating System (CRS) program as described in section Mitigation actions 16 through 25 in Table 5-2 address the continued compliance with the NFIP.

SECTION 6 PLAN MAINTENANCE

6.1 OVERVIEW

This section describes a formal plan maintenance process to ensure that the MCM LHMP remains an active and applicable document. It includes an explanation of how the Marin County Sheriff's OES and the MCM LHMP Planning Committee intends to organize their efforts to ensure that improvements and revisions to the MCM LHMP occur in a well-managed, efficient, and coordinated manner.

The following process steps are addressed in detail below:

- Monitoring, evaluating, and updating the MCM LHMP
- Implementation through existing planning mechanisms
- Continued public involvement

6.2 MONITORING, EVALUATING AND UPDATING THE PLAN

The MCM LHMP was prepared as a collaborative effort between the Planning Committee and other representatives of participating jurisdictions. To maintain momentum and build on previous hazard mitigation planning efforts and successes, Marin County Sheriff's OES will make use of the Planning Committee to monitor, evaluate, and update the MCM LHMP. The Marin County Sheriff's OES will continue to serve as the POC and will coordinate all local efforts to monitor, evaluate, and update this document.

Similar to the plan maintenance procedures outlined in the 2013 Marin County LHMP, the Planning Committee will meet quarterly to review related activities and have the opportunity to evaluate the plan annually. As such, the Marin County Sheriff's OES and the Planning Committee have developed the following revised approach to the MCM LHMP plan maintenance. In addition to hosting quarterly review meetings, every 12 months from plan adoption the Marin County Sheriff's OES will email each member of the Planning Committee an Annual Review Questionnaire to complete. The Annual Review Questionnaire will include the following requests:

1) Provide a summary of any hazard events that occurred during the prior year and their impact on your community.
2) Provide a review of successful mitigation initiatives identified in your jurisdictions existing/prior LHMP (if applicable). Provide comment on why targeted strategies were not completed.
3) Re-evaluation of the action plan to determine if the timeline for identified projects needs to be amended (such as changing a long-term project to a short-term project because of funding availability).

4) Provide recommendations for new projects.

5) Provide recommended changes in, or potential for, new funding options (e.g. grant opportunities).

6) Provide recommendation on integration of new data such as GIS data and mapping used to inform the Plan.

7) Identify the impact of any other planning programs or initiatives within the community that involve hazard mitigation.

8) Attach any additional important notes on vulnerability analysis and hazard mitigation planning for your community (e.g. attach annual reports regarding plan implementation).

The Marin County Sheriff's OES will collect all completed questionnaires and determine if the MCM LHMP needs to be updated to address new or more threatening hazards, new technical reports or findings, and new or better-defined mitigation projects. The Marin County Sheriff's OES will summarize these findings and email them out to the Planning Committee. If the Marin County Sheriff's OES believes that the MCM LHMP needs to be updated based on the findings, then department will request that the Planning Committee attend a MCM LHMP update meeting.

In addition, the implementation strategy will be monitored and updated through the use of the Mitigation Project Progress Report or a FEMA annual report. During each annual review, each department or agency currently administering a FEMA mitigation project will submit a progress report or quarterly reports to the Marin County Sheriff's OES to review and evaluate. As shown in Appendix F, the progress report will discuss the current status of the mitigation project, including any changes made to the project, identify implementation problems, and describe appropriate strategies to overcome them. After considering the findings of the submitted progress reports, the Marin County Sheriff's OES may request that the implementing department or agency meet to discuss project conditions.

In addition to quarterly meetings, the Annual Review Questionnaire, the Mitigation Project Progress Report or FEMA annual report, and any other meetings, the Planning Committee will reinitiate the plan update process MCM LHMP every 4 years to meet the 5 year planning cycle. To ensure that this update occurs, within the first six months of the fourth year following plan adoption, the Planning Committee will undertake the following update process activities:

- Research funding available to assist in MCM LHMP update (and apply for funds that may take up to one year to obtain)
- Thoroughly analyze and update the risk of natural hazards in the communities of Marin County
- Complete a new Annual Review Questionnaire and review previous questionnaires
- Provide a detailed review and revision of the mitigation strategy
- Prepare a new implementation strategy
- Prepare a new draft MCM LHMP and submit it to the local participants governing bodies for adoption
- Submit an updated MCM LHMP to CalOES and FEMA for approval

- Submit approved MCM LHMP to governing bodies of each jurisdiction participating in the plan

6.3 IMPLEMENTATION THROUGH EXISTING PLANNING MECHANISMS

After the adoption of the MCM LHMP, the Marin County Sheriff's OES and the Planning Committee will ensure that elements of the MCM LHMP are incorporated into other existing planning mechanisms. The processes for incorporating the MCM LHMP into various planning documents will occur as (1) other plans are updated and (2) new plans are developed.

Therefore, the MCM LHMP participants will undertake the some or all of the following activities:

Activity 1: The County and cities will use information from the hazard analysis and mitigation strategy sections in the MCM LHMP to update the safety element in their respective general plans.

Activity 2: The County, cities, and special districts will use information from the hazard analysis and vulnerability analysis sections in the MCM LHMP to update their respective Emergency Operation Plans.

Activity 3: The County, cities/towns, and special districts will use information from the vulnerability analysis section in the MCM LHMP to develop emergency preparedness public information and related outreach efforts.

Activity 4: CRS program participants will use information from the vulnerability analysis (specifically the RL properties analysis) in the MCM LHMP to develop CRS-eligible mitigation activities and reduce the number of RL properties within the county.

Activity 5: The County, cities, and special districts will refer to the mitigation strategy section in the MCM LHMP when updating their respective capital improvement plans.

6.4 CONTINUED PUBLIC INVOLVEMENT

The Marin County Sheriff's OES and the MCM LHMP Planning Committee are dedicated to involving the public directly in the continual reshaping and updating of this plan. Similar to the 2013 Marin County LHMP, a downloadable copy of the MCM LHMP will be available on the Marin County Sheriff's Office Website. Also, any proposed changes or updates will be posted on this Website. The Marin County's Sheriff's Website will also contain an e-mail address and phone number to which people can direct their comments or concerns. Additionally, copies of the plan will continue to be kept with all of the local participants. The existence and location of these copies will also be posted on the County Website as well as websites maintained by participating jurisdictions.

Finally, a press release will be issued prior to finalization of the 2018 Marin County Multi-Jurisdictional LHMP. This will provide the public an outlet for which they can express their concerns, opinions, or ideas about any updates/changes that are proposed to the plan. The Marin

County Sheriff's OES will be responsible for using county resources to publicize the press releases and maintain public involvement through public access channels, web pages, and newspapers as deemed appropriate.