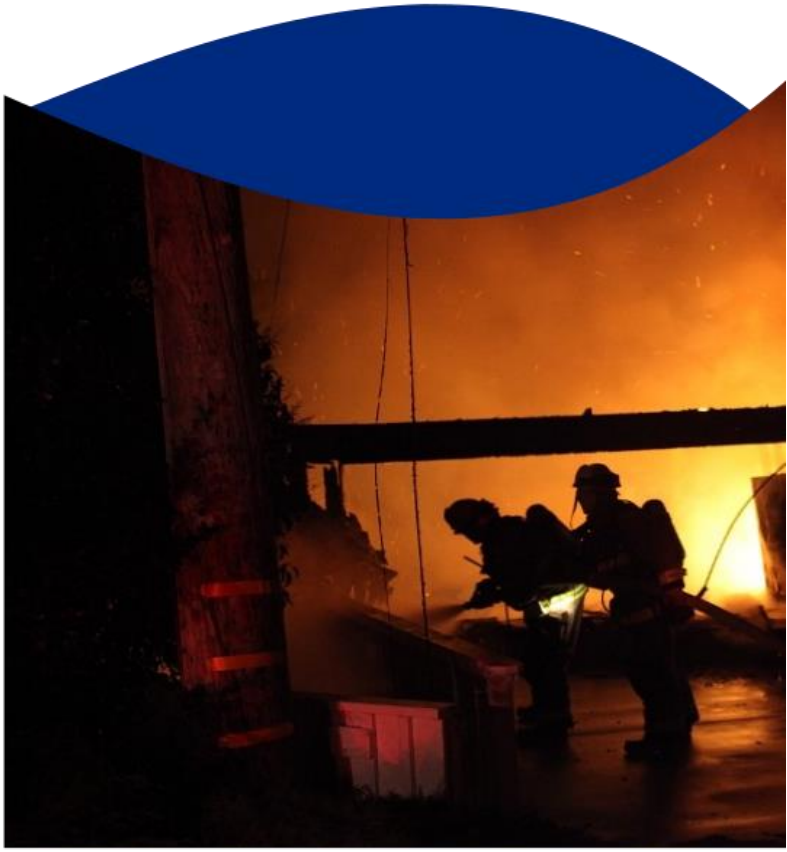
San Rafael
Local Hazard Mitigation Plan
April 2017 Public Review Draft



Foster Morrison

Executive Summary

The City of San Rafael prepared this Local Hazard Mitigation Plan (LHMP) to guide hazard mitigation planning to better protect the people and property of the City from the effects of natural disasters and hazard events. This plan demonstrates the community's commitment to reducing risks from hazards and serves as a tool to help decision makers direct mitigation activities and resources. This plan was also developed in order for the City to be eligible for certain federal disaster assistance, specifically, the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Grant Program (HMGP), Pre-Disaster Mitigation (PDM) Program, and the Flood Mitigation Assistance (FMA) Program.

Each year in the United States, natural disasters take the lives of hundreds of people and injure thousands more. Nationwide, taxpayers pay billions of dollars annually to help communities, organizations, businesses, and individuals recover from disasters. These monies only partially reflect the true cost of disasters, because additional expenses to insurance companies and nongovernmental organizations are not reimbursed by tax dollars. Many natural disasters are predictable, and much of the damage caused by these events can be alleviated or even eliminated. The purpose of hazard mitigation is to reduce or eliminate long-term risk to people and property from hazards

LHMP Plan Development Process

Hazard mitigation planning is the process through which hazards that threaten communities are identified, likely impacts determined, mitigation goals set, and appropriate mitigation strategies determined, prioritized, and implemented. This plan documents the hazard mitigation planning process and identifies relevant hazards and vulnerabilities and strategies the City will use to decrease vulnerability and increase resiliency and sustainability in the community.

This LHMP was prepared pursuant to the requirements of the Disaster Mitigation Act of 2000 (Public Law 106-390) and the implementing regulations set forth by the Interim Final Rule published in the Federal Register on February 26, 2002, (44 CFR §201.6) and finalized on October 31, 2007. The City followed a planning process prescribed by FEMA as detailed in Table ES-1.

Table ES-1 Local Hazard Mitigation Planning Process

DMA Process	Modified CRS Process
1) Organize Resources	
201.6(c)(1)	1) Organize the Planning Effort
201.6(b)(1)	2) Involve the Public
201.6(b)(2) and (3)	3) Coordinate with Other Departments and Agencies
2) Assess Risks	
201.6(c)(2)(i)	4) Identify the Hazards
201.6(c)(2)(ii)	5) Assess the Risks

DMA Process	Modified CRS Process
3) Develop the Mitigation Plan	
201.6(c)(3)(i)	6) Set Goals
201.6(c)(3)(ii)	7) Review Possible Activities
201.6(c)(3)(iii)	8) Draft an Action Plan
4) Implement the Plan and Monitor Progress	
201.6(c)(5)	9) Adopt the Plan
201.6(c)(4)	10) Implement, Evaluate, and Revise the Plan

The planning process began with the organizational phase to establish the hazard mitigation planning committee (HMPC) comprised of key City representatives, and other local and regional stakeholders; to involve the public; and to coordinate with other departments and agencies. A detailed risk assessment was then conducted followed by the development of a focused mitigation strategy for San Rafael. Once approved by Cal OES and FEMA, this plan will be adopted and implemented by the City over the next five years.

Risk Assessment

The HMPC conducted a risk assessment that identified and profiled hazards that pose a risk to the City, assessed the vulnerability of the planning area to these hazards, and examined the existing capabilities to mitigate them.

The City is vulnerable to numerous hazards that are identified, profiled, and analyzed in this plan. Floods, earthquakes, drought, liquefaction, landslides, wildfires, and other severe weather events are among the hazards that can have a significant impact on the City. Table ES-2 details the hazards identified for the City LHMP.

Table ES-2 San Rafael Hazard Identification Assessment

Hazard	Geographic Extent	Likelihood of Future Occurrences	Magnitude/ Severity	Significance	Climate Change Impacts
Climate Change	Extensive	Highly Likely	Limited	Medium	N/A
Coastal Flooding and sea level rise	Significant	Likely	Critical	Medium	High
Dam Failure	Limited	Unlikely	Negligible	Low	Medium
Drought and Water Shortage	Extensive	Likely	Critical	Medium	High
Earthquake	Extensive	Occasional/Likely	Catastrophic	High	Low
Earthquake: Liquefaction	Limited	Occasional/Likely	Catastrophic	High	Low
Flood: (100/500 year)	Significant	Occasional/Unlikely	Critical	High	High
Flood: Localized/Stormwater	Extensive	Highly Likely	Limited	Medium	High
Landslide, Mudslides, Hillside Erosion, and Debris Flows	Significant	Likely	Limited	Medium	Medium
Levee Failure	Significant	Occasional	Limited	Medium	High
Severe Weather: Extreme Heat	Extensive	Highly Likely	Critical	Medium	High
Severe Weather: Heavy Rains and Storms	Extensive	Highly Likely	Critical	Medium	Medium
Tsunami	Limited	Unlikely	Limited	Medium	High
Wildfire	Significant	Likely	Catastrophic	High	Medium

Geographic Extent
Limited: Less than 10% of City
Significant: 10-50% of City
Extensive: 50-100% of City

Probability of Future Occurrences
Highly Likely: Near 100% chance of occurrence in next year, or happens every year.
Likely: Between 10 and 100% chance of occurrence in next year, or has a recurrence interval of 10 years or less.
Occasional: Between 1 and 10% chance of occurrence in the next year, or has a recurrence interval of 11 to 100 years.
Unlikely: Less than 1% chance of occurrence in next 100 years, or has a recurrence interval of greater than every 100 years.

Magnitude/Severity
Catastrophic—More than 50 percent of property severely damaged; shutdown of facilities for more than 30 days; and/or multiple deaths
Critical—25-50 percent of property severely damaged; shutdown of facilities for at least two weeks; and/or injuries and/or illnesses result in permanent disability
Limited—10-25 percent of property severely damaged, shutdown of facilities for more than a week; and/or injuries/illnesses treatable do not result in permanent disability
Negligible—Less than 10 percent of property severely damaged, shutdown of facilities and services for less than 24 hours; and/or injuries/illnesses treatable with first aid

Significance
Low: minimal potential impact
Medium: moderate potential impact
High: widespread potential impact

Climate Change Impact:
Low: Climate change is not likely to increase the probability of this hazard.
Medium: Climate change is likely to increase the probability of this hazard.
High: Climate change is very likely to increase the probability of this hazard.

Mitigation Strategy

Based on the results of the risk assessment, the HMPC developed a mitigation strategy for reducing the City's risk and vulnerability to hazards. The resulting Mitigation Strategy for San Rafael is comprised of LHMP goals and objectives and a mitigation action plan which includes a series of mitigation action projects and implementation measures.

The goals and objectives of this LHMP are:

GOAL 1: Minimize risk and vulnerability of the City of San Rafael to the impacts of natural hazards, and protect lives and reduce damages and losses to property, public health, economy, and the environment.

Objectives:

- Protect life and reduce exposure and hazard losses to City residents, businesses, vulnerable populations, and visitors
- Increase community resiliency to the impacts of natural hazards and promote sustainable growth
- Protect and enhance quality of life in the City
- Assure long term protection and resiliency of existing and future redevelopment from natural hazards
- Protect critical facilities from natural hazards and minimize interruption of essential infrastructure, utilities, and services
- Plan for and prioritize measures to respond to and address potential short- and long- term hazard impacts associated with climate change

GOAL 2: Enhance public outreach, awareness, education, and preparedness for all hazards to minimize hazard related losses

Objectives:

- Engage the community in disaster awareness and prevention education to reduce the risk and vulnerability of natural hazard impacts on quality of life
- Improve the communities' understanding of natural hazards and how to effectively be prepared and take action to mitigate the impacts of hazard events
- Develop and target outreach and education for each hazard type and risk area
- Support and encourage public responsibility
- Enhance public outreach programs to target vulnerable populations, including multi-language communications

GOAL 3: Improve City's resiliency and capabilities to mitigate losses and to be prepared for, respond to, and recover from a disaster event

Objectives:

- Take a proactive approach to identifying and mitigating hazards
- Maintain current service levels
- Continued enhancements to community capabilities, leveraging new technologies to reduce losses and save lives
- Provide protection and increase safety for City employees and first responders from hazards

GOAL 4: Maintain FEMA Eligibility/Position Jurisdictions for Grant Funding

Objectives:

- Maintain good standing with FEMA and State hazard mitigation programs, regulations and requirements
- Develop an overall mitigation funding strategy to prioritize and pursue mitigation projects, including identification and tracking of federal, state, and local grant programs and funding mechanisms

Actions to support these goals are shown on Table ES-1.

Table ES-3 San Rafael's City Planning Team Mitigation Actions

Hazard/ Mitigation Action Title	Goals Addressed	Address Existing Development	Address Future Development	Continued Compliance with NFIP	CRS Category
Multi-Hazard Mitigation Actions					
1. Integrate Local Hazard Mitigation Plan into Safety Element of General Plan	1, 2, 3, 4	X	X	X	Prevention
2. Identify the locations then subsequently equip, stock and train staff in order to establish emergency evacuation shelters used to temporary house people during major emergencies.	1, 2, 3, 4	X	X		Emergency Services
3. Update the San Rafael Emergency Operations Center (EOC) Handbook	1, 2, 3	X	X		Emergency Services
4. Outfit and equip the City's new Emergency Operation's Center (EOC) scheduled for operation in Calendar Year 2019	1, 2, 3, 4	X	X		Emergency Services
5. Plan, prepare, conduct community outreach and deploy emergency evacuation exercises in neighborhoods prone to wildfire or tidal flooding during extreme wet weather periods.	1, 2, 3, 4	X	X	X	Emergency Services Public Information
6. Bayside Acres Beach Sewer Relocation/Replacement	1, 2, 3, 4	X	X	X	Property Protection Structural
7. Beach Drive (Fiberglass) Pump Station and Sewer Rehabilitation	1, 2, 3, 4	X	X	X	Property Protection Structural
8. Recruit and ultimate appoint a new Emergency Management Coordinator (EMC) to fill vacant post.	1, 2, 3	X	X		Emergency Services
9. Evaluate and Implement signal timing for first responders	1, 2, 3	X	X		Emergency Services
10. Tree Safety Maintenance Program	1, 2, 3	X	X		Property Protection
11. Purchase and installation of EMTRAC signal control equipment into 17 San Rafael Fire Vehicles and 25 intersections.	1, 2, 3	X	X		Emergency Services
Climate Change Actions					
12. Elevate/Raise Low Lying Roadways	1, 2, 3, 4	X	X	X	Property Protection Structural
13. Elevate Critical Infrastructure	1, 2, 3, 4	X	X	X	Property Protection Structural

Hazard/ Mitigation Action Title	Goals Addressed	Address Existing Development	Address Future Development	Continued Compliance with NFIP	CRS Category
14. Improvements to Existing Berms, Levees and Flood Control Systems	1, 2, 3, 4	X	X	X	Property Protection Structural Natural Resource Protection
15. Continued involvement in the BayWAVE county-wide vulnerability assessment (Phase 1 and 2); Implement resulting strategies from Phase 2 of the program.	1, 2, 3, 4	X	X	X	Prevention Property Protection Structural Natural Resource Protection Public Outreach
16. Develop a climate adaptation plan, and implement resulting strategies	1, 2, 3, 4	X	X	X	Prevention Property Protection Structural Natural Resource Protection Public Outreach
17. Develop an energy storage plan	1, 2, 3	X	X		Prevention Property Protection Structural
Drought Mitigation Actions					
18. Water Storage Facility Study	1, 2, 3, 4	X	X		Prevention Property Protection Structural
19. Leaky Pipe Replacement Program	1, 2, 3, 4	X	X		Property Protection
20. Marin Municipal Water District exploration of desalination plants	1, 2, 3	X	X		Property Protection Structural
21. Evaluate the use of reclaimed water/increase purple pipes	1, 2, 3	X	X		Property Protection Structural
22. Evaluate and enhance conservation measures to reduce water consumption	1, 2, 3, 4	X	X		Prevention Property Protection
Earthquake Mitigation Actions					
23. Retrofit/upgrade four remaining URM's	1, 2, 3, 4	X	X		Property Protection Structural
24. Earthquake Hazard Study	1, 2, 3, 4	X	X		Prevention

Hazard/ Mitigation Action Title	Goals Addressed	Address Existing Development	Address Future Development	Continued Compliance with NFIP	CRS Category
25. Public Facility Vulnerability Assessment and Improvements	1, 2, 3, 4	X	X		Property Protection Structural
Flood Mitigation Actions					
26. Develop and Maintain a Community Rating System (CRS)	1, 2, 3, 4	X	X	X	Prevention Property Protection Structural Natural Resource Protection Public Outreach Emergency Services
27. Beach Drive Structural Flood Protection	1, 2, 3, 4	X	X	X	Property Protection Structural
28. Adopt a Drain Program	1, 2, 3, 4	X	X	X	Prevention Property Protection
29. City Pump Station Analysis and Improvements	1, 2, 3, 4	X	X	X	Prevention Property Protection Structural
30. City Storm Drain System Analysis and Improvements	1, 2, 3, 4	X	X	X	Prevention Property Protection Structural
31. City Flood Alert System	1, 2, 3, 4	X	X	X	Emergency Services
Landslide Mitigation Actions					
32. 70-96 Bret Harte Sewer Easement Repair	1, 2, 3, 4	X	X		Property Protection Structural
33. Landslide Identification and Management Program	1, 2, 3, 4				Prevention Property Protection Structural Natural Resource Protection
Wildfire Mitigation Actions					
34. Funding for Vegetation Management Coordinator Position	1, 2, 3, 4	X	X		Prevention Property Protection

Hazard/ Mitigation Action Title	Goals Addressed	Address Existing Development	Address Future Development	Continued Compliance with NFIP	CRS Category
35. Create a City of San Rafael specific Community Wildfire Protection Plan (CWPP).	1, 2, 3, 4	X	X		Prevention Property Protection Natural Resource Protection
36. Create new strategic fuel interruption zones in WUI areas and maintain and expand existing fuel interruption zones already in place.	1, 2, 3, 4	X	X		Prevention Property Protection Natural Resource Protection
37. Juniper and Bamboo Clearing Program from Residential Properties within WUI.	1, 2, 3, 4	X	X		Prevention Property Protection Natural Resource Protection
38. Create new point specific wildfire prevention programs specifically targeting areas where homeless encampments are known to exist.	1, 2, 3, 4	X	X		Prevention Property Protection Natural Resource Protection

Table ES-4 San Rafael Mitigation Actions

Hazard/ Mitigation Action Title	Goals Addressed	Address Existing Development	Address Future Development	Continued Compliance with NFIP	CRS Category
39. East San Rafael Shore Project: Plan	1, 2, 3, 4	X	X	X	Prevention Property Protection Structural Natural Resource Protection Public Outreach
40. East San Rafael Shore Project: Permitting and Construction	1, 2, 3, 4	X	X	X	Prevention Property Protection Structural Natural Resource Protection Public Outreach

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Abbreviations and Acronyms WILL BE UPDATED

Acronym	Definition
AB	Assembly Bill
AGL	Above Ground Level
AHPS	Advanced Hydrologic Prediction Service
ALERT	Automated Local Evaluation in Real Time
APG	California Adaptation Planning Guide
BAM	Best Available Map
BLM	Bureau of Land Management
BMP	Best Management Practices
CA	California
CA-DWR	California Department of Water Resources
CAP	Climate Adaptation Plan
CAS	Climate Adaptation Strategy
CDAA	California Disaster Assistance Act
CDEC	California Data Exchange Center
CDFA	California Department of Food & Agriculture
CDFW	California Department of Fish and Wildlife
CEC	California Energy Commission
CEQA	California Environmental Quality Act
CERT	Community Emergency Response Training
CFR	Code of Federal Regulations
CGS	California Geologic Survey
CHP	California Highway Patrol
CIP	Capital Improvements Plan
CLEMARS	California Law Enforcement Mutual Aid Radio System
CLOMR	Conditional Letter of Map Revision
CNPS	California Native Plant Society
CNRA	California Natural Resource Agency
CRS	(National Flood Insurance Program's) Community Rating System
CVFPB	Central Valley Flood Protection Board
CVFMP	Central Valley Flood Management Plan
CWPP	Community Wildfire Protection Plan
DGS	Department of General Services
DMA	Disaster Mitigation Act of 2000
DOT	Department of Transportation
DPC	Delta Protection Commission

Acronym	Definition
DRMS	Delta Risk Management Strategy
DSC	Delta Stewardship Council
DSOD	Division of Safety of Dams
EAS	Emergency Alert System
EDIS	Emergency Digital Information System
EOC	Emergency Operations Center
EOP	Emergency Operations Plan
FAA	Federal Aviation Agency
FEMA	Federal Emergency Management Agency
FIA	Flood Insurance Assessment
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FMA	Flood Mitigation Assistance Program
FWS	US Fish and Wildlife Service
GHG	Greenhouse Gases
GIS	Geographic Information Systems
GRR	General Reevaluation Report
HMGP	Hazard Mitigation Grant Program
HI	Heat Index
HVAC	Heating, Ventilation, and Air Conditioning
IBC	International Business Code
IPCC	Intergovernmental Panel on Climate Change
IRC	International Residential Code
JFP	Joint Federal Project
LFPZ	Levee Flood Protection Zone
LHMP	Local Hazard Mitigation Plan
LOMA	Letter of Map Amendment
LOMR	Letter of Map Revision
MHDP	Multi Hazard Demonstration Project
MMI	Modified Mercalli Scale
MSL	Mean Sea Level
NASA	National Aerospace and Science Agency
NAVD 88	North America Vertical Datum 1988
NCDC	National Climactic Data Center
NDMC	National Drought Mitigation Center
NEPA	National Environmental Policy Act
NFIP	National Flood Insurance Program

Acronym	Definition
NGVD 29	National Geodetic Vertical Datum 1929
NIDIS	National Integrated Drought Information System
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NWS	National Weather Service
OHP	Office of Historic Preservation
PAL	Provisionally Accredited Levee
PDM	Pre-Disaster Mitigation Program
PG&E	Pacific Gas & Electric
PMR	Physical Map Revision
PPI	Program for Public Information
PRP	Preferred Risk Policy
RAWS	Remote Automated Weather Stations
RFMP	Regional Flood Management Plan
RL	Repetitive Loss
RLA	Repetitive Loss Area
RLAA	Repetitive Loss Area Analysis
SB	Senate Bill
SBA	Small Business Administration
SCADA	Supervisory Control and Acquisition Data system
SFHA	Special Flood Hazard Area
SGMA	Sustainable Groundwater Management Act
SRL	Severe Repetitive Loss
TMDL	Total Maximum Daily Loads
UCERF	Uniform California Earthquake Rupture Forecast
UDA	Urban Development Area
UHI	Urban Heat Island
ULDC	Urban Levee Design Criteria
ULOP	Urban Level of Protection Criteria
USACE	US Army Corp of Engineers
USGS	United States Geologic Survey
USDA	United States Department of Agriculture
WMP	Wildlife Hazard Management Plan
WRCC	Western Regional Climate Center
WUI	Wildland Urban Interface

Chapter 1 Introduction

1.1 Purpose

The City of San Rafael prepared this Local Hazard Mitigation Plan (LHMP) to guide hazard mitigation planning to better protect the people and property of the City from the effects of hazard events. This plan demonstrates the community's commitment to reducing risks from hazards and serves as a tool to help decision makers direct mitigation activities and resources. This plan was also developed so the City can be eligible for certain federal disaster assistance, specifically, the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Grant Program (HMGP), Pre-Disaster Mitigation (PDM) program, and the Flood Mitigation Assistance (FMA) program.

1.2 Background and Scope

Each year in the United States, natural disasters take the lives of hundreds of people and injure thousands more. Nationwide, taxpayers pay billions of dollars annually to help communities, organizations, businesses, and individuals recover from disasters. These monies only partially reflect the true cost of disasters, because additional expenses to insurance companies and nongovernmental organizations are not reimbursed by tax dollars. Many natural disasters are predictable, and much of the damage caused by these events can be alleviated or even eliminated.

Hazard mitigation is defined by FEMA as "any sustained action taken to reduce or eliminate long-term risk to human life and property from a hazard event." The results of a three-year, congressionally mandated independent study to assess future savings from mitigation activities provides evidence that mitigation activities are highly cost-effective. On average, each dollar spent on mitigation saves society an average of $4 in avoided future losses in addition to saving lives and preventing injuries (National Institute of Building Science Multi-Hazard Mitigation Council 2005).

Hazard mitigation planning is the process through which hazards that threaten communities are identified, likely impacts determined, mitigation goals set, and appropriate mitigation strategies determined, prioritized, and implemented. This plan documents the City's hazard mitigation planning process and identifies relevant hazards, vulnerabilities, and mitigation strategies the City will use to decrease vulnerability and increase resiliency and sustainability in the community.

The San Rafael LHMP is a single jurisdictional plan that geographically covers the entire area within the City's jurisdictional boundaries. This plan was prepared pursuant to the requirements of the Disaster Mitigation Act of 2000 (Public Law 106-390) and the implementing regulations set forth by the Interim Final Rule published in the Federal Register on February 26, 2002, (44 CFR §201.6) and finalized on October 31, 2007. (Hereafter, these requirements and regulations will be referred to collectively as the Disaster Mitigation Act (DMA) or DMA 2000.) This planning effort also follows FEMA's most current Plan Preparation and Review Guidance. While the DMA 2000 emphasized the need for mitigation plans and more coordinated mitigation planning and implementation efforts, the regulations established the

requirements that local hazard mitigation plans must meet in order for a local jurisdiction to be eligible for certain federal disaster assistance and hazard mitigation funding under the Robert T. Stafford Disaster Relief and Emergency Act (Public Law 93-288). Because the City is subject to many kinds of hazards, access to these programs is vital.

Information in this plan will be used to help guide and coordinate mitigation activities and decisions for local land use policy in the future. Proactive mitigation planning will help reduce the cost of disaster response and recovery to communities and their residents by protecting critical community facilities, reducing liability exposure, and minimizing overall community impacts and disruptions. San Rafael has been affected by hazards in the past and is thus committed to reducing future impacts from hazard events and becoming eligible for mitigation-related federal funding.

1.3 Plan Organization

The City of San Rafael's Local Hazard Mitigation Plan is organized as follows:

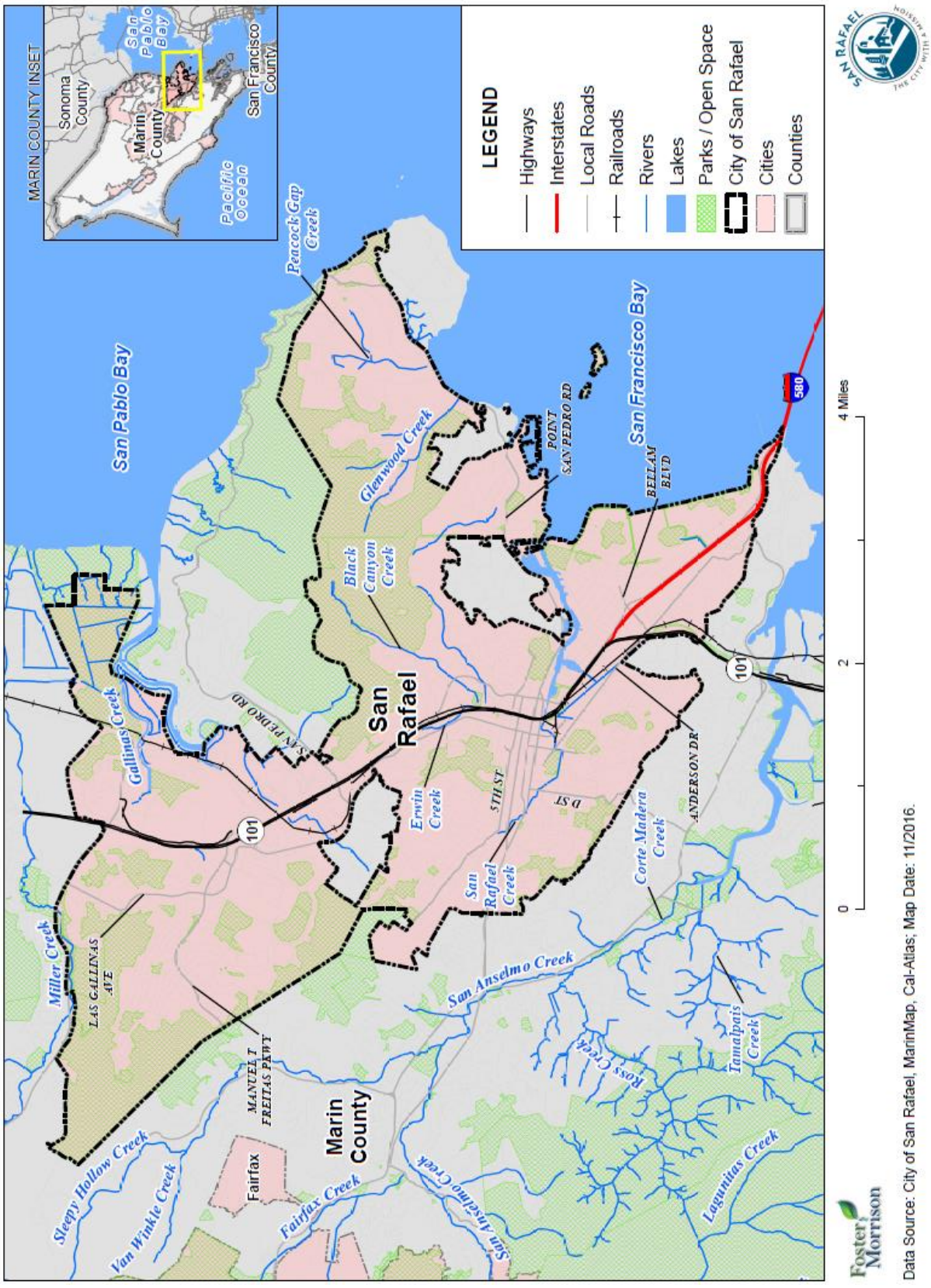
- Chapter 1: Introduction
- Chapter 2: Community Profile
- Chapter 3: Planning Process
- Chapter 4: Risk Assessment
- Chapter 5: Mitigation Strategy
- Chapter 6: Plan Adoption
- Chapter 7: Plan Implementation and Maintenance
- Appendices

Chapter 2 Community Profile

2.1 City of San Rafael Profile

The City of San Rafael is the county seat of Marin County. According to the United States Census Bureau, the City has a total area of 22.4 square miles. 16.5 square miles of it is land and 6.0 square miles of it is water. The City is located 17 miles to the north of the City of San Francisco. The City is served by Highway 101 and Interstate 580. It is bounded by Big Rock Ridge and the Novato city limits to the north, San Pablo and San Rafael bays on the east, the San Rafael-Sleepy Hollow Divide on the northwest, and Southern Heights Ridge and Cal Park Hill on the Southwest. The City can be seen on Figure 2-1 below.

Figure 2-1 City of San Rafael



2.2 History

What is now San Rafael was once the site of several Coast Miwok villages; Awani-wi, near downtown San Rafael, Ewu, near Terra Linda, and Shotomko-cha, in Marinwood. Mission San Rafael Arcángel was founded in what is now downtown San Rafael as the 20th Spanish mission in the colonial Mexican province of Alta California by three priests—Father Narciso Durán from Mission San José, Father Abella from Mission San Francisco de Asís, Father Luis Gíl y Taboada from La Iglesia de Nuestra Señora Reina de los Angeles—on Dec. 14, 1817, four years before Mexico gained independence from Spain. Mission San Rafael Arcángel was located a donkey's day walk to the mission below it. The mission and the city are named after the Archangel Raphael, the Angel of Healing.

The mission was originally planned as a hospital site for Central Valley American Indians who had become ill at the cold San Francisco Mission Dolores. Father Luis Gil, who spoke several Native American languages, was put in charge of the facility. In part because of its ideal weather, San Rafael was later upgraded to full mission status in 1822. The mission had 300 converts within its first year, and 1,140 converts by 1828. The Mexican government took over the California missions in 1834, and Mission San Rafael was abandoned in 1844, eventually falling into ruin. The current mission was built in 1949 in the style of the original, but faces at right angles to the alignment of the original.

The San Francisco and North Pacific Railroad reached San Rafael in 1879 and was linked to the national rail network in 1888. The United States Navy operated a San Pablo Bay degaussing range from San Rafael through World War II.

San Rafael is a city with many neighborhoods that are distinctive. There are older neighborhoods, from the days when San Rafael's residences were a mix of large ornate homes for wealthy merchants, summer retreats for San Francisco residents, and smaller simpler homes for workers from other countries. Neighborhoods built before World War II were developed with narrow tree-lined streets, neighborhood stores, and homes with front porches. The larger suburbs built in the 1960s and 1970s, with three- and four- bedroom homes, tend toward a similarity in design, such as the Eichler-designed homes which strive to unify indoor spaces with the outdoors while maintaining privacy. More recently, attached housing, including condominiums, apartments, and townhomes, ranging in size from single rooms to four-bedrooms, has been located throughout the city.

2.3 Geography and Climate

The San Rafael shoreline has been historically filled to a considerable extent to accommodate land development, with underlying bay mud (saturated clayed silt) of up to 90 feet in thickness. At certain locations such as Murphy's Point, the sandstone or shale rock outcrops through the mud.

The climate of the City is semiarid and may be classified as interior Mediterranean. Summers are hot and dry with low humidity, while winters are very mild with infrequent snowfall. In the City, temperatures vary from average summer highs near 82°F to average winter lows near 41°F. Precipitation is concentrated during October through April, when 95 percent of the seasonal precipitation normally occurs. Average annual precipitation in the City is 35.6 inches. 90 percent of the annual precipitation occurs between November and April.

2.4 Economy and Tax Base

San Rafael is the business center of Marin County. According to the 2020 General Plan, over 10,000 businesses exist in Marin County, half of which are in San Rafael. The commercial base is broad and diverse, with many small and medium sized businesses. Less than 50 of the almost 5,400 businesses in San Rafael have 100 or more employees. Over the past decade, high technology businesses have increased in importance and number, resulting in one of the highest concentrations of game software production in the world. The number of home-based businesses has also increased by over 17 percent in the past five years.

Overall, San Rafael's robust and stable economy is due to three factors. First, San Rafael is viewed as a desirable place to do business with good transportation access, high income residents and a good reputation. Second, the City's economic base is diverse and buffers impacts from economic downturns. Third, San Rafael responds to change and accommodates new opportunities.

The US Census Bureau tracks economic statistics for the City of San Rafael. These are shown in Table 2-1.

Table 2-1 City of San Rafael Civilian Employed Population 16 years and Over

Industry	Estimated Employment	Percent
Agriculture, forestry, fishing and hunting, and mining	121	0.4%
Construction	2,124	7.1%
Manufacturing	1,306	4.4%
Wholesale trade	475	1.6%
Retail trade	3,232	10.8%
Transportation and warehousing, and utilities	665	2.2%
Information	862	2.9%
Finance and insurance, and real estate and rental and leasing	2,427	8.1%
Professional, scientific, and management, and administrative and waste management services	5,614	18.8%
Educational services, and health care and social assistance	6,153	20.6%
Arts, entertainment, and recreation, and accommodation and food services	3,588	12.0%
Other services, except public administration	2,183	7.3%
Public administration	1,121	3.8%

Source: US Census Bureau American Community Survey 2014 Estimates

According to San Rafael's 2010 Comprehensive Annual Financial Report, the top employers in the City are shown in Table 2-2.

Table 2-2 City of San Rafael Largest Employers

Employer	Number of Employees
Kaiser Permanente	1,330
Autodesk	928
Comcast	619
City of San Rafael	592
Safeway	452
Macy's	450
MHN	350
Bradley Real Estate	350
Dominican University of California	336
Guide Dogs for the Blind	280

Source: San Rafael's 2010 Comprehensive Annual Financial Report

The City has a wide and varied tax base. Table 2-3 shows the breakdown of the City's taxable values. Table 2-4 shows the largest individual assessees in the City by taxable value of land and structure.

Table 2-3 San Rafael – Tax Base by Property Use

Property Use Category	Parcels	Net Taxable Value	Percentage of Total Value
Agricultural	1	$1	0.01%
Commercial	1,195	$2,351,589,780	6.71%
Exempt	771	$497,537,113	4.33%
Industrial	275	$268,781,666	1.55%
Residential	15,554	$9,060,681,811	87.32%
Total	**17,796**	**$12,178,590,371**	**100.00%**

Source: Marin County Assessor's Office

Table 2-4 San Rafael Largest Tax Assessees

Assessee (Top 10 Values)	Total Value
Corte Madera Village LLC	$137,723,038.00
RP Maximus Cove Owner LLC	$133,342,564.00
Skywalker Properties Ltd LLC	$104,541,462.00
Skywalker Properties Ltd	$99,659,546.00
Kaiser Foundation Hospitals	$83,417,768.00
Northgate Mall Association	$78,000,000.00
Bay Vista at Meadow Park	$77,372,001.00
Buck Institute for Research on Aging	$68,693,822.00
195-205 Tamal Vista Boulevard LLC	$59,313,220.00

Assessee (Top 10 Values)	Total Value
South Valley Apartments LLC	$51,776,500.00

Source: Marin County Assessor's Office

2.5 Population and Socioeconomic Makeup

According to 2015 California Department of Finance estimates, the population of the City is 59,214. This represents a mild increase in population from the 2000 US Census, which estimated the City population at 56,063.

Select social and economic information for the City is shown in Table 2-5.

Table 2-5 San Rafael– Select Social and Economic Statistics

Statistic	Number
Populations	
Population under 5	6.2%
Population over 65	15.8%
Median Age	40.2
Racial Makeup	
White	70.6%
Black or African American	2.0%
American Indian or Alaska Native	1.2%
Asian	6.1%
Native Hawaiian or Pacific Islander	0.2%
Other Races	14.8%
Two or more races	5.1%
Income and Poverty	
Median income	$77,294
Mean Income	$119,274
Poverty rate	
All families	8.1%
All people	13.2%
Unemployment Rate (September 2016)	3.8%

Source: 2010 US Census, 2015 US Census American Community Survey, Bureau of Labor Statistics

Chapter 3 Planning Process

Requirements §201.6(b) and §201.6(c)(1): An open public involvement process is essential to the development of an effective plan. In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include:

1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval;

2) An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia, and other private and nonprofit interests to be involved in the planning process; and

3) Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.

[The plan shall document] the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved.

The City of San Rafael recognized the need and importance of a Local Hazard Mitigation Plan (LHMP) and initiated its development. After receiving a grant from the Federal Emergency Management Agency (FEMA), which served as the primary funding source for this plan, the City contracted with Foster Morrison Consulting, Ltd. (Foster Morrison) to facilitate and develop the plan. Jeanine Foster, a professional planner with Foster Morrison, was the project manager in charge of overseeing the planning process and the development of this LHMP. Chris Morrison, also a professional planner with Foster Morrison, was the lead planner for the development of this LHMP. The Foster Morrison's team's role was to:

- Assist in establishing the Hazard Mitigation Planning Committee (HMPC) as defined by the Disaster Mitigation Act (DMA);
- Meet the DMA requirements as established by federal regulations and following FEMA's planning guidance;
- Support objectives under the NFIPs CRS and the Flood Mitigation Assistance (FMA) program;
- Facilitate the entire planning process;
- Identify the data requirements that HMPC participants could provide and conduct the research and documentation necessary to augment that data;
- Assist in facilitating the public input process;
- Produce the draft and final plan documents; and
- Coordinate with the California Office of Emergency Services (Cal OES) and FEMA Region IX plan reviews.

3.1 Local Government Participation

The DMA planning regulations and guidance stress that each local government seeking FEMA approval of their mitigation plan must participate in the planning effort in the following ways:

- Participate in the process as part of the HMPC;
- Detail where within the planning area the risk differs from that facing the entire area;

- Identify potential mitigation actions; and
- Formally adopt the plan.

For the City of San Rafael's HMPC, "participation" meant the following:

- Providing facilities for meetings;
- Providing printed materials and refreshments for meeting attendees;
- Attending and participating in the HMPC meetings;
- Completing and returning the Data Collection Worksheets;
- Collecting and providing other requested data (as available);
- Coordinating information sharing between internal and external agencies;
- Managing administrative details;
- Making decisions on plan process and content;
- Identifying mitigation actions for the plan;
- Reviewing and providing comments on plan drafts;
- Informing the public, local officials, and other interested stakeholders about the planning process and providing opportunity for them to comment on the plan;
- Coordinating, and participating in the public input process; and
- Coordinating the formal adoption of the plan by the governing board.

San Rafael met all of these participation requirements. In most cases one or more representatives for each City department and other local agency stakeholders attended the HMPC meetings described in Table 3-2 and worked together to help collect data, identify mitigation actions and implementation strategies, and review and provide data on plan drafts. Appendix A provides additional information and documentation of the planning process.

3.2 The 10-Step Planning Process

Foster Morrison established the planning process for the City of San Rafael LHMP using the DMA planning requirements and FEMA's associated guidance. This guidance is structured around a four-phase process:

1. Organize Resources;
2. Assess Risks;
3. Develop the Mitigation Plan; and
4. Implement the Plan and Monitor Progress.

Into this process, Foster Morrison integrated a more detailed 10-step planning process used for FEMA's CRS and FMA programs. Thus, the modified 10-step process used for this plan meets the requirements of six major programs: FEMA's Hazard Mitigation Grant Program (HMGP); Pre-Disaster Mitigation (PDM) program; CRS program; FMA Program; Severe Repetitive Loss (SRL) program; and new flood control projects authorized by the U.S. Army Corps of Engineers (USACE).

Table 3-1 shows how the modified 10-step process fits into FEMA's four-phase process. The sections that follow describe each planning step in more detail.

Table 3-1 Mitigation Planning Processes Used to Develop the San Rafael Local Hazard Mitigation Plan

DMA Process	Modified CRS Process
1) Organize Resources	
201.6(c)(1)	1) Organize the Planning Effort
201.6(b)(1)	2) Involve the Public
201.6(b)(2) and (3)	3) Coordinate with Other Departments and Agencies
2) Assess Risks	
201.6(c)(2)(i)	4) Identify the Hazards
201.6(c)(2)(ii)	5) Assess the Risks
3) Develop the Mitigation Plan	
201.6(c)(3)(i)	6) Set Goals
201.6(c)(3)(ii)	7) Review Possible Activities
201.6(c)(3)(iii)	8) Draft an Action Plan
4) Implement the Plan and Monitor Progress	
201.6(c)(5)	9) Adopt the Plan
201.6(c)(4)	10) Implement, Evaluate, and Revise the Plan

3.2.1. Phase 1: Organize Resources

Planning Step 1: Organize the Planning Effort

With San Rafael's commitment to participate in the DMA planning process, Foster Morrison worked with the City of San Rafael's Fire Department (SRFD), as overall project lead, to establish the framework and organization for development of the plan. An initial call was held with key community representatives to discuss the organizational and process aspects of the planning process

The initial kick-off meeting was held on October 12, 2016. Invitations to the kickoff meeting was extended to key city departments and other federal, state, and local stakeholders that might have an interest in participating in the planning process. Representatives from the City and key community stakeholders participated in this LHMP project with additional invitations extended as appropriate throughout the planning process. The list of initial invitees is included in Appendix A.

The HMPC was established as a result of the initial kickoff meeting, as well as through interest generated through the initial public meeting and outreach conducted for this project as detailed later in this section. The HMPC, comprising key city, county, special district, and other government and stakeholder representatives and the public, developed the plan with leadership from the SRFD and facilitation by Foster Morrison. The following participated on the HMPC:

City of San Rafael

- San Rafael Fire
- San Rafael Economic Development
- San Rafael Community Development
- San Rafael Community Services
- San Rafael Office of Emergency Services
- San Rafael Police
- San Rafael Public Information Officer
- San Rafael Information Technology
- San Rafael Sanitation District
- San Rafael Public Works

Other Government and Stakeholder Representatives

- Canal Alliance
- Center for Volunteer and Nonprofit Leadership
- Marin County Fire
- Marin County Office of Emergency Services
- Marin Municipal Water District
- Marin Sanitary Service
- National Weather Service
- Pacific Gas & Electric
- Red Cross
- ShoreUp Marin / Canal Welcome Center
- Sonoma Marin Area Rail Transit (SMART)

A list of participating HMPC representatives is included in Appendix A. This list includes all HMPC members that attended one or more HMPC meetings detailed in Table 3-2. The above list of HMPC members also includes several other government and stakeholder representatives that were invited to participate and contributed to the planning process, by providing technical data, plan reviews, and other requested input.

Meetings

The planning process officially began with a kick-off meeting held in in the City on October 12, 2016, followed by public kick-off meeting held the same day at 6:00 pm at the same location. The meetings covered the scope of work and an introduction to the DMA, CRS, and FMA requirements. During the HMPC meetings, participants were provided with data collection worksheets to facilitate the collection of information necessary to support development of the plan. Using FEMA guidance, these worksheets were designed to capture information on past hazard events, identify hazards of concern to the City, quantify values at risk to identified hazards, inventory existing capabilities, and to record possible mitigation actions. A copy of the worksheets for this project are included in Appendix A. The City and HMPC participants completed and returned the worksheets to Foster Morrison for incorporation into the plan document.

During the planning process, the HMPC communicated through face-to-face meetings, email, telephone conversations, file transfer protocol (ftp) and Dropbox websites, and through a City developed webpage dedicated to the plan development process. This later website was developed to provide information to the

HMPC, the public and all other stakeholders on the LHMP process. Draft documents were also posted on these websites so that the HMPC members and the public could easily access and review them. The LHMP website can be accessed at:

- https://www.cityofsanrafael.org/hazard-mitigation-plan/

The HMPC met formally five times during the planning period (September 2016 – May 2017) which adequately covers the four phases of DMA and the 10-Step CRS planning process. The formal meetings held and topics discussed are described in Table 3-2. Agendas and sign-in sheets for each of the meetings are included in Appendix A.

Table 3-2 HMPC Meetings

Meeting Type	Meeting Topic	Meeting Date(s)	Meeting Location(s)
HMPC #1 Kick-off Meeting	1) Introduction to DMA 2000 and the planning process 2) Organize Resources: (DMA./CRS Steps 1,2, &3): the role of the HMPC, planning for public involvement, coordinating with other agencies/stakeholders 3) Introduction to Hazard Identification	October 12, 2016	San Rafael Community Center
HMPC #2	1) Risk assessment overview and work session -DMA/CRS Step 4: Assess the Hazard -DMA/CRS Step 5: Assess the Problem	January 25, 2017	San Rafael Fire Department OES Facility
HMPC #3	1) Review of risk assessment summary 2) Review of mitigation goals -DMA/CRS Step 6: Set Goals	February 21, 2017	San Rafael Community Development Conference Room
HMPC #4	1) Review of mitigation action alternatives 2) Identify list of mitigation actions by hazard 3) Review of mitigation selection criteria 4) Prioritize mitigation actions 5) Mitigation Action Strategy Implementation and Draft Action Development -DMA/CRS Step 7: Review possible activities -DMA/CRS Step 8: Draft an Action Plan	February 22, 2017	San Rafael Community Development Conference Room
HMPC #5	1) Review of final HMPC, City, and public comments and input to plan 2) Review and documentation of changed conditions, vulnerabilities and mitigation priorities 3) DMA/CRS Step 8: Draft an Action Plan 4) DMA/CRS Step 9 & 10: Plan maintenance and Implementation Procedures	May 11, 2017	San Rafael Community Development Conference Room

Planning Step 2: Involve the Public

Up-front coordination discussions with the City of San Rafael and HMPC established the initial plan for public involvement. Public involvement activities for this LHMP included press releases, social media communications, stakeholder and public meetings, development of an LHMP webpage and associated website postings, a public survey, the collection of public and stakeholder comments on the draft plan through a variety of mechanisms, and other public outreach activities as further described below, as well as

specific targeted outreach to different groups of people and other agencies throughout the City. Information provided to the public included an overview of the LHMP process, including a review of the hazard risk assessment and proposed mitigation strategies for this LHMP. As part of the plan development process, a Public Involvement Strategy was also developed to ensure a meaningful public process that utilized. At the planning established public information mechanisms and resources within the community.

Public Meetings

Three public meetings for the San Rafael LHMP were held during key times of the LHMP development process:

Public Meeting #1: LHMP Kickoff

Public outreach for this LHMP began at the beginning of the plan development process with an advertisement placed in the local newspaper and other local outreach methods to inform the public of the purpose of the DMA and the hazard mitigation planning process for the City of San Rafael. A press release was also issued at the beginning of the project to invite the public to a public meeting for the kick-off the LHMP project on October 12, 2016 at the San Rafael Community Center in central San Rafael.

Public Meeting #2: Risk Assessment Overview

A second public meeting was held to provide an overview of the hazard risk assessment portion of the LHMP. This meeting was held the evening of the HMPC risk assessment in the San Rafael Community Development Conference Room. This meeting was advertised through the City website and through direct emails to those members of the public expressing an interest in the LHMP planning process.

Figure 3-1 Public Notice of the Public Meeting #2 on the City Website

Source: City of San Rafael

Public Meeting #3: Meeting on the Draft LHMP

The first draft of the plan was provided to the HMPC in March of 2017, with a public review draft provided in April of 2017. A public meeting was held on May 10, 2017 to present the draft LHMP and to collect public comments on the plan prior to finalization and submittal to Cal OES/FEMA. The public meeting on the draft LHMP was advertised in a variety of ways to maximize outreach efforts to both targeted groups and to the public at large and included an advertisement in two local newspapers. The advertisement in the local newspapers included information on the date, location and time of the meeting, where the draft plan could be accessed in the community, and how to provide comments on the draft plan. In addition to a copy of the draft plan being placed on the City website in advance of these meetings, hard copies of the draft of the plan were made available to interested parties at two San Rafael Public Libraries. A copy was also placed in the Community Development Department.

Figure 3-2 Public Outreach at San Rafael Library

Source: City of San Rafael

Figure 3-3 Public Outreach at XYZ Library

Source: City of San Rafael

Documentation to support the all the public meetings can be found in Appendix A. In addition to advertisement for public participation, notices of meetings were sent directly to all persons on the HMPC contact list and also to other agency and key stakeholders with an interest in the San Rafael LHMP project. The majority of these people reside in San Rafael, Marin County and surrounding communities. The formal public meetings for this project are summarized in Table 3-3.

Table 3-3 Schedule of Public and Stakeholder Meetings

Meeting Type	Meeting Topic	Meeting Date	Meeting Locations
Public Meeting #1	1) Intro to DMA and mitigation planning 2) The 2017San Rafael LHMP Development Process	October 12, 2016	San Rafael Community Center
Public Meeting #2	1)Risk Assessment Overview	February 22, 2017	San Rafael Community Development Conference Room
Public Meeting #3	1)Presentation of Draft LHMP and solicitation of public and stakeholder comments	May 11, 2017	San Rafael Community Development Conference Room

Where appropriate, stakeholder and public comments and recommendations were incorporated into the final plan throughout the plan development process, including the sections that address mitigation goals and strategies. No formal comments were provided on the draft plan. All press releases, newspaper advertisements and articles, website postings, and public outreach efforts are on file with the San Rafael Fire Department and are included in Appendix A.

Public Outreach Survey

An integral element in hazard mitigation planning is broad public participation. Information provided by residents fosters a better understanding of local hazard concerns and can spawn innovative ideas to reduce impacts of future hazard events. A public opinion survey was accomplished to gather information from San Rafael area residents concerning local hazards and related input. The survey was located on the City's LHMP website throughout most of the planning process and survey participation was promoted through public meetings, program websites, press releases, social media, and other public outreach events as previously described. Following is a summary of survey results.

- INSERT WHEN COMPLETE

The survey and survey results are included in Appendix F.

Planning Step 3: Coordinate with Other Departments and Agencies

Early in the planning process, the HMPC determined that data collection, mitigation strategy development, and plan approval would be greatly enhanced by inviting other local, state and federal agencies and organizations to participate in the process. Based on their involvement in hazard mitigation planning, their landowner status in the City, and/or their interest as a neighboring jurisdiction, representatives from the following agencies were invited to participate on the HMPC:

- American Red Cross
- CAL FIRE
- California Department of Water Resources
- California Office of Emergency Services
- Canal Alliance
- Center for Volunteer and Nonprofit Leadership
- Federal Emergency Management Agency
- Fire Safe Marin
- Marin Builder's Association
- Marin County Fire
- Marin County Office of Emergency Services
- Marin Municipal Water District
- Marin Sanitary Service
- Marin Transit
- National Weather Service
- Neighboring Communities
- NFIP/CRS Program Coordinators
- Pacific Gas & Electric
- Red Cross
- San Rafael Chamber of Commerce
- San Rafael City Schools
- ShoreUp Marin
- ShoreUp Marin / Canal Welcome Center
- Sonoma Marin Area Rail Transit (SMART)
- United States Corps of Engineers

Coordination with key agencies, organizations, and advisory groups throughout the planning process allowed the HMPC to review common problems, development policies, and mitigation strategies as well as identifying any conflicts or inconsistencies with regional mitigation policies, plans, programs and regulations. Coordination involved contacting these agencies through a variety of mechanisms and informing them on how to participate in the LHMP process and if they had any expertise or assistance they could lend to the planning process or specific mitigation strategies. Coordination with these groups included, holding face-to-face meetings, sending e-mails, some with follow up phone calls; and making phone calls alone to out of area agencies. All of these groups and agencies were solicited asking for their assistance and input, telling them how to become involved in the LHMP process, and inviting them to HMPC meetings.

In addition, as part of the overall stakeholder and agency coordination effort, the HMPC coordinated with and utilized input to the LHMP from the following agencies:

- Association of Bay Area Governments
- CAL OES
- CAL FIRE
- California Department of Finance
- California Department of Water Resources
- California Geological Survey
- FEMA Region IX
- Library of Congress
- National Oceanic and Atmospheric Association
- National Performance of Dams Program
- National Register of Historic Places
- National Resource Conservation Service
- National Response Center
- National Weather Service
- United States Army Corps of Engineers
- United States Bureau of Land Management
- United States Bureau of Reclamation
- United States Department of Agriculture
- United States Farm Service Agency
- United States Forest Service
- United States Geological Survey
- Western Regional Climate Center

Several opportunities were provided for the groups listed above to participate in the planning process. At the beginning of the planning process, invitations were extended to many of these groups to actively participate on the HMPC. Specific participants from these groups are detailed in Appendix A. Others assisted in the process by providing data directly as requested in the Data Worksheets or through data contained on their websites or as maintained by their offices. Further as part of the public outreach process, all groups were invited to attend the public meetings and to review and comment on the plan prior to submittal to CAL OES and FEMA. In addition, as part of the review of the draft plan, key agency stakeholders were contacted and their comments specifically solicited.

Other Community Planning Efforts and Hazard Mitigation Activities

Coordination with other community planning efforts is also paramount to the success of this plan. Hazard mitigation planning involves identifying existing policies, tools, and actions that will reduce a community's risk and vulnerability to hazards. San Rafael uses a variety of comprehensive planning mechanisms, such as general plans and ordinances, to guide growth and development. Integrating existing planning efforts and mitigation policies and action strategies into this plan establishes a credible and comprehensive plan that ties into and supports other community programs. The development of this plan incorporated information from the following existing plans, studies, reports, and initiatives as well as other relevant data from neighboring communities and other jurisdictions.

- City of San Rafael 2020 General Plan
- City of San Rafael 2020 General Plan Background Report
- City of San Rafael Climate Change Action Plan.
- City of San Rafael Community Emergency Preparedness Plan
- City of San Rafael Greenhouse Gas Reduction Strategy Report
- Climate Adaptation – Sea Level Rise, San Rafael CA. White Paper
- Marin Bay Shoreline Sea Level Rise Vulnerability Assessment
- Marin Countywide Plan
- Marin County Local Hazard Mitigation Plan
- Marin County Community Wildfire Protection Plan
- Marin County Flood Insurance Study
- Plan Bay Area 2040.

Specific source documents are referenced at the beginning of each section of Chapter 4 and Appendix B, References. These and other documents were reviewed and considered, as appropriate, during the collection of data to support Planning Steps 4 and 5, which include the hazard identification, vulnerability assessment, and capability assessment. Data from these plans and ordinances were incorporated into the risk assessment and hazard vulnerability sections of the plan. Data was also used to support the resulting mitigation strategy. Where the data from the existing studies and reports is used, the source document is referenced throughout this LHMP. The data was also used in determining the capability of the community in being able to implement certain mitigation strategies. Appendix B, References, provides a detailed list of references used in the preparation of this LHMP.

3.2.2. Phase 2: Assess Risks

Planning Steps 4 and 5: Identify the Hazards and Assess the Risks

Foster Morrison led the HMPC in a research effort to identify, document, and profile all the hazards that have, or could have, an impact to the planning area. The HMPC relied on information from the City's Safety Element to the General Plan, the 2020 General Plan Background Report, the City's initial LHMP efforts as part of the Association of Bay Area Governments (ABAG) hazard mitigation plans, the 2013 State of California Hazard Mitigation Plan, and other sources to establish the hazards list for this LHMP. Data collection worksheets and other data provided by the HMPC and other stakeholders were used in this effort to aid in determining hazards and vulnerabilities and where the risk varies across the planning area.

Geographic information systems (GIS) were used to display, analyze, and quantify hazards and vulnerabilities.

The HMPC also conducted a capability assessment to review and document the planning area's current capabilities to mitigate risk from and vulnerability to hazards. By collecting information about existing government programs, policies, regulations, ordinances, and emergency plans, the HMPC could assess those activities and measures already in place that contribute to mitigating some of the risks and vulnerabilities identified. A more detailed description of the risk assessment process, methodologies, and results are included in Chapter 4 Risk Assessment.

3.2.3. Phase 3: Develop the Mitigation Plan

Planning Steps 6 and 7: Set Goals and Review Possible Activities

Foster Morrison facilitated brainstorming and discussion sessions with the HMPC that described the purpose and process of developing planning goals and objectives, a comprehensive range of mitigation alternatives, and a method of selecting and defending recommended mitigation actions using a series of selection criteria. This information is included in Chapter 5 Mitigation Strategy. Additional documentation on the process the HMPC used to develop the goals and strategy is in Appendix C.

Planning Step 8: Draft an Action Plan

Based on input from the HMPC regarding the draft risk assessment and the goals and activities identified in Planning Steps 6 and 7, a complete first draft of the plan was developed. This complete draft was provided for HMPC review and comment via a Dropbox web link. Other agencies were invited to comment on this draft as well. HMPC and agency comments were integrated into the second public review draft, which was advertised and distributed to collect public input and comments. The HMPC integrated comments and issues from the public, as appropriate, along with additional internal review comments and produced a final draft for the CAL OES and FEMA Region IX to review and approve, contingent upon final adoption by the San Rafael City Council.

3.2.4. Phase 4: Implement the Plan and Monitor Progress

Planning Step 9: Adopt the Plan

In order to secure buy-in and officially implement the plan, the plan was adopted by the governing board of the City, the San Rafael City Council, using the sample resolution contained in Appendix D.

Planning Step 10: Implement, Evaluate, and Revise the Plan

The true worth of any mitigation plan is in the effectiveness of its implementation. Up to this point in the planning process, all of the HMPC's efforts have been directed at researching data, coordinating input from participating entities, and developing appropriate mitigation actions. Each recommended action includes key descriptors, such as a lead manager and possible funding sources, to help initiate implementation. An overall implementation strategy is described in Chapter 7 Plan Implementation and Maintenance.

Finally, there are numerous organizations within San Rafael whose goals and interests interface with hazard mitigation. Coordination with these other planning efforts, as addressed in Planning Step 3, is paramount to the implementation and ongoing success of this plan and mitigation in San Rafael and is addressed further in Chapter 7.

Chapter 4 Risk Assessment

Requirement §201.6(c)(2): [The plan shall include] A risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.

As defined by FEMA, risk is a combination of hazard, vulnerability, and exposure. "It is the impact that a hazard would have on people, services, facilities, and structures in a community and refers to the likelihood of a hazard event resulting in an adverse condition that causes injury or damage."

The risk assessment process identifies and profiles relevant hazards and assesses the exposure of lives, property, and infrastructure to these hazards. The process allows for a better understanding of a jurisdiction's potential risk to hazards and provides a framework for developing and prioritizing mitigation actions to reduce risk from future hazard events.

This risk assessment followed the methodology described in the FEMA publication Understanding Your Risks—Identifying Hazards and Estimating Losses (FEMA 386-2, 2002), which breaks the assessment into a four-step process:

1. Identify hazards
2. Profile hazard events
3. Inventory assets
4. Estimate losses

Data collected through this process has been incorporated into the following sections of this chapter:

- **Section 4.1 Hazard Identification**: Natural Hazards identifies the natural hazards that threaten the City and describes why some hazards have been omitted from further consideration.
- **Section 4.2 Hazard Profiles** discusses the threat to the City and describes previous occurrences of hazard events and the likelihood of future occurrences.
- **Section 4.3 Vulnerability Assessment** assesses the City's total exposure to natural hazards, considering assets at risk, critical facilities, and future development trends.
- **Section 4.4 Capability Assessment** inventories existing mitigation activities and policies, regulations, and plans that pertain to mitigation in the City and can affect net vulnerability.

This risk assessment covers the entire geographical extent of the City of San Rafael.

4.1 Hazard Identification: Natural Hazards

Requirement §201.6(c)(2)(i): [The risk assessment shall include a] description of the type…of all natural hazards that can affect the jurisdiction.

The HMPC conducted a hazard identification study to determine the hazards that threaten the City. This section details the methodology and results of this effort.

Data Sources

The following data sources were used for this Hazard Identification: Natural Hazards portion of the plan:

- HMPC input
- 2013 State of California Hazard Mitigation Plan
- FEMA Disaster Declaration Database

4.1.1. Methodology and Results

Using existing natural hazards data and input gained through the kickoff planning meeting, the HMPC agreed upon a list of natural hazards that could affect San Rafael. Hazards data from the California Office of Emergency Services (Cal OES), FEMA, the National Oceanic and Atmospheric Administration (NOAA), and many other sources were examined to assess the significance of these hazards to the City. Significance of each identified hazard was measured in general terms and focused on key criteria such as frequency and resulting damage, which includes deaths and injuries, as well as property and economic damage. The natural hazards evaluated as part of this plan include those that have occurred historically or have the potential to cause significant human and/or monetary losses in the future.

As a starting point, the updated 2013 California State Hazard Mitigation Plan was consulted to evaluate the applicability of State hazards of concern to the City. Building upon this effort, hazards from the Marin County LHMP and an older draftCity LHMP were also identified and considered.

The worksheet below was completed by the HMPC to identify, profile, and rate the significance of identified hazards. Only the more significant (or priority) hazards have a more detailed hazard profile and are analyzed further in Section 4.3 Vulnerability Assessment. Table 4-1 in Section 4.2.16 Natural Hazards Summary provides an overview of these significant hazards.

Table 4-1 City of San Rafael Hazard Identification

Hazard	Geographic Extent	Likelihood of Future Occurrences	Magnitude/ Severity	Significance	Climate Change Impacts
Climate Change	Extensive	Highly Likely	Limited	Medium	N/A
Coastal Flooding and sea level rise	Significant	Likely	Critical	Medium	High
Dam Failure	Limited	Unlikely	Negligible	Low	Medium
Drought and Water Shortage	Extensive	Likely	Critical	Medium	High
Earthquake	Extensive	Occasional/Likely	Catastrophic	High	Low
Earthquake: Liquefaction	Limited	Occasional/Likely	Catastrophic	High	Low
Flood: (100/500 year)	Significant	Occasional/Unlikely	Critical	High	High
Flood: Localized/Stormwater	Extensive	Highly Likely	Limited	Medium	High
Landslide, Mudslides, Hillside Erosion, and Debris Flows	Significant	Likely	Limited	Medium	Medium
Levee Failure	Significant	Occasional	Limited	Medium	High
Severe Weather: Extreme Heat	Extensive	Highly Likely	Critical	Medium	High
Severe Weather: Heavy Rains and Storms	Extensive	Highly Likely	Critical	Medium	Medium
Tsunami	Limited	Unlikely	Limited	Medium	High
Wildfire	Significant	Likely	Catastrophic	High	Medium

Geographic Extent
Limited: Less than 10% of City
Significant: 10-50% of City
Extensive: 50-100% of City

Probability of Future Occurrences
Highly Likely: Near 100% chance of occurrence in next year, or happens every year.
Likely: Between 10 and 100% chance of occurrence in next year, or has a recurrence interval of 10 years or less.
Occasional: Between 1 and 10% chance of occurrence in the next year, or has a recurrence interval of 11 to 100 years.
Unlikely: Less than 1% chance of occurrence in next 100 years, or has a recurrence interval of greater than every 100 years.

Magnitude/Severity
Catastrophic—More than 50 percent of property severely damaged; shutdown of facilities for more than 30 days; and/or multiple deaths
Critical—25-50 percent of property severely damaged; shutdown of facilities for at least two weeks; and/or injuries and/or illnesses result in permanent disability
Limited—10-25 percent of property severely damaged, shutdown of facilities for more than a week; and/or injuries/illnesses treatable do not result in permanent disability
Negligible—Less than 10 percent of property severely damaged, shutdown of facilities and services for less than 24 hours; and/or injuries/illnesses treatable with first aid

Significance
Low: minimal potential impact
Medium: moderate potential impact
High: widespread potential impact

Climate Change Impact:
Low: Climate change is not likely to increase the probability of this hazard.
Medium: Climate change is likely to increase the probability of this hazard.
High: Climate change is very likely to increase the probability of this hazard.

4.1.2. Disaster Declaration History

One method to identify hazards based upon past occurrences is to look at what events triggered federal and/or state disaster declarations within the City (though disaster declarations are declared on a county basis). Disaster declarations are granted when the severity and magnitude of the event's impact surpass the ability of the local government to respond and recover. Disaster assistance is supplemental and sequential. When the local government's capacity has been surpassed, a state disaster declaration may be issued, following the local agency's declaration, allowing for the provision of state assistance. Should the disaster be so severe that both the local and state government's capacity is exceeded, a federal disaster declaration may be issued allowing for the provision of federal disaster assistance.

The federal government may issue a disaster declaration through FEMA, the U.S. Department of Agriculture (USDA), and/or the Small Business Administration (SBA). FEMA also issues emergency declarations, which are more limited in scope and without the long-term federal recovery programs of major disaster declarations. The quantity and types of damage are the determining factors. This section focuses on state and federal disaster and emergency declarations.

Marin County has experience 17 federal and 27 state declarations since 1950. 6 of the federal declarations were associated with flood events, 6 with severe storm, 1 with coastal storm, 1 with drought, 1 with earthquake, 1 with freezing, and 1 with hurricane (for evacuations stemming from Hurricane Katrina in 2005). 17 of the state declarations were associated with flood events, 2 were related to drought, 2 were economic, 2 were related to fire, 1 was related to earthquake, 1 was related to freeze, 1 was related to an oil spill, and 1 was related to tsunami. A summation of federal and state disaster declarations is shown in Table 4-2.

Table 4-2 Marin County Disaster Declaration History 1950 to 2016

Year	Disaster Name	Disaster Type	Disaster Cause	Disaster #	State Declaration #	Federal Declaration #
2014	California Drought	Drought	Drought	GP 2014-13	1/17/2014	–
2007	Bay Area Oil Spill	Other	Accident	GP 2007-15	11/9/2007	–
2006	2006 June Storms	Flood	Storms	DR 1646	–	6/5/2006
2005/2006	2005/06 Winter Storms	Flood	Storms	DR-1628	–	2/3/2006
2005	Hurricane Katrina Evacuations	Economic	Hurricane	EM-3248 2005	–	9/13/2005
2003	State Road Damage	Road Damage	Flood	GP 2003	1/1/2003	–
2001	Energy Emergency	Economic	Greed	GP 2001	1/1/2001	–
1998	1998 El Nino Floods	Flood	Storms	DR-1203	Proclaimed	2/19/1998
1997	1997 January Floods	Flood	Storms	DR-1155	1/2/97-1/31/97	1/4/1997

Year	Disaster Name	Disaster Type	Disaster Cause	Disaster #	State Declaration #	Federal Declaration #
1995	Vision Fire	Fire	Fire	DC 95-05	10/95	–
1995	1995 Severe Winter Storms	Flood	Storms	DR-1044	1/6/95-3/14/95	1/13/1995
1990	1990 Freeze	Freeze	Freeze	DR-894	12/19/90-1/18/91	2/11/1991
1989	Loma Prieta Earthquake	Earthquake	Earthquake	DR-845	10/18/89-10/30/89	10/18/1989
1986	1986 Storms	Flood	Storms	DR-758	2/18-86-3/12/86	2/18/1986
1983	Winter Storms	Flood	Flood	DR-677	12/8/82-3/21/83	2/9/1983
1982	1982 Winter Storms	Flood	Storms	DR-651	1/5/82-1/9/82	1/7/1982
1980	April Storms	Flood	Storms	–	4/1/1980	–
1979	Gasoline Shortage	Economic	OPEC	–	5/8/1979-11/13/79	–
1978	Heavy Rains (Marin)	Flood	Storms	DC 78-02	1/1/1978	–
1977	Drought	Drought	Drought	DR-3023	–	1/20/1977
1976	1976 Drought	Drought	Drought	–	2/9/76-7/6/76	–
1973	Coastal Flooding	Flood	Storms	DR 364	1/23/73-2/28/73	2/3/1973
1970	1970 Northern California Flooding	Flood	Flood	DR 283	1/27/1970 - 3/2/1970	2/16/1970
1969	1969 Storms	Flood	Storms	DR-253	1/23/69-3/12/69	1/26/1969
1965	1965 Fires	Fire	Fire	–	9/18/1965	–
1964	1964 Late Winter Storms	Flood	Storms	DR-183	-	12/24/1964
1964	1964 Tsunami	Tsunami	Earthquake	–	9/15/1964	–
1963	1963 Floods	Flood	Storms	-	2/14/1964	–
1958	1958 April Storms and Floods	Flood	Storms	DR-52	4/5/1958	4/4/1958
1958	1958 February Storms and Floods	Flood	Storms	CDO 58-03	2/26/1958	–
1955	1955 Floods	Flood	Flood	DR-47	12/22/1955	12/23/1955
1950	1950 Floods	Flood	Flood	OCD 50-01	11/21/1950	–

Source: Cal OES, FEMA

4.2 Hazard Profiles

Requirement §201.6(c)(2)(i): [The risk assessment shall include a] description of the…location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.

The hazards identified in Section 4.1 Hazard Identification Natural Hazards, are profiled individually in this section. In general, information provided by planning team members is integrated into this section with information from other data sources. These profiles set the stage for Section 4.3 Vulnerability Assessment, where the vulnerability is quantified, as data allows, for each of the priority hazards.

Each hazard is profiled in the following format:

- **Hazard/Problem Description**—This section gives a description of the hazard and associated issues followed by details on the hazard specific to the City. Where known, this includes information on the hazard extent, seasonal patterns, speed of onset/duration, and magnitude and/or any secondary effects.
- **Past Occurrences**—This section contains information on historical incidents, including impacts where known. The extent or location of the hazard within or near the City is also included here. Historical incident worksheets were used to capture information from the City on past occurrences.
- **Likelihood of Future Occurrence**—The frequency of past events is used in this section to gauge the likelihood of future occurrences. Where possible, frequency was calculated based on existing data. It was determined by dividing the number of events observed by the number of years on record and multiplying by 100. This gives the percent chance of the event happening in any given year (e.g., three droughts over a 30-year period equates to a 10 percent chance of a experiencing a drought in any given year). The likelihood of future occurrences is categorized into one of the following classifications:
  - ✓ **Highly** Likely—Near 100 percent chance of occurrence in next year or happens every year
  - ✓ **Likely**—Between 10 and 100 percent chance of occurrence in next year or has a recurrence interval of 10 years or less
  - ✓ **Occasional**—Between 1 and 10 percent chance of occurrence in the next year or has a recurrence interval of 11 to 100 years
  - ✓ **Unlikely**—Less than 1 percent chance of occurrence in next 100 years or has a recurrence interval of greater than every 100 years.
- **Climate Change**—This section contains the effects of climate change (if applicable). The possible ramifications of climate change on the hazard are discussed.

Section 4.2.16 Natural Hazards Summary provides an initial assessment of the profiles and assigns a level of significance or priority to each hazard. Those hazards determined to be of medium or high significance were characterized as priority hazards that required further evaluation in Section 4.3 Vulnerability Assessment. Those hazards that occur infrequently or have little or no impact on the City were determined to be of low significance and not considered a priority hazard. Significance was determined based on the hazard profile, focusing on key criteria such as frequency and resulting damage, including deaths/injuries and property, crop, and economic damage. This assessment was used by the HMPC to prioritize those hazards of greatest significance to the City, enabling San Rafael to focus resources where they are most needed.

The following sections provide profiles of the natural hazards that the HMPC identified in Section 4.1 Hazard Identification. Given that most disasters that affect the City are directly or indirectly related to severe weather events, severe weather hazards begin this section, and the individual hazard profiles follow alphabetically.

Data Sources

The following data sources formed the basis for this Hazard Profiles portion of the plan:

- 2013 State of California Multi-Hazard Mitigation Plan
- CAL FIRE Wildfire History Database
- California Climate Adaptation Strategy
- California Department of Water Resources Division of Safety of Dams
- California Department of Water Resources Best Available Maps
- California's Drought of 2007-2009, An Overview. State of California Natural Resources Agency, California Department of Water Resources.
- California Division of Mines and Geology
- California Natural Resources Report
- City of San Rafael 2020 General Plan.
- City of San Rafael 2020 General Plan Background Report
- City of San Rafael Climate Change Action Plan
- City of San Rafael Community Emergency Preparedness Plan
- City of San Rafael Greenhouse Gas Reduction Strategy Report
- Climate Adaptation – Sea Level Rise, San Rafael CA
- Climate Change Impacts in the United States
- Enhanced Fujita Scale. National Oceanic and Atmospheric Administration Storm Prediction Center.
- Federal Emergency Management Agency: Building Performance Assessment: Oklahoma and Kansas Tornadoes
- Federal Emergency Management Agency: Multi-Hazard Identification and Risk Assessment.
- Federal Emergency Management Agency – Wind Zones in the United States
- Johnstone, J. and Dawson, T. Climatic context and ecological implications of summer fog decline in the coast redwood region. Proceedings of the National Academy of Sciences, January 7, 2010.
- Galloway, Jr Dr. Gerald E. Levees in History: The Levee Challenge. Water Policy Collaborative, University of Maryland, Visiting Scholar, USACE, IWR.
- Lighthouse Marina EIR/EIS.
- Marin Bay Shoreline Sea Level Rise Vulnerability Assessment
- Marin Countywide Plan
- Marin County Local Hazard Mitigation Plan
- Marin County Community Wildfire Protection Plan
- Marin County Flood Insurance Study
- National Aeronautics and Space Administration
- National Climatic Data Center Storm Events Database.
- National Drought Mitigation Center
- National Flood Insurance Program
- National Integrated Drought Information System
- National Oceanic and Atmospheric Administration's National Climatic Data Center

- National Oceanic and Atmospheric Administration Storm Prediction Center
- National Performance of Dams Program
- National Weather Service Heat Index
- National Weather Service Wind Chill Index
- Post Authorization Change Report for the Sacramento River Bank Protection Project Draft EIS
- Public Policy Institute of California. If drought continues: Environment and poor rural communities most likely to suffer. [press release].
- State of California Department of Conservation Farmland Mapping and Monitoring Program
- Underwood, E. Models predict longer, deeper US droughts. Science, 347(6223) 707 DOI: 10.1126/science.347.6223.707. 2015.
- University of California Santa Barbara Department of Geology
- United State Geologic Survey. Earthquake Intensity Zonation and Quaternary Deposits, Miscellaneous Field Studies Map 9093, 1977.
- USA TODAY
- US Army Corps of Engineers
- US Bureau of Reclamation
- US Drought Monitor
- USDA Secretarial Disasters Declarations
- Western Regional Climate Center

4.2.1. Severe Weather: General

Severe weather is generally any destructive weather event, but usually occurs in the City as localized storms that bring heavy rain, strong winds, and sometimes hail and lightning.

The National Oceanic and Atmospheric Administration's National Climatic Data Center (NCDC) has been tracking severe weather since 1950. Their Storm Events Database contains data on the following: all weather events from 1993 to current (except from 6/1993-7/1993); and additional data from the Storm Prediction Center, which includes tornadoes (1950-1992), thunderstorm winds (1955-1992), and hail (1955-1992). This database contains 236 severe weather events that occurred in Marin County between January 1, 1950, and June 30, 2016. Table 4-3 summarizes these events.

*Table 4-3 NCDC Weather Events for Marin County, 1950 to June 30, 2016**

Event Type	Number of Events	Deaths	Deaths (indirect	Injuries	Injuries (indirect)	Property Damage	Crop Damage
Coastal Flood	9	0	0	0	0	$340,000	$0
Debris Flows	6	1	0	0	0	$27,905,500	$20,000,000
Dense Fog	1	0	0	0	2	$100,000	$0
Extreme Cold/Wind Chill	1	0	1	0	0	$0	$0
Flash Flood	16	0	0	0	0	$5,556,000	$500,000
Flood	22	0	0	0	0	$216,183,100	$0
Frost/Freeze	3	0	0	0	0	$60,000	$3,000,000
Hail	1	0	0	0	0	$0	$0

Event Type	Number of Events	Deaths	Deaths (indirect	Injuries	Injuries (indirect)	Property Damage	Crop Damage
Heat	5	1	0	0	0	$0	$0
Heavy Rain	7	1	0	0	0	$264,000	$0
Heavy Snow	1	0	0	0	0	$0	$0
High Surf	6	8	0	0	0	$75,000	$0
High Wind	44	2	0	0	0	$713,500	$0
Landslide	6	0	0	0	0	$1,132,000	$0
Lightning	1	0	0	0	0	$30,000	$0
Rip Current	1	0	0	0	0	$0	$0
Sneakerwave	4	5	0	1	0	$0	$0
Storm Surge/Tide	3	0	0	0	0	$10,000	$0
Strong Wind	93	2	1	1	0	$3,131,200	$0
Thunderstorm Winds	1	0	0	0	0	$0	$0
Tornado	1	0	0	0	0	$200,000	$5,000
Wildfire	3	0	0	0	0	$505,000	$5,000
Winter Weather	1	2	0	15	0	$0	$0
Total	**236**	**22**	**2**	**17**	**2**	**$256,205,300**	**$23,510,000**

Source: NCDC

*Note: Losses reflect totals for all impacted areas, not just Marin County or San Rafael

The NCDC table above summarizes severe weather events that occurred in Marin County, many of which likely similarly affected San Rafael. Only a few of the events actually resulted in state and federal disaster declarations.

As previously mentioned, most all of Marin County's state and federal disaster declarations have been a result of severe weather and related flooding. For this plan, severe weather is discussed in the following subsections:

- Extreme Heat
- Heavy Rains and Storms

While the HMPC decided not to include cold and freeze as a hazard, cold weather does happen periodically, with little effect to the City. Record colds are shown in Table 4-4.

Table 4-4 San Rafael – Record Cold Temperatures by Month from 1894 to 2016

Month	Temperature	Date	Month	Temperature	Date
January	23°	1/2/1895	July	34°	7/2/1975
February	26°	2/25/1904	August	41°	8/6/1996
March	24°	3/13/1977	September	32°	9/30/1894
April	27°	4/21/1894	October	28°	10/28/1894

Month	Temperature	Date	Month	Temperature	Date
May	31°	5/4/1965	November	25°	11/18/1894
June	28°	6/11/1894	December	20°	12/20/1990

Source: Western Regional Climate Center – San Rafael Civic Center Coop Station

4.2.2. Severe Weather: Extreme Heat Hazard Profile

Hazard/Problem Description

According to information provided by FEMA, extreme heat is defined as temperatures that hover 10 degrees or more above the average high temperature for the region and last for several weeks. Heat kills by taxing the human body beyond its abilities. In a normal year, about 175 Americans succumb to the demands of summer heat. According to the NWS, among natural hazards, only the cold of winter—not lightning, hurricanes, tornados, floods, or earthquakes—takes a greater toll. In the 40-year period from 1936 through 1975, nearly 20,000 people were killed in the United States by the effects of heat. In the heat wave of 1980, more than 1,250 people died.

Heat disorders generally have to do with a reduction or collapse of the body's ability to shed heat by circulatory changes and sweating or a chemical (salt) imbalance caused by too much sweating. When heat gain exceeds the level the body can remove, or when the body cannot compensate for fluids and salt lost through perspiration, the temperature of the body's inner core begins to rise and heat-related illness may develop. Elderly persons, small children, chronic invalids, those on certain medications or drugs, and persons with weight and alcohol problems are particularly susceptible to heat reactions, especially during heat waves in areas where moderate climate usually prevails.

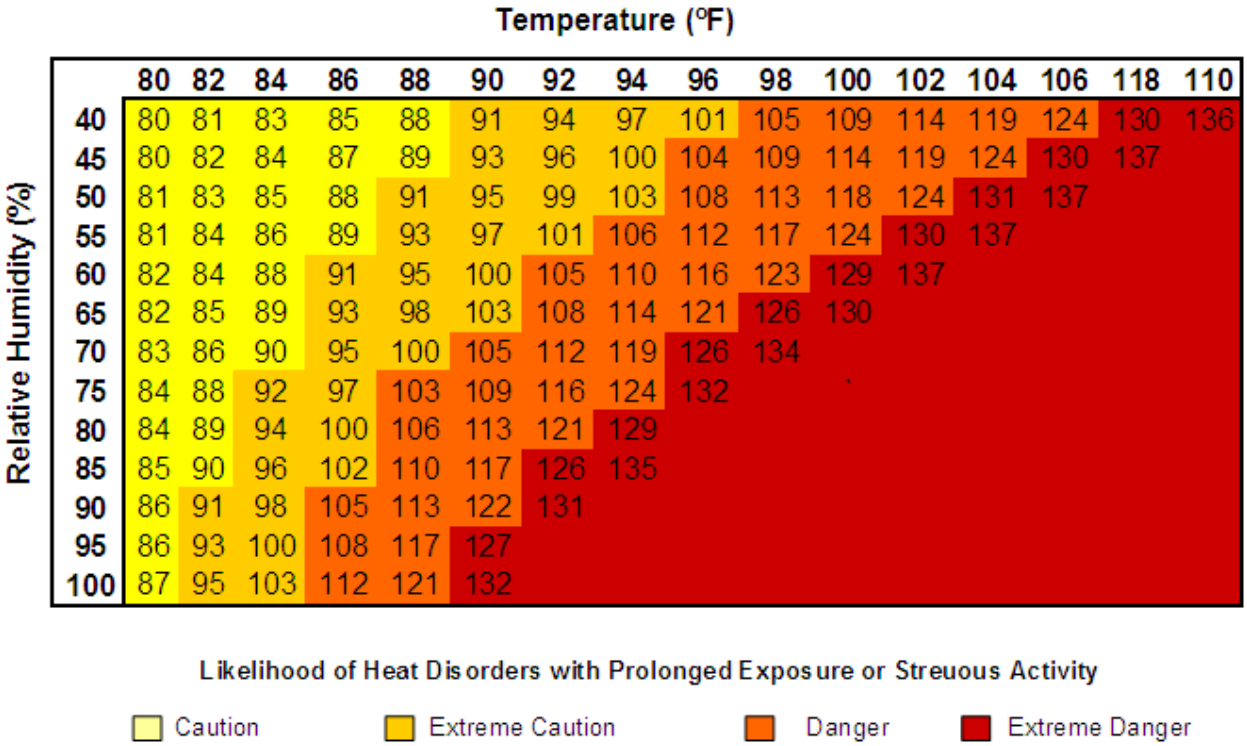
Heat emergencies are often slower to develop, taking several days of continuous, oppressive heat before a significant or quantifiable impact is seen. Heat waves do not strike victims immediately, but rather their cumulative effects slowly take the lives of vulnerable populations. Heat waves do not cause damage or elicit the immediate response of floods, fires, earthquakes, or other more "typical" disaster scenarios. While heat waves are obviously less dramatic, they are potentially more deadly. According to the 2010 California State Hazard Mitigation Plan, the worst single heat wave event in California occurred in Southern California in 1955, when an eight-day heat wave resulted in 946 deaths. Severe heat in California often causes rolling blackouts. These blackouts have occurred in the past (namely 2001 and 2002) and can increase the risk of injury or death.

Figure 4-1 and Figure 4-2 show the Heat Index (HI) as a function of heat and relative humidity. The Heat Index describes how hot the heat-humidity combination makes it feel. As relative humidity increases, the air seems warmer than it actually is because the body is less able to cool itself via evaporation of perspiration. As the HI rises, so do health risks.

- When the HI is 90°F, heat exhaustion is possible with prolonged exposure and/or physical activity.
- When it is 90°-105°F, heat exhaustion is probable with the possibility of sunstroke or heat cramps with prolonged exposure and/or physical activity.
- When it is 105°-129°F, sunstroke, heat cramps or heat exhaustion is likely, and heatstroke is possible with prolonged exposure and/or physical activity.

- When it is 130°F and higher, heatstroke and sunstroke are extremely likely with continued exposure. Physical activity and prolonged exposure to the heat increase the risks.

Figure 4-1 Heat Index



Source: National Weather Service

Note: Since HI values were devised for shady, light wind conditions, exposure to full sunshine can increase HI values by up to 15°F. Also, strong winds, particularly with very hot, dry air, can be extremely hazardous.

Figure 4-2 Possible Heat Disorders by Heat Index Level

Heat Index	Category	Possible heat disorders for people in high risk groups
130°F or higher	Extreme Danger	Heatstroke risk extremely high with continued exposure.
105° - 129°F	Danger	Sunstroke, Heat Cramps and Heat Exhaustion likely, Heatstroke possible with prolonged exposure and/or physical activity.
90° - 105°F	*Extreme Caution*	*Sunstroke, Heat Cramps and Heat Exhaustion possible with prolonged exposure and/or physical activity.*
80° - 90 °F	Caution	Fatigue possible with prolonged exposure and/or physical activity.

Source: National Weather Service

The NWS has in place a system to initiate alert procedures (advisories or warnings) when the Heat Index is expected to have a significant impact on public safety. The expected severity of the heat determines whether advisories or warnings are issued. A common guideline for the issuance of excessive heat alerts is when the maximum daytime high is expected to equal or exceed 105°F and a nighttime minimum high

of 80°F or above is expected for two or more consecutive days. The NWS office in Monterey can issue the following heat-related advisory as conditions warrant.

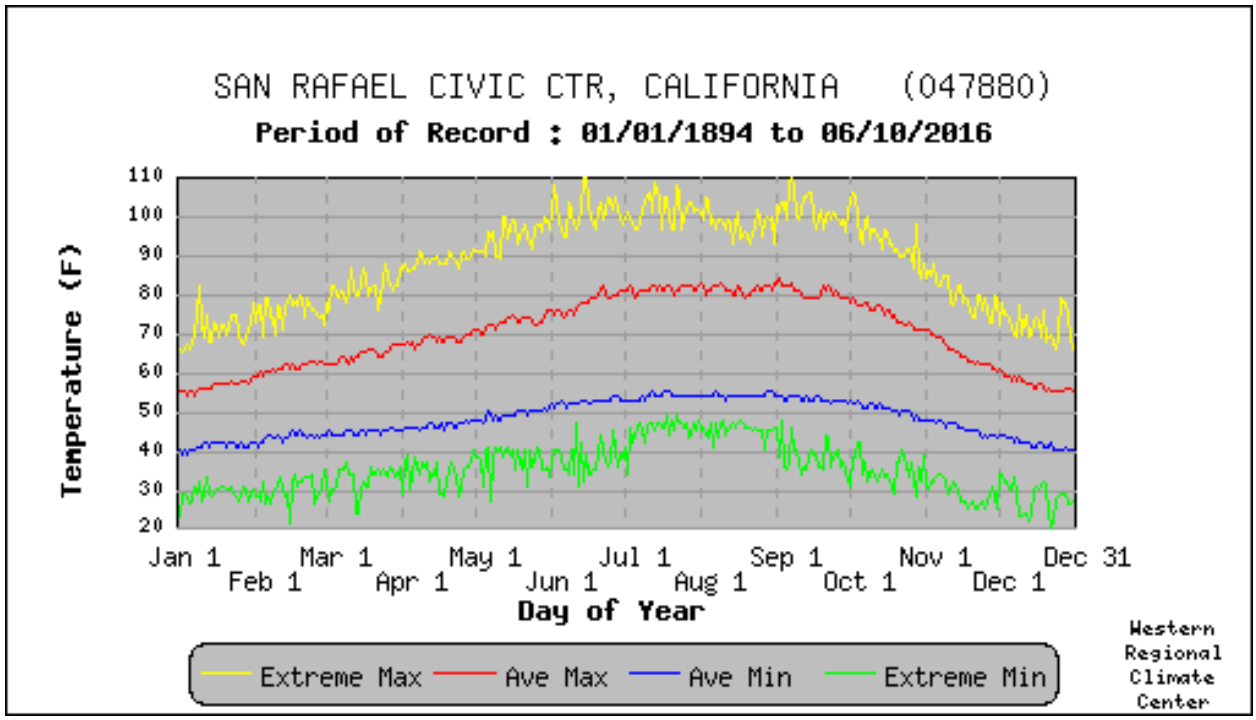
- **Excessive Heat Outlook**: are issued when the potential exists for an excessive heat event in the next 3-7 days. An Outlook provides information to Heat Index forecast map for the contiguous United States those who need considerable lead time to prepare for the event, such as public utilities, emergency management and public health officials.
- **Excessive Heat Watch**: is issued when conditions are favorable for an excessive heat event in the next 12 to 48 hours. A Watch is used when the risk of a heat wave has increased, but its occurrence and timing is still uncertain. A Watch provides enough lead time so those who need to prepare can do so, such as cities that have excessive heat event mitigation plans.
- **Excessive Heat Warning/Advisory**: are issued when an excessive heat event is expected in the next 36 hours. These products are issued when an excessive heat event is occurring, is imminent, or has a very high probability of occurring. The warning is used for conditions posing a threat to life or property. An advisory is for less serious conditions that cause significant discomfort or inconvenience and, if caution is not taken, could lead to a threat to life and/or property.

There is a COOP weather stations in the City. Information from the San Rafael Civic Center weather station is summarized below.

San Rafael Civic Center Weather Station, Period of Record 1894 to 2016

In the City, the Western Regional Climate Center shows that monthly average high temperatures in the warmest months (July through September) range from the mid 70s to low 80s. The highest recorded daily extreme was 110°F on September 7 of 1904 and again on June 14, 1961. In a typical year, maximum temperatures exceed 90°F on 20.2 days. Average and high temperatures for the County are shown in Figure 4-3. Details of monthly high temperatures are shown in Table 4-5.

Figure 4-3 Daily Average Temperatures and Extremes – City of San Rafael Civic Center Station



Source: Western Regional Climate Center

Table 4-5 Record High Temperatures – San Rafael Civic Center Station

Month	Temperature	Date	Month	Temperature	Date
January	82°	1/9/1962	July	109°	7/13/1972
February	80°	2/19/1964	August	105°	8/3/1998
March	88°	3/25/1952	September	110°	9/7/1904
April	92°	4/30/1996	October	106°	10/2/1980
May	100°	5/29/1950	November	88°	11/4/1980
June	110°	6/14/1961	December	79°	12/26/1967

Source: Western Regional Climate Center

Past Occurrences

Disaster Declaration History

There have been no federal or state disaster declarations due to extreme heat.

NCDC Events

The NCDC database reported 5 extreme heat events for the County since 1993. These 5 events occurred on 2 dates. These are shown on Table 4-6. It should be noted that heat events in California often are unreported to the NCDC database.

Table 4-6 NCDC Extreme Heat Events in Marin County 1993 to 6/30/2016

Date	Event Type	Deaths Direct	Injuries Direct	Property Damage	Crop Damage	Injuries Indirect	Deaths (Indirect
7/21/2006	Heat	1	0	$0	$0	0	0
7/21/2006	Heat	0	0	$0	$0	0	0
5/17/2009	Heat	0	0	$0	$0	0	0
5/17/2009	Heat	0	0	$0	$0	0	0
5/17/2009	Heat	0	0	$0	$0	0	0
Totals		**1**	**0**	**$0**	**$0**	**0**	**0**

Source: NCDC

City Planning Team Events

CAN THE CITY IDENTIFY ANY PAST HEAT EVENTS AND THEIR IMPACTS?

WHAT ARE THE CITY'S PRIMARY IMPACTS/CONCERNS WITH EXTREME HEAT EVENTS?

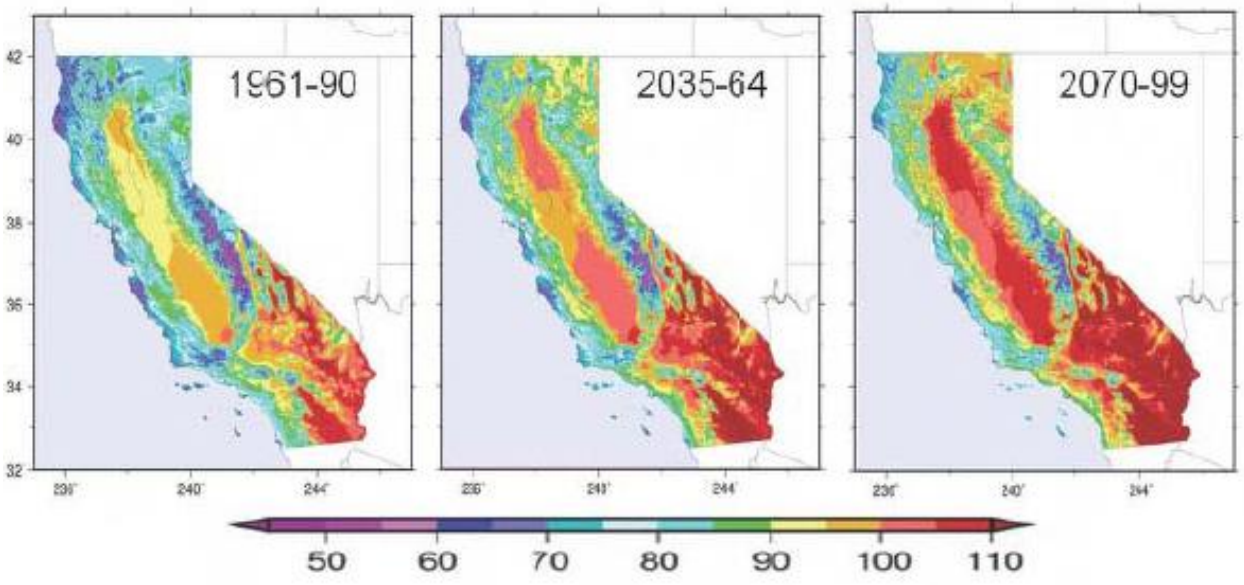
Likelihood of Future Occurrence

Highly Likely—Although only one past event was recorded in national databases, data from the Western Regional Climate Center (shown in Table 4-5) indicates that high temperatures will continue to occur in the City on an annual basis; thus the likelihood of future occurrence is highly likely.

Climate Change and Extreme Heat

The CAS, citing a California Energy Commission study, states that "over the past 15 years, heat waves have claimed more lives in California than all other declared disaster events combined." This study shows that California is getting warmer, leading to an increased frequency, magnitude, and duration of heat waves. These factors may lead to increased mortality from excessive heat, as shown in Figure 4-4.

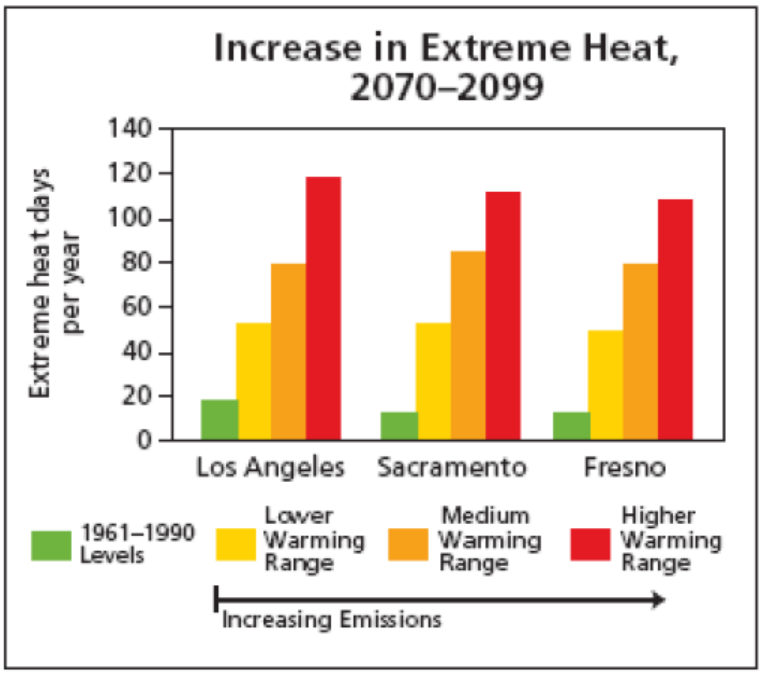
Figure 4-4 California Historical and Projected Temperature Increases - 1961 to 2099



Source: Dan Cayan; California Climate Adaptation Strategy

As temperatures increase, California, Marin County, and the City of San Rafael will face increased risk of death from dehydration, heat stroke, heat exhaustion, heart attack, stroke and respiratory distress caused by extreme heat. Per the CAS report and the 2013 State of California Hazard Mitigation Plan, by 2100, hotter temperatures are expected throughout the state, with projected increases of 3-5.5°F (under a lower emissions scenario) to 8-10.5°F (under a higher emissions scenario). If temperatures rise to the higher warming range, there could be 100 more days per year with temperatures above 95°F in the City (see Figure 4-5). These changes could lead to an increase in deaths related to extreme heat in San Rafael.

Figure 4-5 Increase in Heat in Major California Cities from 2070 to 2099

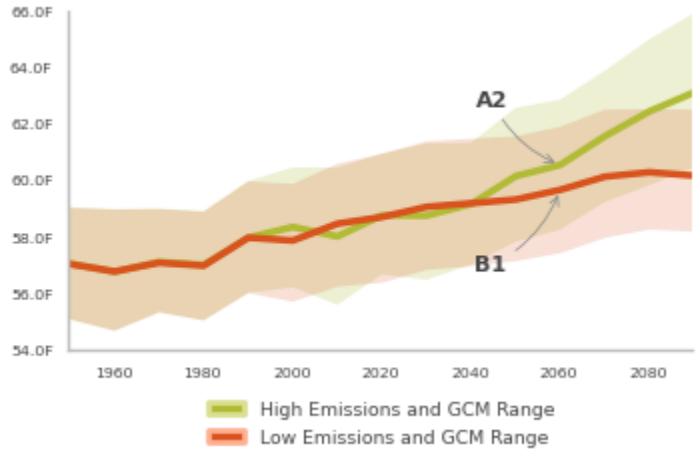


Source: 2010 California State Hazard Mitigation Plan

Cal Adapt noted that overall temperatures are expected to rise substantially throughout this century. During the next few decades, scenarios project average temperature to rise between 1 and 2.3°F; however, the projected temperature increases begin to diverge at mid-century so that, by the end of the century, the temperature increases projected in the higher emissions scenario (A2) are approximately twice as high as those projected in the lower emissions scenario (B1).

These projections also differ depending on the time of year and the type of measurement (high's vs. lows), all of which have different potential effects to the state's ecosystem health, agricultural production, water use and availability, and energy demand. Future temperature estimates from Cal-Adapt are shown in Figure 4-6.

Figure 4-6 San Rafael – Future Temperature Estimates in High and Low Emission Scenarios



Source: Cal-Adapt – Temperature: Decadal Averages Map

4.2.3. Severe Weather: Heavy Rains and Storms Hazard Profile

Hazard/Problem Description

According to the NWS Office in Monterey, storms in Marin County and the City of San Rafael and are generally characterized by heavy rain often accompanied by strong winds and sometimes lightning and hail. Approximately 10 percent of the thunderstorms that occur each year in the United States are classified as severe. A thunderstorm is classified as severe when it contains one or more of the following phenomena: hail that is three-quarters of an inch or greater, winds in excess of 50 knots (57.5 mph), or a tornado. Heavy precipitation in the City area falls mainly in the fall, winter, and spring months.

Heavy Rain and Thunderstorms

Thunderstorms result from the rapid upward movement of warm, moist air. They can occur inside warm, moist air masses and at fronts. As the warm, moist air moves upward, its cools, condenses, and forms cumulonimbus clouds that can reach heights of greater than 35,000 ft. As the rising air reaches its dew point, water droplets and ice form and begin falling the long distance through the clouds towards earth's surface. As the droplets fall, they collide with other droplets and become larger. The falling droplets create a downdraft of air that spreads out at Earth's surface and causes strong winds associated with thunderstorms.

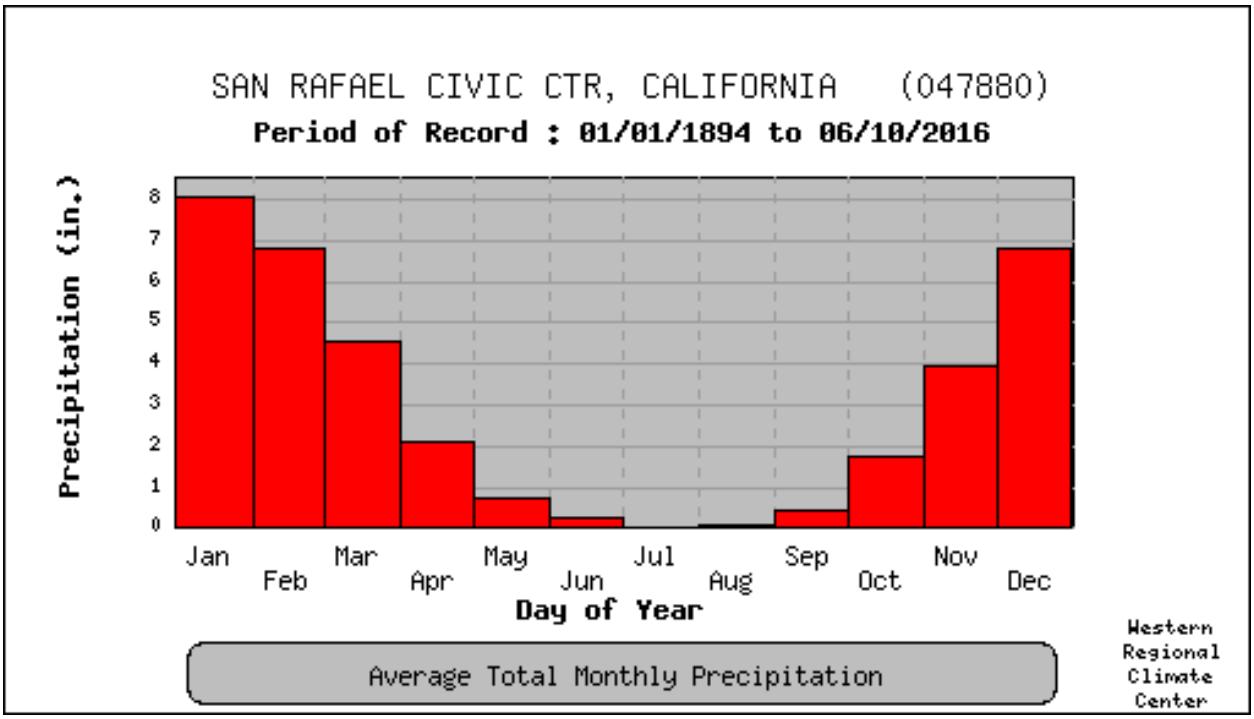
Information from the San Rafael Civic Center Station regarding rainfall and precipitation is summarized below.

San Rafael Civic Center Weather Station, Period of Record 1894 to 2016

Average annual precipitation at the San Rafael Civic Center Station is 35.59 inches per year. The highest recorded annual precipitation is 60.46 inches in 1973; the highest for a 24-hour period is 8.74 inches on December 11, 1995. The lowest recorded annual precipitation was 13.4 inches in 1990. Average monthly

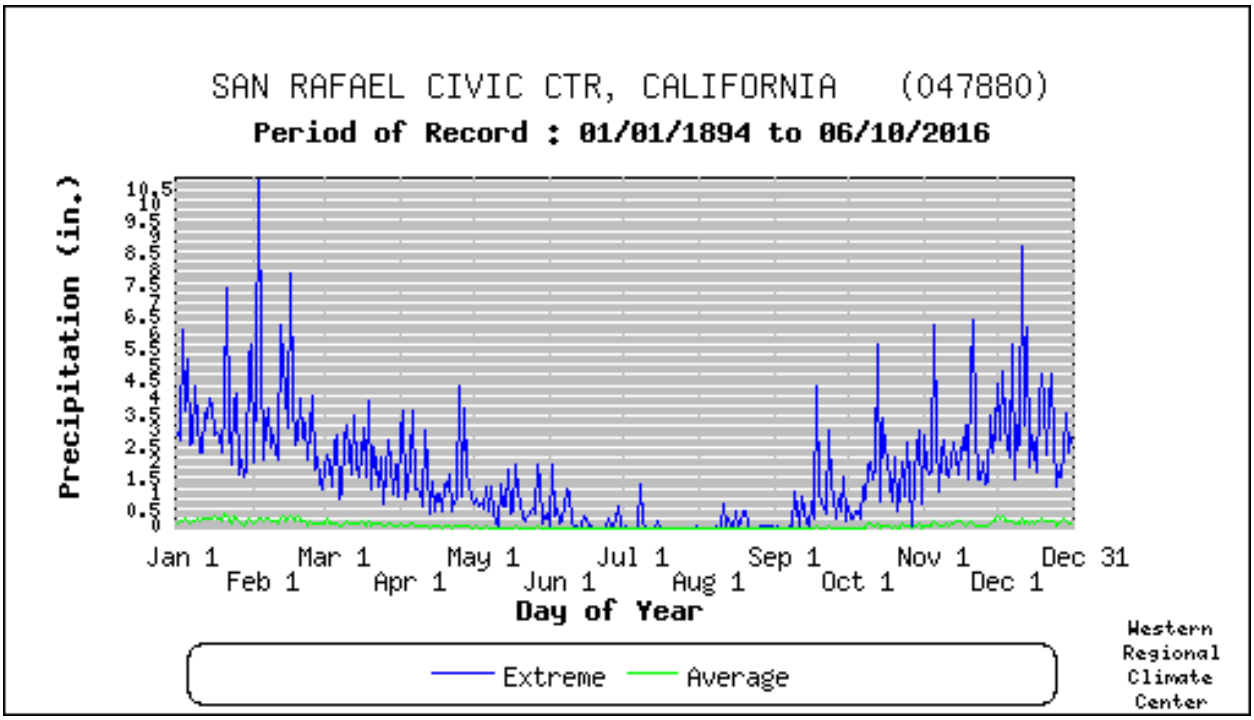
precipitation totals for this station are shown in Figure 4-7. Precipitation extremes for this station are shown in Figure 4-8.

Figure 4-7 Monthly Average Total Precipitation – San Rafael Civic Center Station



Source: Western Regional Climate Center

Figure 4-8 Daily Precipitation Average and Extremes – San Rafael Civic Center Station



Source: Western Regional Climate Center

Hail

According to the NWS, hail is formed when water droplets freeze and thaw as they are thrown high into the upper atmosphere by the violent internal forces of thunderstorms. Hail is sometimes associated with severe storms within the City. Hailstones are usually less than two inches in diameter and can fall at speeds of 120 miles per hour (mph). Severe hailstorms can be quite destructive, causing damage to roofs, buildings, automobiles, vegetation, and crops. The National Weather Service classifies hail by diameter size, and corresponding everyday objects to help relay scope and severity to the population. Table 4-7 indicates the hailstone measurements utilized by the National Weather Service.

Table 4-7 Hailstone Measurements

Average Diameter	Household Object	Average Diameter	Household Object
.25 inch	Pea	2.0 inch	Hen Egg
.5 inch	Marble/Mothball	2.5 inch	Tennis Ball
.75 inch	Dime/Penny	2.75 inch	Baseball
.875 inch	Nickel	3.00 inch	Teacup
1.0 inch	Quarter	4.00 inch	Grapefruit
1.5 inch	Ping-pong ball	4.5 inch	Softball
1.75 inch	Golf-Ball		

Source: National Weather Service

Lightning

Lightning is defined by the NWS as any and all of the various forms of visible electrical discharge caused by thunderstorms. Thunderstorms and lightning are usually (but not always) accompanied by rain. Cloud-to-ground lightning can kill or injure people by direct or indirect means. Objects can be struck directly, which may result in an explosion, burn, or total destruction. Or, damage may be indirect, when the current passes through or near an object, which generally results in less damage.

Intra-cloud lightning is the most common type of discharge. This occurs between oppositely charged centers within the same cloud. Usually it takes place inside the cloud and looks from the outside of the cloud like a diffuse brightening that flickers. However, the flash may exit the boundary of the cloud, and a bright channel, similar to a cloud-to-ground flash, can be visible for many miles.

Cloud-to-ground lightning is the most damaging and dangerous type of lightning, though it is also less common. Most flashes originate near the lower-negative charge center and deliver negative charge to earth. However, a large minority of flashes carry positive charge to earth. These positive flashes often occur during the dissipating stage of a thunderstorm's life. Positive flashes are also more common as a percentage of total ground strikes during the winter months. This type of lightning is particularly dangerous for several reasons. It frequently strikes away from the rain core, either ahead or behind the thunderstorm. It can strike as far as 5 or 10 miles from the storm in areas that most people do not consider to be a threat. Positive lightning also has a longer duration, so fires are more easily ignited. And, when positive lightning strikes, it usually carries a high peak electrical current, potentially resulting in greater damage.

Heavy rains and severe storms occur in the City primarily during the late fall, winter, and spring (i.e., November through April). Damaging winds often accompany winter storm systems moving through the area. Tornadoes may also occur, but are very rare in the City as well as in Marin County.

According to the HMPC, short-term, heavy storms can cause both widespread flooding as well as extensive localized drainage issues. With the increased growth of the area, the lack of adequate drainage systems has become an increasingly important issue. In addition to the flooding that often occurs during these storms, strong winds, when combined with saturated ground conditions, can down very mature trees and cause localized slides on sloped areas

Wind

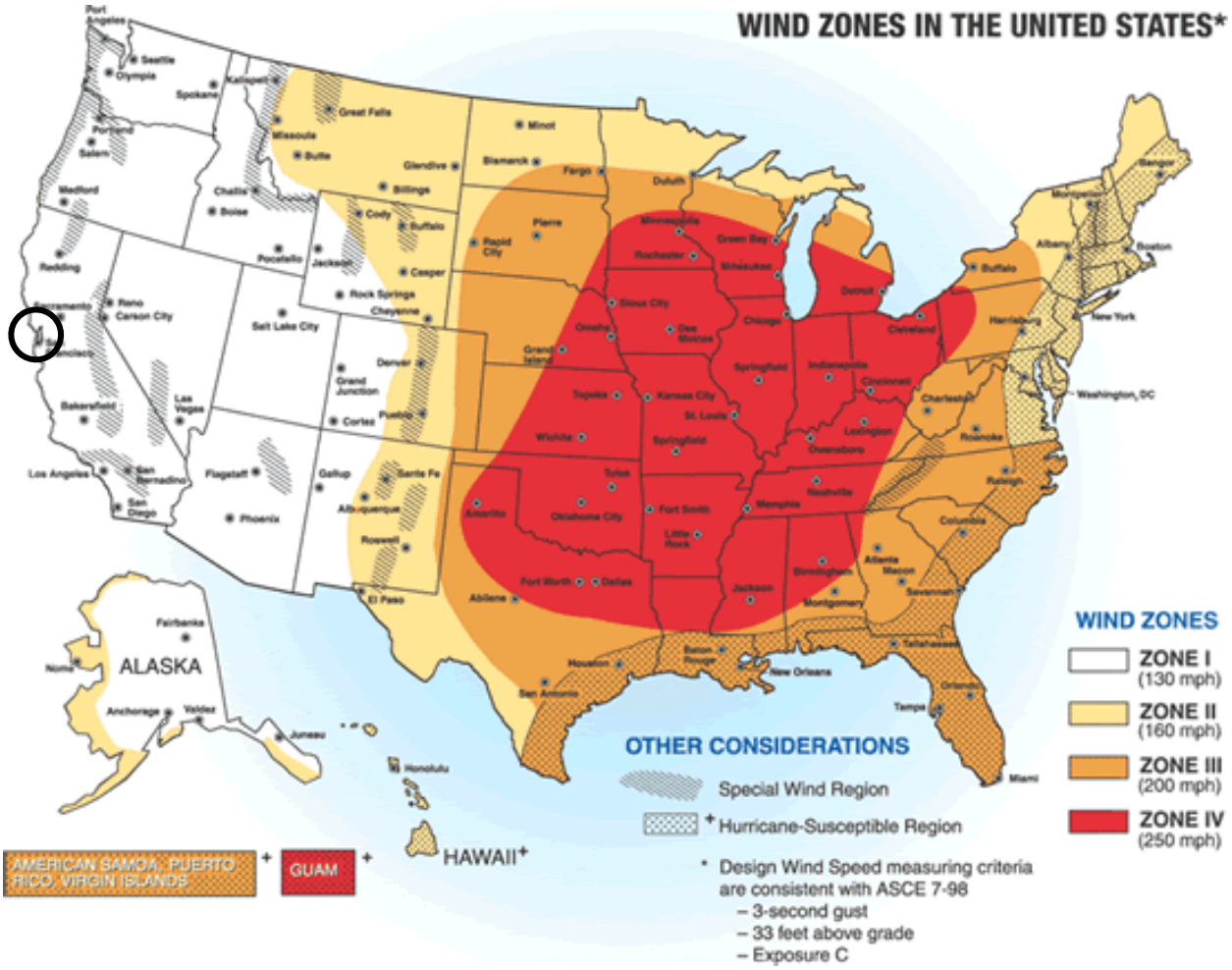
High winds, often accompanying severe thunderstorms, can cause significant property and crop damage, threaten public safety, and have adverse economic impacts from business closures and power loss.

The City is subject to significant, non-tornadic (straight-line), winds. High winds, as defined by the NWS glossary, are sustained wind speeds of 40 mph or greater lasting for 1 hour or longer, or winds of 58 mph or greater for any duration. These winds may occur as part of a seasonal climate pattern or in relation to other severe weather events such as thunderstorms. Straight-line winds may also exacerbate existing weather conditions by increasing the effect on temperature and decreasing visibility due to the movement of particulate matters through the air, as in dust and snow storms. The winds may also exacerbate fire conditions by drying out the ground cover, propelling fuel around the region, and increasing the ferocity of

exiting fires. These winds may damage crops, push automobiles off roads, damage roofs and structures, and cause secondary damage due to flying debris.

Figure 4-9 depicts wind zones for the United States. The map denotes that San Rafael falls into Zone I, which is characterized by high winds of up to 130 mph.

Figure 4-9 Wind Zones in the United States



Source: FEMA

Past Occurrences

Disaster Declaration History

A search of FEMA and Cal OES disaster declarations turned up multiple events. 13 FEMA federal disaster declarations occurred in 1958 (twice), 1963, 1964, 1969, 1983, 1986, 1989, 1995 (twice), 1997, 1998, 2006. 17 state disaster declarations occurred in 1950, 1955, 1958 (twice), 1963, 1969, 1982 (twice), 1983, 1986, 1989, 1995 (twice), 1996, 1997, 1998, and 2008. More information can be found in Table 4-2 in Section 4.1.2.

NCDC Events

The NCDC data recorded 147 hail, heavy rain, lightning and wind incidents for Marin County since 1950. A summary of these events is shown in Table 4-8 Storms that were recorded to have caused specific damages in the City are discussed below the table.

Table 4-8 NCDC Severe Weather Events in Marin County 1950 to 6/30/2016

Event Type	Number of Events	Deaths	Deaths (indirect	Injuries	Injuries (indirect)	Property Damage	Crop Damage
Hail	1	0	0	0	0	$0	$0
Heavy Rain	7	1	0	0	0	$264,000	$0
High Wind	44	2	0	0	0	$713,500	$0
Lightning	1	0	0	0	0	$30,000	$0
Strong Wind	93	2	1	1	0	$3,131,200	$0
Thunderstorm Winds	1	0	0	0	0	$0	$0
Total	**147**	**5**	**1**	**1**	**0**	**$4,138,700**	**$0 0**

Source: NCDC

December 2, 1996 – 2-4 inches of rain fell in San Rafael. This caused some urban and small stream flooding. No injuries or deaths were reported. Damage estimates were unavailable.

December 2002 – There were three primary episodes of precipitation in December, the first a two-day storm on the 9th and 10th. With less than an inch and a half accumulation at any one location over the period, flooding problems were not an issue. However, the rainfall totals helped to further saturate the soil. The next and by far most serious storm episode begin on the 13th of the month and lasted on and off through the 21st. A very strong and moist jet stream developed across the Pacific Ocean and brought a series of storms into California. Wave after wave of locally heavy rain pounded the north bay counties for days. Over a 4-day period from the 13th to the 16th, San Rafael had rainfall totals of 4.51", 2.98", 1.16", and 2.72" respectively. Flooding became a serious issue, not just for urban and small stream flooding, but for mainstem flooding as well. Flood warnings were issued in San Rafael. Most of the mainstem flooding was minor in nature but there were areas of moderate flooding, mostly agricultural land. The last storm episode occurred from the 28th to the 31st.

April 2006 – Persistent heavy rainfall caused a number of landslides near San Rafael area during the first half of April. More information can be found in the landslide section of this Plan (Section 4.2.11).

December 11, 2014 – An Atmospheric River event brought heavy rain and gusty winds with a strong winter storm that impacted the Bay Area for several days in mid-December. Cyclogenesis occurred with a 979 mb low forming off the Northern California coast. On December 11, the intense surface low moved up the coast and drug a narrow cold frontal rainband through the Bay Area that morning and early afternoon. These are rapidly moving fronts that are notorious for intense rainfall and gusty winds despite having limited instability. This storm wasn't a major wind producer, but the rainfall rates were impressive. Instantaneous rainfall rates of 1.5-2 inches/hr were reported in and near San Rafael. No injuries or deaths were reported. $4 million in damages were recorded, though most of it not in the City of San Rafael.

City Planning Committee Events

CAN THE CITY IDENTIFY ANY PAST SEVERE WEATHER EVENTS AND THEIR IMPACTS?

CAN WE GET INFORMATION ON IMPACTS FROM JANUARY 2017 STORMS/OTHER PAST STORM EVENTS?

WHAT ARE THE CITY'S PRIMARY IMPACTS/CONCERNS WITH EXTREME STORM EVENTS?

Likelihood of Future Occurrence

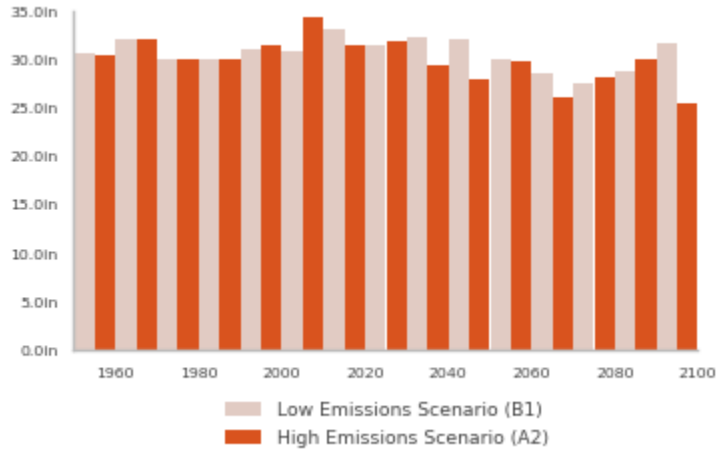
Highly Likely — 147 events were recorded in the County since 1950. The NCDC database doesn't report all heavy rain, hail, and lightning events. Severe weather, is a well-documented seasonal occurrence that will continue to occur annually in San Rafael.

Climate Change and Heavy Rains and Storms

Per the CAS, while average annual rainfall may increase or decrease slightly, the intensity of individual rainfall events is likely to increase during the 21st century. It is unlikely that hail will become more common in the County. The amount of lightning is not projected to change.

Cal-Adapt noted that, on average, the projections show little change in total annual precipitation in California. Furthermore, among several models, precipitation projections do not show a consistent trend during the next century. The Mediterranean seasonal precipitation pattern is expected to continue, with most precipitation falling during winter from North Pacific storms. One of the four climate models projects slightly wetter winters, and another projects slightly drier winters with a 10 to 20 percent decrease in total annual precipitation. However, even modest changes would have a significant impact because California ecosystems are conditioned to historical precipitation levels and water resources are nearly fully utilized. Future precipitation estimates for the City are shown in Figure 4-10.

Figure 4-10 San Rafael – Future Precipitation Estimates: High and Low Emission Scenarios



Source: Cal-Adapt – Precipitation: Decadal Averages Map

4.2.4. Climate Change Hazard Profile

Hazard/Problem Description

Climate change is the distinct change in measures of weather patterns over a long period of time, ranging from decades to millions of years. More specifically, it may be a change in average weather conditions such as temperature, rainfall, snow, ocean and atmospheric circulation, or in the distribution of weather around the average. While the Earth's climate has cycled over its 4.5-billion-year age, these natural cycles have taken place gradually over millennia, and the Holocene, the most recent epoch in which human civilization developed, has been characterized by a highly stable climate – until recently.

Through changes to oceanic and atmospheric circulation cycles and increasing heat, climate change affects weather systems around the world. Climate change increases the likelihood and exacerbates the severity of extreme weather – more frequent or intense storms, floods, droughts, and heat waves. Consequences for human society include loss of life and injury, damaged infrastructure, long-term health effects, loss of agricultural crops, disrupted transport and freight, and more. Climate change is not a discrete event but a long-term hazard, the effects of which communities are already experiencing.

This LHMP is concerned with human-induced climate change that has been rapidly warming the Earth at rates unprecedented in the last 1,000 years. Since industrialization began in the 19th century, the burning of fossil fuels (coal, oil, and natural gas) at escalating quantities has released vast amounts of carbon dioxide and other greenhouse gases responsible for trapping heat in the atmosphere, increasing the average temperature of the Earth. Secondary impacts include changes in precipitation patterns, the global water cycle, melting glaciers and ice caps, and rising sea levels. According to the Intergovernmental Panel on Climate Change (IPCC), climate change will "increase the likelihood of severe, pervasive and irreversible impacts for people and ecosystems" if unchecked.

Through changes to oceanic and atmospheric circulation cycles and increasing heat, climate change affects weather systems around the world. Climate change increases the likelihood and exacerbates the severity of extreme weather – more frequent or intense storms, floods, droughts, and heat waves. Consequences for human society include loss of life and injury, damaged infrastructure, long-term health effects, loss of agricultural crops, disrupted transport and freight, and more. Climate change is not a discrete event but a long-term hazard, the effects of which communities are already experiencing.

The 2009 San Rafael Climate Adaptation Plan noted that despite environmental consciousness, per capita greenhouse gas (GHG) emissions from Marinites are among the highest in the U.S. due to affluence – citizens own more vehicles, live in larger homes, and purchase more products. Transportation accounts for 62% of GHG emissions in San Rafael – the largest source of emissions. This is a very difficult area to address because San Rafael has little control over traffic on highways, fuel efficiency standards, gas taxes, or technological breakthroughs.

Climate change adaptation is a key priority of the State of California. The 2013 State of California Multi-Hazard Mitigation Plan stated that climate change is already affecting California. Sea levels have risen by as much as seven inches along the California coast over the last century, increasing erosion and pressure on the state's infrastructure, water supplies, and natural resources. The State has also seen increased average temperatures, more extreme hot days, fewer cold nights, a lengthening of the growing season, shifts in the water cycle with less winter precipitation falling as snow, and earlier runoff of both snowmelt and rainwater in the year. In addition to changes in average temperatures, sea level, and precipitation patterns, the intensity of extreme weather events is also changing. Data suggests that the effects of climate change have already been felt in the San Francisco Bay region.

Past Occurrences

Disaster Declaration History

Climate change has never been directly linked for any declared disasters.

NCDC Events

The NCDC does not track climate change events.

City Planning Team Events

Past flooding, wildfire, levee failure, and drought disasters may have been exacerbated by climate change, but it is impossible to make direct connections to individual events. Unlike earthquake and floods that occur over a finite time period, climate change is a slow onset, long term hazard, the effects of which some communities may already be already experiencing, but for which little empirical data exists. Further, given the science, it is likely that measurable effects may not be seriously experienced for years, decades, or may be avoided altogether by mitigation actions taken today.

CAN THE CITY PROVIDE ANY INPUT ON NOTABLE IMPACTS TO THE CITY FROM CLIMATE CHANGE?

Likelihood of Future Occurrences

Highly Likely – Climate change is virtually certain to continue without immediate and effective global action. According to NASA, 2016 is on track to be the hottest year on record, and 15 of the 17 hottest years ever have occurred since 2000. Without significant global action to reduce greenhouse gas emissions, the IPCC concludes in its Fifth Assessment Synthesis Report (2014) that average global temperatures is likely to exceed 1.5 C by the end of the 21st century, with consequences for people, assets, economies and ecosystems, including risks from heat stress, storms and extreme precipitation, inland and coastal flooding, landslides, air pollution, drought, water scarcity, sea level rise and storm surges.

The 2009 CAP noted that the City of San Rafael will have to comply with recent and anticipated state and federal regulations on reducing GHG emissions, such as California's landmark AB32 and SB375 legislation. At present, local governments in California are being asked to reduce GHG emissions 15% from current levels by 2020, with an ultimate state-wide goal of 80% reductions by 2050, which scientists have determined to be the amount necessary to arrest the effects of global warming.

Climate Scenarios

The United Nations IPCC developed several GHG emissions scenarios based on differing sets of assumptions about future economic growth, population growth, fossil fuel use, and other factors. The emissions scenarios range from "business-as-usual" (i.e., minimal change in the current emissions trends) to more progressive (i.e., international leaders implement aggressive emissions reductions policies). Each of these scenarios leads to a corresponding GHG concentration, which is then used in climate models to examine how the climate may react to varying levels of GHGs. Climate researchers use many global climate models to assess the potential changes in climate due to increased GHGs.

Key Uncertainties Associated with Climate Projections

- Climate projections and impacts, like other types of research about future conditions, are characterized by uncertainty. Climate projection uncertainties include but are not limited to:
  - ✓ Levels of future greenhouse gas concentrations and other radiatively important gases and aerosols,
  - ✓ Sensitivity of the climate system to greenhouse gas concentrations and other radiatively important gases and aerosols,
  - ✓ Inherent climate variability, and
  - ✓ Changes in local physical processes (such as afternoon sea breezes) that are not captured by global climate models.

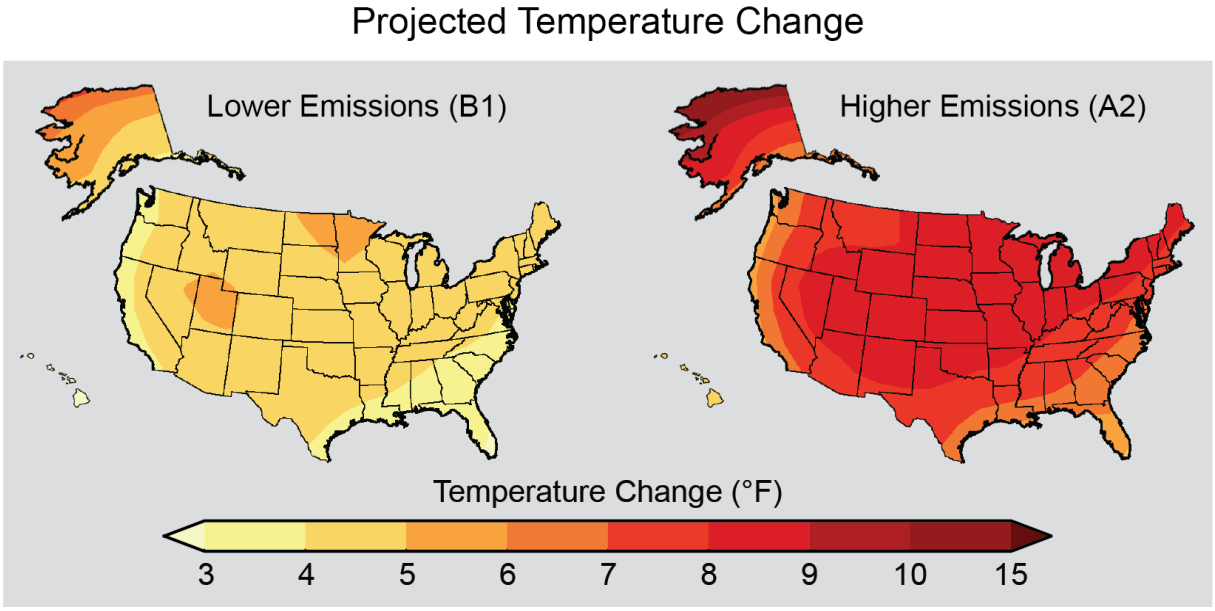
Even though precise quantitative climate projections at the local scale are characterized by uncertainties, the information provided can help identify the potential risks associated with climate variability/climate change and support long term mitigation and adaptation planning.

The following maps (shown in and) are excerpts from the Global Climate Change Impacts report that show the magnitude of the observed and projected changes in annual average temperature. It is important to discuss these projected temperature changes, as heat is a major driver of climate and climate related phenomena. The map for the period around 2000 shows that most areas of the United States have warmed 1 to 2°F compared to the 1960s and 1970s. Although not reflected in these maps of annual average

temperature, this warming has generally resulted in longer warm seasons and shorter, less intense cold seasons. The average warming for the country as a whole is shown on the thermometers adjacent to each map. By the end of the century, the average U.S. temperature is projected to increase by approximately 7 to 11°F under the higher emissions scenario and by approximately 4 to 6.5°F under the lower emissions scenario.

Maps show projected change in average surface air temperature in the later part of this century (2071-2099) relative to the later part of the last century (1970-1999) under a scenario that assumes substantial reductions in heat trapping gases and a higher emissions scenario that assumes continued increases in global emissions. These are shown in Figure 4-11.

Figure 4-11 Projected Temperature Change – Lower and Higher Emissions Scenario



Source: National Climate Assesment

According to the California Natural Resource Agency (CNRA), climate change is already affecting California and is projected to continue to do so well into the foreseeable future. Current and projected changes include increased temperatures, seal level rise, a reduced winter snowpack altered precipitation patterns, and more frequent storm events. Over the long term, reducing greenhouse gases can help make these changes less severe, but the changes cannot be avoided entirely. Unavoidable climate impacts can result in a variety of secondary consequences including detrimental impacts on human health and safety, economic continuity, ecosystem integrity and provision of basic services.

The CNRA's 2014 Climate Adaptation Strategy (CAS) delineated how climate change may impact and exacerbate natural hazards in the future, including wildfires, extreme heat, floods, drought, and levee failure:

- Climate change is expected to lead to increases in the frequency, intensity, and duration of extreme heat events and heat waves in San Rafael and the rest of California, which are likely to increase the risk of

mortality and morbidity due to heat-related illness and exacerbation of existing chronic health conditions. Those most at risk and vulnerable to climate-related illness are the elderly, individuals with chronic conditions such as heart and lung disease, diabetes, and mental illnesses, infants, the socially or economically disadvantaged, and those who work outdoors.

- Higher temperatures will melt the Sierra snowpack earlier and drive the snowline higher, resulting in less snowpack to supply water to California users.
- Droughts are likely to become more frequent and persistent in the 21st century.
- Intense rainfall events, periodically ones with larger than historical runoff, will continue to affect California with more frequent and/or more extensive flooding.
- Storms and snowmelt may coincide and produce higher winter runoff from the landward side, while accelerating sea-level rise will produce higher storm surges during coastal storms. Together, these changes may increase the probability of floods and levee and dam failures, along with creating issues related to salt water intrusion.
- Warmer weather, reduced snowpack, and earlier snowmelt can be expected to increase wildfire through fuel hazards and ignition risks. These changes can also increase plant moisture stress and insect populations, both of which affect forest health and reduce forest resilience to wildfires. An increase in wildfire intensity and extent will increase public safety risks, property damage, fire suppression and emergency response costs to government, watershed and water quality impacts, vegetation conversions and habitat fragmentation.
- Sea-level rise will increase erosion, threatening public and private property and structures and causing social, economic, and resource losses.

4.2.5. Coastal Flooding and Sea Level Rise Hazard Profile

Hazard/Problem Description

Coastal Flooding

According to FEMA, historically, cities, towns and villages are settled around ports along the nation's coastlines, providing individuals and families opportunities for trade, jobs and transportation, recreation and relaxation. These areas are extremely important to our nation, with great economic, historic and cultural significance. Although the coastal areas of the United States comprise only one-fifth of the land area of the contiguous 48 states, they account for more than half of the nation's population and housing supply. In 1990, over 133 million Americans lived in the 673 counties along the Atlantic and Pacific Oceans, the Gulf of Mexico and the Great Lakes. Since 1960, population in these areas increased by 41 percent. The continued increase in coastal population leads to increased coastal development, which places greater numbers of structures at risk for damage from coastal hazards.

Coastal flooding can result from a variety of different causes including storm surges created by storms like hurricanes and tropical cyclones, rising sea levels due to climate change (discussed below) and by tsunamis (discussed in Section 4.2.14).

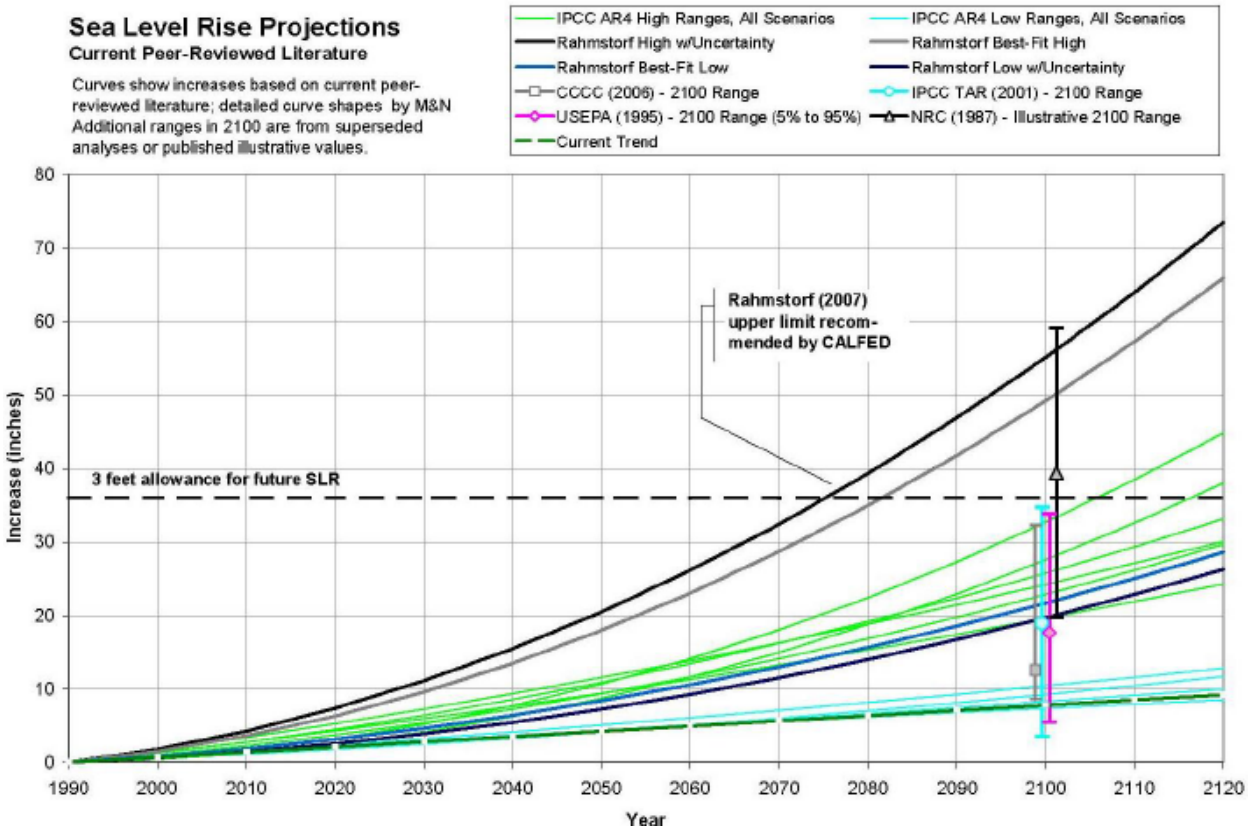
Sea Level Rise

In the past decade, there have been groundbreaking studies and an increased public awareness on the worldwide effects of climate change associated with global warming. Studies continue to document that

global warming is continuing at progressive rates, which has been demonstrated by warmer and colder seasonal temperatures and patterns of more severe seasonal storm events. It is projected that sea levels will continue to rise as precipitation continues to increase and ice caps continue to melt. There are number of large geographic areas of San Rafael that are at risk for flooding and will be dramatically impacted by sea level rise. These geographic areas include valley floors, properties with low-lying elevations (some at sea level), and areas that are now filled and were once marshland.

In 2007, the Bay Conservation and Development Commission (BCDC) completed and published maps showing predictions for sea level rise in and around the San Francisco Bay for years 2050 and 2100. This is shown in Figure 4-12. Given the limited yet evolving information that is available to date on this issue, there is still a great amount of uncertainty surrounding precise predictions on the extent on potential sea level rise. However, BCDC predicts, based on information available to date (FEMA flood zones, existing watersheds, and former tidelands/bay lands), that water levels in the San Francisco Bay will raise 16-inches by 2050 and 55-inches by 2100. It is important to note that BCDC includes a disclosure on its maps, which states, "For Informational Purposes Only." The intent of this disclosure is to ensure that they are not be used as a technical tool in making local land use decisions, but rather a precautionary resource to trigger further study when addressing projects in areas prone to potential sea level rise.

Figure 4-12 San Rafael – Sea Level Rise Projections



Source: Argonaut Company 2013

To date, the City of San Rafael has used the BCDC maps as a reference in scoping and conducting environmental review on specific development projects. The BCDC maps identify four geographic areas of San Rafael that are vulnerable to projected sea level rise, which are:

- Central San Rafael Basin – includes San Rafael Canal/Creek and neighborhoods bordering the creek, and major portions of Downtown
- Southeast San Rafael –- includes Canal/Spinnaker Point/Baypoint residential areas and the greater commercial and light industrial areas around the I-580 corridor
- San Pedro Peninsula – low-lying areas of Peacock Gap and Glenwood neighborhoods and portions of residential neighborhoods bordering the Bay
- North San Rafael – greater Gallinas Creek Basin from the Bay west to US 101

These maps were refined in the 2016 Marin Bay Shoreline Sea Level Rise Assessment. That assessment forms the basis of the vulnerability assessment for the City of San Rafael in Section 4.3.4.

Past Occurrences

Disaster Declaration History

There have been no past disaster declarations related to coastal flooding or sea level rise.

NCDC Events

The NCDC reported 18 events of coastal flooding for Marin County. None of these events were reported in the NCDC database to have had a direct effect on San Rafael. Table 4-3 summarizes these events.

*Table 4-9 NCDC Weather Events for Marin County, 1950 to June 30, 2016**

Event Type	Number of Events	Deaths	Deaths (indirect	Injuries	Injuries (indirect)	Property Damage	Crop Damage
Coastal Flood	9	0	0	0	0	$340,000	$0
High Surf	6	8	0	0	0	$75,000	$0
Storm Surge/Tide	3	0	0	0	0	$10,000	$0
Total	**18**	**8**	**0**	**0**	**0**	**$425,000**	**$0**

Source: NCDC

*Note: Losses reflect totals for all impacted areas, not just San Rafael or Marin County

City Planning Team Events

CAN THE CITY IDENTIFY ANY PAST COASTAL FLOODING EVENTS, LOCATIONS, AND THEIR IMPACTS?

WHAT ARE THE CITY'S PRIMARY IMPACTS/CONCERNS WITH COASTAL FLOODING AND SEA LEVEL RISE?

Likelihood of Future Occurrences

Likely – Studies continue to document that global warming is continuing at progressive rates, which has been demonstrated by warmer and colder seasonal temperatures and patterns of more severe seasonal storm events. It is projected that sea levels will continue to rise as precipitation continues to increase and ice caps continue to melt. Therefore, the HMPC regards the likelihood of future occurrence of coastal flooding and sea level rise as likely.

Climate Change and Coastal Flooding/Sea Level Rise

Global models indicate that California will see substantial sea level rise during this century, with the exact magnitude depending on such factors as, global emissions, rate at which oceans absorb heat, melting rates and movement of land-based ice sheets, and local coastal land subsidence or uplift. Cal-Adapt's "Sea Level Rise" map tool displays areas that may be vulnerable to inundation during an extreme storm event coupled with sea level rise. Information from that tool for the City of San Rafael is shown in Figure 4-13. This map shows expected sea level rise. 6 scenarios for sea level rise were used for the Marin Bay Shoreline Sea Level Rise Assessment. Those maps are located in Section 4.3.4.

Figure 4-13 San Rafael – Sea Level Rise Threatened Areas

Source: Cal Adapt Sea Leve rise: Threatened Areas Map

According to the California Adaptation Planning Guide, Understanding Regional Characteristics, with all of the coastal development in the Bay Area Region, sea level rise is likely to be the greatest threat to the Bay Area from Climate Change significantly affecting development, infrastructure, transportation infrastructure, populations, and the environment.

4.2.6. Dam Failure Hazard Profile

Hazard/Problem Description

According to the California Division of Safety of Dams, dams are manmade structures built for a variety of uses including flood protection, power generation, agriculture, water supply, and recreation. When dams are constructed for flood protection, they are usually engineered to withstand a flood with a computed risk of occurrence. For example, a dam may be designed to contain a flood at a location on a stream that has a certain probability of occurring in any one year. If prolonged periods of rainfall and flooding occur that exceed the design requirements, that structure may be overtopped and fail. Overtopping is the primary cause of earthen dam failure in the United States.

Dam failures can also result from any one or a combination of the following causes:

- Earthquake;
- Inadequate spillway capacity resulting in excess overtopping flows;
- Internal erosion caused by embankment or foundation leakage, or piping or rodent activity;
- Improper design;
- Improper maintenance;
- Negligent operation; and/or
- Failure of upstream dams on the same waterway.

Water released by a failed dam generates tremendous energy and can cause a flood that is catastrophic to life and property. A catastrophic dam failure could challenge local response capabilities and require evacuations to save lives. Impacts to life safety will depend on the warning time and the resources available to notify and evacuate the public. Major loss of life could result as well as potentially catastrophic effects to roads, bridges, and homes. Electric generating facilities and transmission lines could also be damaged and affect life support systems in communities outside the immediate hazard area. Associated water supply, water quality and health concerns could also be an issue. Factors that influence the potential severity of a full or partial dam failure are the amount of water impounded; the density, type, and value of development and infrastructure located downstream; and the speed of failure.

In general, there are three types of dams: concrete arch or hydraulic fill; earth and rockfill; and concrete gravity. Each type of dam has different failure characteristics. A concrete arch or hydraulic fill dam can fail suddenly; the flood wave builds up rapidly to a peak then gradually declines. An earthfill or rockfill dam gradually fails due to erosion of the breach; a flood wave will build gradually to a peak and then decline until the reservoir is empty. A concrete gravity dam can fail suddenly or gradually with a corresponding buildup and decline of the flood wave.

Dams and reservoirs have been built throughout California to supply water for agriculture and domestic use, to allow for flood control, as a source of hydroelectric power, and to serve as recreational facilities. The storage capacities of these reservoirs range from a less than a hundred acre feet to 4.5 million acre-feet. The water from these reservoirs eventually makes its way to the Pacific Ocean by way of several river systems.

The California Department of Water Resources Division of Safety of Dams has jurisdiction over impoundments that meet certain capacity and height criteria. Embankments that are less than six feet high and impoundments that can store less than 15 acre-feet are non-jurisdictional. Additionally, dams that are less than 25 feet high can impound up to 50 acre-feet without being jurisdictional. The California Department of Water Resources (Cal DWR) Division of Safety of Dams assigns hazard ratings to large dams within the State. The following two factors are considered when assigning hazard ratings: existing land use and land use controls (zoning) downstream of the dam. Dams are classified in three categories that identify the potential hazard to life and property:

- **High hazard** indicates that a failure would most probably result in the loss of life
- **Significant hazard** indicates that a failure could result in appreciable property damage
- **Low hazard** indicates that failure would result in only minimal property damage and loss of life is unlikely

Table 4-10 identifies the 4 dams in the vicinity of the City of San Rafael. All of these dams are located in Marin County.

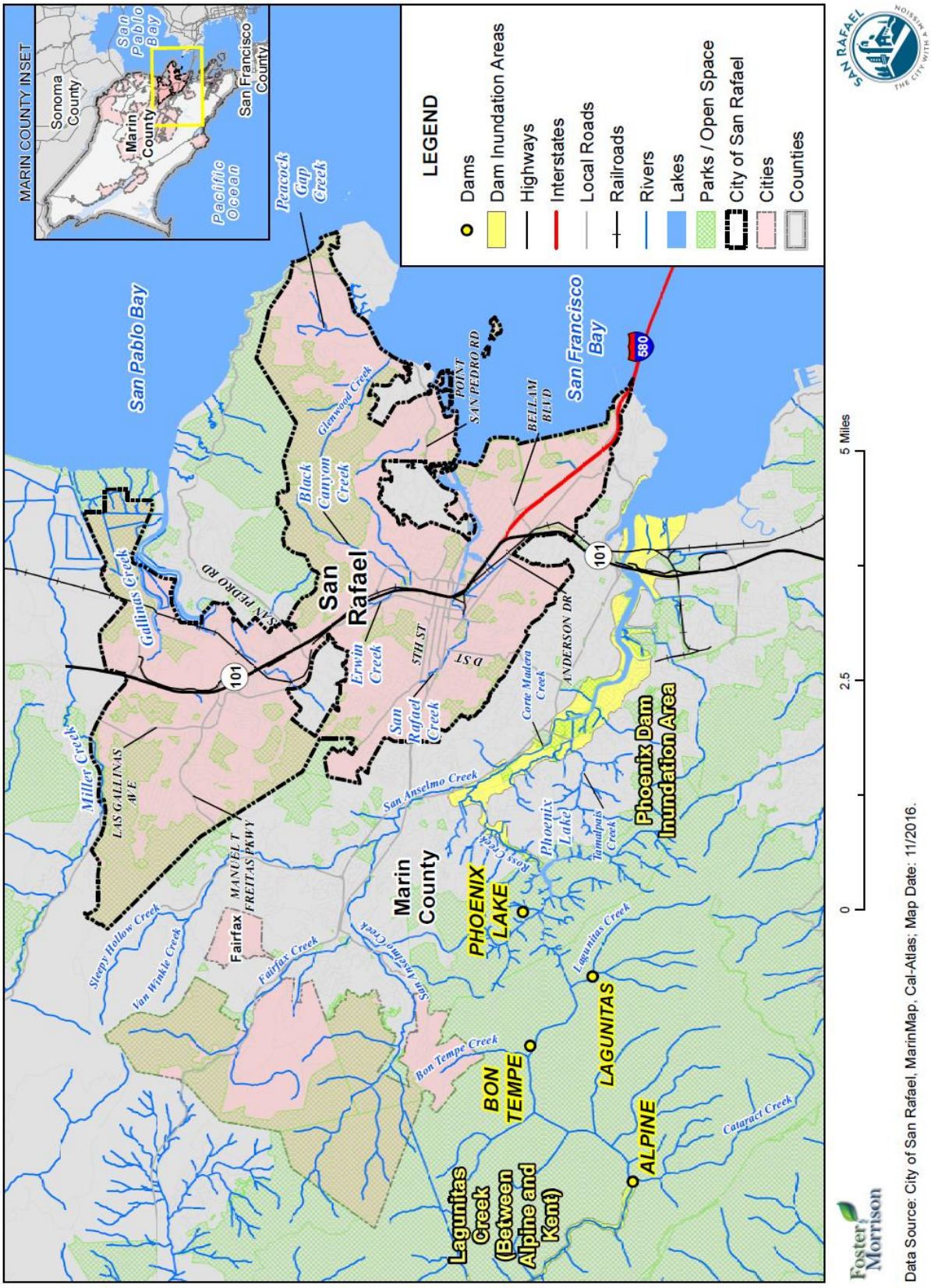
Table 4-10 City of San Rafael – Dams of Concern Inventory

Name	Federal Hazard Classification	River	Dam Type	Structural Height of Dam (ft)	Maximum Storage of Dam (acre-ft)*
Alpine	High	Lagunitas Creek	Gravity	44	8,892
Lagunitas	Significant	Lagunitas Creek	Rockfill	15	341
Phoenix Lake	High	Ross Creek	Rockfill	27	612
Bon Tempe	High	Lagunitas Creek	Rockfill	30	4,300

Source: National Inventory of Dams and California Division of Safety of Dams
*One Acre Foot=326,000 gallons

Though they are in the vicinity, there is a low chance of any of these dams affecting the City. The dam inundation area associated with the Phoenix Lake dam was reviewed for its potential impact to the City. The Phoenix dam inundation layer, created by Cal OES, was downloaded from Marin Map. Inundation boundaries were developed by individual dam owners and submitted to the Office of Emergency Services for review and acceptance. The California Office of Emergency Services initiated digitization of the dam inundation map content, in order to make them useable in Geographic Information Systems. Area dams and the Phoenix dam inundation area relative to the City of San Rafael is shown on Figure 4-14.

Figure 4-14 San Rafael – Area Dams and Phoenix Dam Inundation Area



Past Occurrences

Disaster Declaration History

There are no federal or state disaster declarations related to dam failure in Marin County.

NCDC Events

The NCDC does not track dam failure events.

NPDP Events

The National Performance of Dams Program (NPDP) database was searched for dam failure incidents in Marin County or the City of San Rafael. No dam failure incidents were found.

City Planning Team Events

The City Planning Team noted no events of dam failure that have affected the City.

Likelihood of Future Occurrence

Unlikely – There have been no recorded events of dam failure in or around San Rafael. It is unlikely a dam failure will occur in the future that would impact the City of San Rafael.

Climate Change and Dam Failure

According to the CAS and the HMPC, increases in both precipitation and heat causing snow melt could increase the potential for dam failure and uncontrolled releases in Marin County and the City of San Rafael. However, since no dams directly threaten the City, it is not expected that the City's future risk to dam failure would increase.

4.2.7. Drought and Water Shortage Hazard Profile

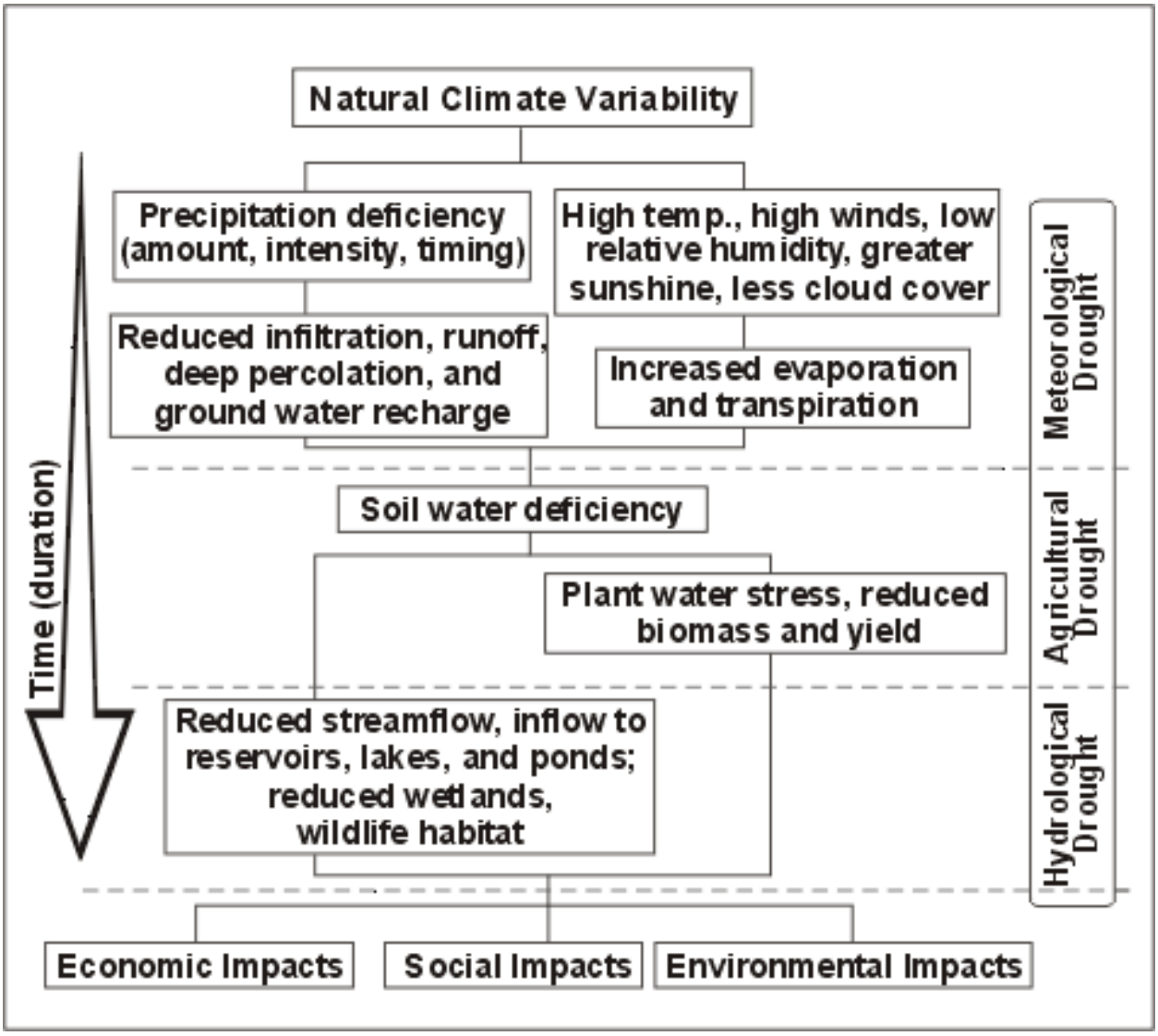
Hazard/Problem Description

The National Drought Mitigation Center states that drought is a gradual phenomenon. Although droughts are sometimes characterized as emergencies, they differ from typical emergency events. Most natural disasters, such as floods or forest fires, occur relatively rapidly and afford little time for preparing for disaster response. Droughts occur slowly, over a multi-year period, and it is often not obvious or easy to quantify when a drought begins and ends. Water districts normally require at least a 10-year planning horizon to implement a multiagency improvement project to mitigate the effects of a drought and water supply shortage.

Drought is a complex issue involving (see Figure 4-15) many factors—it occurs when a normal amount of precipitation and snow is not available to satisfy an area's usual water-consuming activities. Drought can often be defined regionally based on its effects:

- Meteorological drought is usually defined by a period of below average water supply.
- Agricultural drought occurs when there is an inadequate water supply to meet the needs of the state's crops and other agricultural operations such as livestock.
- Hydrological drought is defined as deficiencies in surface and subsurface water supplies. It is generally measured as streamflow, snowpack, and as lake, reservoir, and groundwater levels.
- Socioeconomic drought occurs when a drought impacts health, well-being, and quality of life, or when a drought starts to have an adverse economic impact on a region.

Figure 4-15 Causes and Impacts of Drought

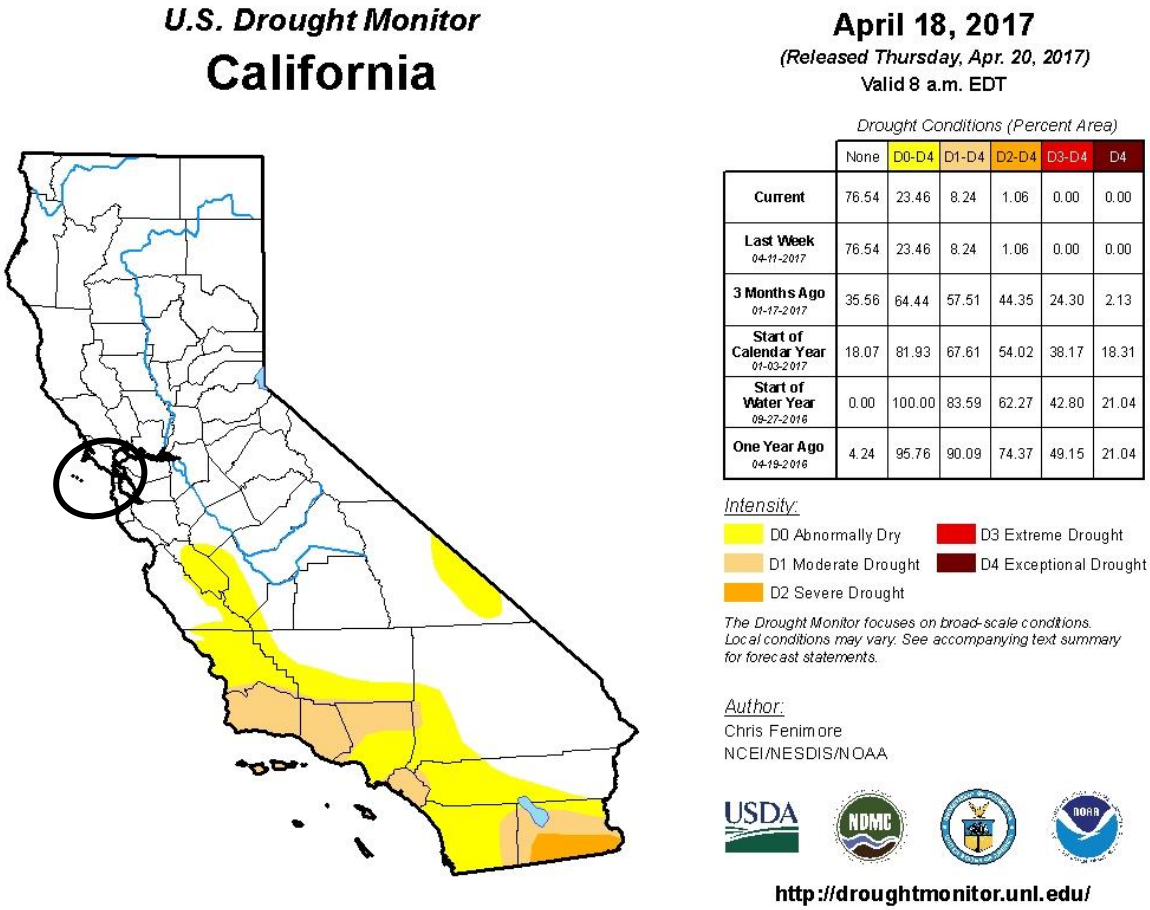


Source: National Drought Mitigation Center

Drought in the United States is monitored by the National Integrated Drought Information System (NIDIS). A major component of this portal is the U.S. Drought Monitor. The Drought Monitor concept was developed jointly by the NOAA's Climate Prediction Center, the NDMC, and the USDA's Joint Agricultural Weather Facility in the late 1990s as a process that synthesizes multiple indices, outlooks and local impacts, into an assessment that best represents current drought conditions. The final outcome of each

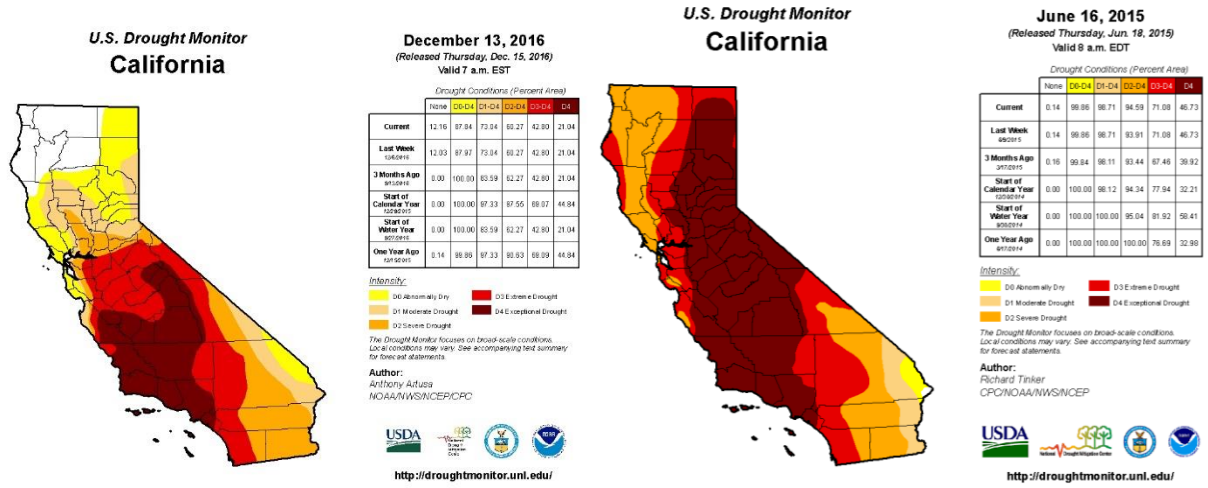
Drought Monitor is a consensus of federal, state, and academic scientists who are intimately familiar with the conditions in their respective regions. A recent snapshot of the drought conditions in San Rafael California can be found in Figure 4-16. A snapshot from 2015 and 2016 is shown in Figure 4-17.

Figure 4-16 Drought Status in San Rafael



Source: US Drought Monitor

Figure 4-17 Previous Drought Status in San Rafael



Source: US Drought Monitor

The California Department of Water Resources (DWR) says the following about drought:

> *One dry year does not normally constitute a drought in California. California's extensive system of water supply infrastructure—its reservoirs, groundwater basins, and inter-regional conveyance facilities—mitigates the effect of short-term dry periods for most water users. Defining when a drought begins is a function of drought impacts to water users. Hydrologic conditions constituting a drought for water users in one location may not constitute a drought for water users elsewhere, or for water users having a different water supply. Individual water suppliers may use criteria such as rainfall/runoff, amount of water in storage, or expected supply from a water wholesaler to define their water supply conditions.*

The drought issue in California is further compounded by water rights. Water is a commodity possessed under a variety of legal doctrines. The prioritization of water rights between farming and federally protected fish habitats in California is part of this issue

Drought is not initially recognized as a problem because it normally originates in what is considered good weather, which typically includes a dry late spring and summer in Mediterranean climates, such as in California. This is particularly true in Northern California where drought impacts are delayed for most of the population by the wealth of stored surface and ground water. The drought complications normally appear more than a year after a drought begins. In most areas of California, including Marin County, farmers and ranchers that rely on rainfall to support forage for their livestock are the earliest and most affected by drought. Even below normal water years could affect ranchers depending on the timing and duration of precipitation events. It is difficult to quantitatively assess drought impacts to Marin County because not many county-specific studies have been conducted. Some factors to consider include the impacts of fallowed agricultural land, habitat loss and associated effects on wildlife, and the drawdown of the groundwater table. The most direct and likely most difficult drought impact to quantify is to local economies, especially agricultural economies. The State has conducted some empirical studies on the economic effects of fallowed lands with regard to water purchased by the State's Water Bank; but these

studies do not quantitatively address the situation in Marin County and San Rafael. It can be assumed, however, that the loss of production in one sector of the economy would affect other sectors.

The drawdown of the groundwater table is one factor that has been recognized to occur during repeated dry years. Lowering of groundwater levels results in the need to deepen wells, which subsequently lead to increased pumping costs. These costs are a major consideration for residents relying on domestic wells and agricultural producers that irrigate with groundwater and/or use it for frost protection. Some communities in higher elevations with shallow bedrock do not have a significant source of groundwater.

Drought impacts are wide-reaching and may be economic, environmental, and/or societal. The most significant impacts associated with drought in the City are those related to water intensive activities such as wildfire protection, municipal usage, commerce, tourism, recreation, agriculture, and wildlife preservation. Also, during a drought, allocations go down and water costs increase, which results in reduced water availability. Voluntary conservation measures are a normal and ongoing part of system operations and actively implemented during extended droughts. A reduction of electric power generation and water quality deterioration are also potential problems. Drought conditions can also cause soil to compact and not absorb water well, potentially making an area more susceptible to flooding and erosion.

Water Shortage

Northern California counties, including Marin County, generally have sufficient groundwater and surface water supplies to mitigate even the severest droughts of the past century. Many other areas of the State, however, also place demands on these water resources during severe drought. For example, Northern California agencies, including those from Marin County, were participants in the Governor's Drought Water Bank of 1991, 1992, and 1994. The City receives its water from reservoirs in Marin County.

Past Occurrences

Disaster Declaration History

There have been one federal and two state declarations:

- Drought State of Emergency – Governor's Proclamation January 17, 2014 (details below)
- 1977 Drought (Federal Emergency Management Declaration EM-3023)
- 1976 Drought (State Proclamation 2/9/1976)

2014 Governor's Drought Declaration

California's ongoing response to its five-year drought has been guided by a series of executive orders issued by Governor Edmund G. Brown Jr. that are listed below beginning with the most recent and continuing in reverse chronological order:

- Executive Order B-37-16, May 9, 2016: The Governor's latest drought-related executive order established a new water use efficiency framework for California. The order bolstered the state's drought resilience and preparedness by establishing longer-term water conservation measures that include permanent monthly water use reporting, new urban water use targets, reducing system leaks and

eliminating clearly wasteful practices, strengthening urban drought contingency plans and improving agricultural water management and drought plans.

- Executive Order B-36-15, November 13, 2015: This executive order called for additional actions to build on the State's ongoing response to record dry conditions and assist recovery efforts from 2015's devastating wildfires.
- Executive Order B-29-15, April 1, 2015: Key provisions included ordering the State Water Resources Control Board (Board) to impose restrictions to achieve a 25-percent reduction in potable urban water usage through February 28, 2016; directing the California Department of Water Resources (DWR) to lead a statewide initiative, in partnership with local agencies, to collectively replace 50 million square feet of lawns and ornamental turf with drought tolerant landscapes, and directing the California Energy Commission to implement a statewide appliance rebate program to provide monetary incentives for the replacement of inefficient household devices.
- Executive Order B-28-14, December 22, 2014: The order cited paragraph 9 of the January 17, 2014 Proclamation and paragraph 19 of the April 25, 2014 Proclamation (both are linked below) and extended the operation of the provisions in these paragraphs through May 31, 2016.
- Executive Order B-27-14, October 6, 2014: The order directed State agencies to assist local governments in their response to wildfires during California's drought conditions.
- Executive Order B-26-14, September 18, 2014: The order facilitated efforts to provide water to families in dire need as extreme drought continued throughout California.
- Proclamation of a Continued State of Emergency, April 25, 2014: The order strengthened the State's ability to manage water and habitat effectively in drought conditions and called on all Californians to redouble their efforts to conserve water.
- Drought State of Emergency, January 17, 2014: The Governor proclaimed a State of Emergency and directed State officials to take all necessary actions to make water immediately available. Key measures in the proclamation included:
  - ✓ Asking all Californians to reduce water consumption by 20 percent and referring residents and water agencies to the Save Our Water campaign – www.saveourwater.com – for practical advice on how to do so;
  - ✓ Directing local water suppliers to immediately implement local water shortage contingency plans;
  - ✓ Ordering the Board to consider petitions for consolidation of places of use for the State Water Project and Central Valley Project, which could streamline water transfers and exchanges between water users;
  - ✓ Directing DWR and the Board to accelerate funding for projects that could break ground in 2014 and enhance water supplies;
  - ✓ Ordering the Board to put water rights holders across the state on notice that they may be directed to cease or reduce water diversions based on water shortages;
  - ✓ Asking the Board to consider modifying requirements for releases of water from reservoirs or diversion limitations so that water may be conserved in reservoirs to protect cold water supplies for salmon, maintain water supplies and improve water quality.

NCDC Drought Events

The NCDC contains no drought events for Marin County or San Rafael.

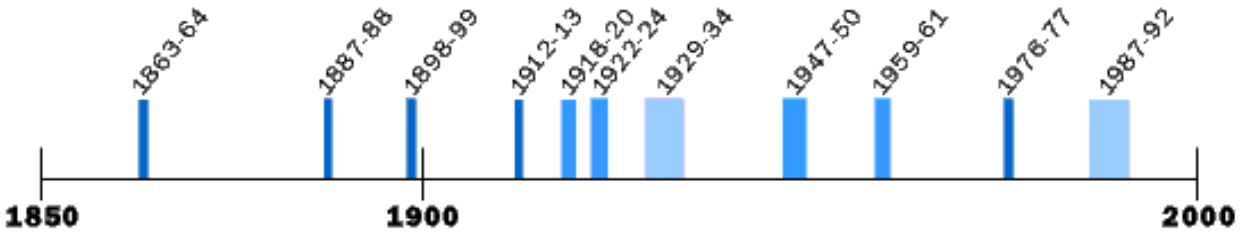
City Planning Team Events

CAN THE CITY IDENTIFY ANY PAST DROUGHT EVENTS AND THEIR IMPACTS?

WHAT ARE THE CITY'S PRIMARY IMPACTS/CONCERNS WITH DROUGHT EVENTS?

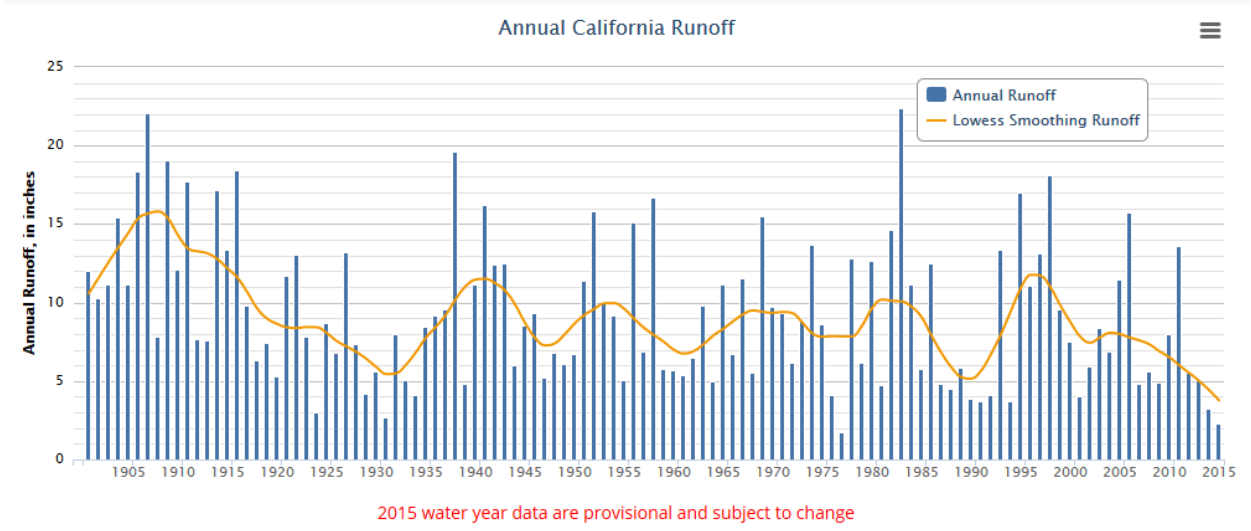
Historically, California has experienced multiple severe droughts. According to the DWR, droughts exceeding three years are relatively rare in Northern California, the source of much of the State's developed water supply. The 1929-34 drought established the criteria commonly used in designing storage capacity and yield of large northern California reservoirs. The driest single year of California's measured hydrologic record between 1850 and 2000 was 1977. Figure 4-18 depicts California's Multi-Year Historical Dry Periods, 1850-2000. Figure 4-19 depicts runoff for the State from 1900 to 2015. This gives a historical context for the 2014-2015 drought to past droughts

Figure 4-18 California's Multi-Year Historical Dry Periods, 1850-2000



Source: California Department of Water Resources, www.water.ca.gov/
Notes: Dry periods prior to 1900 estimated from limited data; covers dry periods of statewide or major regional extent

Figure 4-19 Annual California Runoff – 1900 to 2015



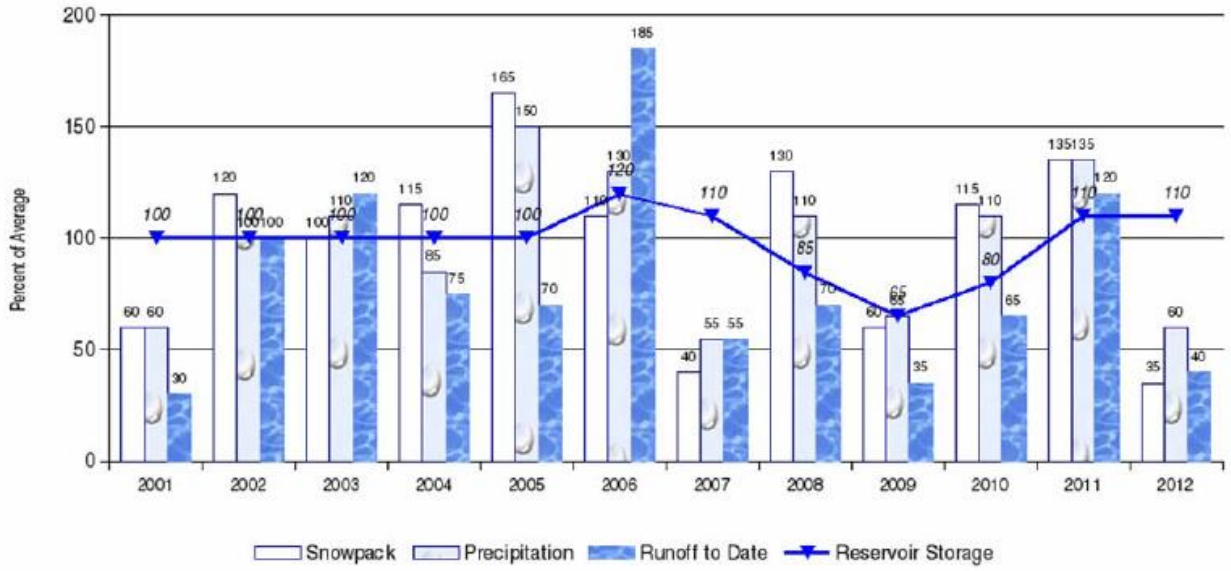
Source: California DWR

Water Shortage

Figure 4-20 illustrates several indicators commonly used to evaluate water conditions in California. The percent of average values are determined by measurements made in each of the ten major hydrologic

regions. The chart describes water conditions in California between 1996 and 2007. The chart illustrates the cyclical nature of weather patterns in California. Snow pack and precipitation increased between 1996 and 1997, began decreasing in 1998, and began to show signs of recovery in 2002, increased in 2005, and decreased sharply in 2007.

Figure 4-20 Water Supply Conditions, 1996 to 2012



Source: 2013 State of California Hazard Mitigation Plan

Since 2012, snowpack levels in California have dropped dramatically. 2015 estimates placed snowpack as 5 percent of normal levels. Snowpack measurements have been kept in California since 1950 and nothing in the historic record comes close 2015's severely depleted level. The previous record for the lowest snowpack level in California, 25 percent of normal, was set both in 1976-77 and 2013-2014. In "normal" years, the snowpack supplies about 30 percent of California's water needs, according to the California Department of Water Resources. Snowpack levels began to increase in 2016, and in 2017 snowpack increased to the largest in 22 years, according to the State Department of Water Resources.

Likelihood of Future Occurrence

Drought

Likely—Historical drought data for San Rafael and region indicate there have been 5 significant droughts in the last 84 years. This equates to a drought every 16.8 years on average or a 6.0 percent chance of a drought in any given year. Based on this data, droughts will affect the City.

Water Shortage

Likely— Recent historical data for water shortage indicates that San Rafael is at risk to both short and prolonged periods of water shortage. Based on this it is likely that water shortages will affect the County. The City's primary water source is surface water, which originates from many local watersheds, with much of it stored in regional reservoirs. The Marin Watershed reservoirs are considered to be generally self –

sustaining. The reservoir capacities provide water to the City for an estimated 2 years if people are adhering to conservation measures. An estimated 75-80% is supplied by the Marin Municipal Water District reservoirs. An estimated 20-25% comes from area rivers. Groundwater is not used by the City.

Climate Change and Drought and Water Shortage

Climate scientists studying California find that drought conditions are likely to become more frequent and persistent over the 21st century due to climate change. The experiences of California during recent years underscore the need to examine more closely the state's water storage, distribution, management, conservation, and use policies. The Climate Adaptation Strategy (CAS) stresses the need for public policy development addressing long term climate change impacts on water supplies. The CAS notes that climate change is likely to significantly diminish California's future water supply, stating that:

> *California must change its water management and uses because climate change will likely create greater competition for limited water supplies needed by the environment, agriculture, and cities.*

According to California's Adaptation Planning Guide: Understanding Regional Characteristics, the City falls within the Bay Area Region designated based on similarities in biophysical setting, climate and jurisdictional characteristics. These regions were established to better address climate change issues associated with climate vulnerability assessment and adaptation planning. According to this guide, approximately 70 percent of the water used in the region is imported, with another 15 percent supplied via groundwater. The vast majority of the water sources originate in the Sierra Nevada, meaning that climate change impacts on droughts and snowpack may have an impact over the long term on the Bay Area water supply.

Members of the HMPC noted a report published in Science magazine in 2015 that stated:

> *Given current greenhouse gas emissions, the chances of a 35+ year "megadrought" striking the Southwest by 2100 are above 80 percent.*

The HMPC also noted a report from the Public Policy Institute of California that thousands of Californians – mostly in rural, small, disadvantaged communities – already face acute water scarcity, contaminated groundwater, or complete water loss. Climate change would make these effects worse.

4.2.8. Earthquake Hazard Profile

Hazard/Problem Description

According to the California Geological Survey (CGS), an earthquake is caused by a sudden slip on a fault. Stresses in the earth's outer layer push the sides of the fault together. Stress builds up, and the rocks slip suddenly, releasing energy in waves that travel through the earth's crust and cause the shaking that is felt during an earthquake. The amount of energy released during an earthquake is usually expressed as a magnitude and is measured directly from the earthquake as recorded on seismographs. An earthquake's magnitude is expressed in whole numbers and decimals (e.g., 6.8). Seismologists have developed several magnitude scales. One of the first was the Richter Scale, developed in 1932 by the late Dr. Charles F. Richter of the California Institute of Technology. The Richter Magnitude Scale is used to quantify the

magnitude or strength of the seismic energy released by an earthquake. Another measure of earthquake severity is intensity. Intensity is an expression of the amount of shaking at any given location on the ground surface (see Table 4-11). Seismic shaking is typically the greatest cause of losses to structures during earthquakes.

Table 4-11 Modified Mercalli Intensity (MMI) Scale

MMI	Felt Intensity
I	Not felt except by a very few people under special conditions. Detected mostly by instruments.
II	Felt by a few people, especially those on upper floors of buildings. Suspended objects may swing.
III	Felt noticeably indoors. Standing automobiles may rock slightly.
IV	Felt by many people indoors; by a few outdoors. At night, some people are awakened. Dishes, windows, and doors rattle.
V	Felt by nearly everyone. Many people are awakened. Some dishes and windows are broken. Unstable objects are overturned.
VI	Felt by everyone. Many people become frightened and run outdoors. Some heavy furniture is moved. Some plaster falls.
VII	Most people are alarmed and run outside. Damage is negligible in buildings of good construction, considerable in buildings of poor construction.
VIII	Damage is slight in specially designed structures, considerable in ordinary buildings, and great in poorly built structures. Heavy furniture is overturned.
IX	Damage is considerable in specially designed buildings. Buildings shift from their foundations and partly collapse. Underground pipes are broken.
X	Some well-built wooden structures are destroyed. Most masonry structures are destroyed. The ground is badly cracked. Considerable landslides occur on steep slopes.
XI	Few, if any, masonry structures remain standing. Rails are bent. Broad fissures appear in the ground.
XII	Virtually total destruction. Waves are seen on the ground surface. Objects are thrown in the air.

Source: Multi-Hazard Identification and Risk Assessment, FEMA 1997

California is seismically active because it sits on the boundary between two of the earth's tectonic plates. Most of the state - everything east of the San Andreas Fault - is on the North American Plate. The cities of Monterey, Santa Barbara, Los Angeles, and San Diego are on the Pacific Plate, which is constantly moving northwest past the North American Plate. The relative rate of movement is about two inches per year. The San Andreas Fault is considered the boundary between the two plates, although some of the motion is taken up on faults as far away as central Utah.

The City of San Rafael is located within the Coast Range Geomorphic province of California. The 2020 General Plan Background Report describes the regional geology surrounding the City. The regional bedrock geology consists of complexly folded, faulted, sheared, and altered sediment, igneous, and metamorphic rock of the Jurassic-Cretaceous age Franciscan Complex. The regional topography is characterized by northwest-southwest rending mountain rideges and intervening valleys that were formed from tectonic activity between the North American Plate and the Pacific Plate. Tectonic activity is concentrated along the San Andreas Fault Zone.

Regional mapping done by the California Geologic Survey indicates that there are four distinct geologic units in San Rafael. These are described below:

- **Bedrock** is the oldest geographic unit in the City. The hillsides and ridgelines consist primarily of shallow soils over bedrock.
  - ✓ **Franciscan Melange** is characterized by a weak matrix of intensely sheared and altered shale and sandstone containing blocks of other rock types including serpentine, greenstone, chert, limestone, and schist. Portions of the Franciscan Melange bedrock on hillside slopes are susceptible to landslides. The Fransiscan sandstone and shale are more stable bedrock units that are less sheared.
- **Colluvium** consists of deposits on unsorted and unconsolidated soild material and weathered rock fragments that accumulate on or at the base of slopes by gravitational or slope wash processes. The colluvial soil in the hillside swales may be susceptible to flow failures.
- **Alluvium** is an unconsolidated sedimentary deposit of clay, silt, sand, and gravel that has been transported and deposited by streams. Alluvium may be susceptible to seismically induced stability.
- **Bay Mud** is compressible, organic silty clay that was hydraulically deposited in marshes, mudflats, and valley floors that were historically subject to tidal action. The present and former marshlands bordering the bay are underlain by bay mud of variable and uneven thickness. Bay mud is 130 feet deep in portions of the bay and 90 feet deep in the City. Bay mud is soft, unconsolidated, water saturated silty clay that contains peaty material, plant remains, and mollusk shells. Bay mud is susceptible to subsidence and liquefaction.

Earthquake Hazards

Earthquakes can cause structural damage, injury, and loss of life, as well as damage to infrastructure networks, such as water, power, gas, communication, and transportation. Earthquakes may also cause collateral emergencies including dam and levee failures, seiches, hazmat incidents, fires, and landslides. The degree of damage depends on many interrelated factors. Among these are: the magnitude, focal depth, distance from the causative fault, source mechanism, duration of shaking, high rock accelerations, type of surface deposits or bedrock, degree of consolidation of surface deposits, presence of high groundwater, topography, and the design, type, and quality of building construction. This section briefly discusses issues related to types of seismic hazards.

Ground Shaking

Groundshaking is motion that occurs as a result of energy released during faulting. The damage or collapse of buildings and other structures caused by groundshaking is among the most serious seismic hazards. Damage to structures from this vibration, or groundshaking, is caused by the transmission of earthquake vibrations from the ground to the structure. The intensity of shaking and its potential impact on buildings is determined by the physical characteristics of the underlying soil and rock, building materials and workmanship, earthquake magnitude and location of epicenter, and the character and duration of ground motion. Much of the County is located on alluvium which increases the amplitude of the earthquake wave. The HMPC noted this is especially true in the Surprise Valley. Ground motion lasts longer and waves are amplified on loose, water-saturated materials than on solid rock. As a result, structures located on alluvium typically suffer greater damage than those located on solid rock.

Seismic Structural Safety

Older buildings constructed before building codes were established, and even newer buildings constructed before earthquake-resistance provisions were included in the codes, are the most likely to be damaged during an earthquake. Buildings one or two stories high of wood-frame construction are considered to be the most structurally resistant to earthquake damage. Older masonry buildings without seismic reinforcement (unreinforced masonry) are the most susceptible to the type of structural failure that causes injury or death.

The susceptibility of a structure to damage from ground shaking is also related to the underlying foundation material. A foundation of rock or very firm material can intensify short-period motions which affect low-rise buildings more than tall, flexible ones. A deep layer of water-logged soft alluvium can cushion low-rise buildings, but it can also accentuate the motion in tall buildings. The amplified motion resulting from softer alluvial soils can also severely damage older masonry buildings.

Other potentially dangerous conditions include, but are not limited to: building architectural features that are not firmly anchored, such as parapets and cornices; roadways, including column and pile bents and abutments for bridges and overcrossings; and above-ground storage tanks and their mounting devices. Such features could be damaged or destroyed during strong or sustained ground shaking.

Settlement

Settlement can occur in poorly consolidated soils during ground shaking. During settlement, the soil materials are physically rearranged by the shaking to result in a less stable alignment of the individual minerals. Settlement of sufficient magnitude to cause significant structural damage is normally associated with rapidly deposited alluvial soils or improperly founded or poorly compacted fill. These areas are known to undergo extensive settling with the addition of irrigation water, but evidence due to ground shaking is not available.

Other Hazards

Earthquakes can also cause landslides and dam failures. Earthquakes may cause landslides (discussed in Section 4.2.11), particularly during the wet season, in areas of high water or saturated soils. Finally, earthquakes can cause dams to fail (see Section 4.2.4 Dam Failure).

Faults

A fault is defined by the CGS as "a fracture or fracture zone in the earth's crust along which there has been displacement of the sides relative to one another." For the purpose of planning there are two types of faults, active and inactive. Active faults have experienced displacement in historic time, suggesting that future displacement may be expected. Inactive faults show no evidence of movement in recent geologic time, suggesting that these faults are dormant. This does not mean, however, that faults having no evidence of surface displacement within the last 11,000 years are necessarily inactive. For example, the 1975 Oroville earthquake, the 1983 Coalinga earthquake, and the 1987 Whittier Narrows earthquake occurred on faults not previously recognized as active. Potentially active faults are those that have shown displacement within

the last 1.6 million years (Quaternary). An inactive fault shows no evidence of movement in historic (last 200 years) or geologic time, suggesting that these faults are dormant.

The Bay Area straddles the boundary where two of the Earth's largest tectonic plates meet and slowly move past one another. When boundary faults break and the North American and Pacific Plates lurch past each other, quakes occur. At least eight faults in the Bay Area are capable of producing earthquakes of magnitude 6.7 or larger. Such quakes can kill and injure many people and cause substantial damage to buildings, roads, bridges, and utilities.

Two types of fault movement represent possible hazards to structures in the immediate vicinity of the fault: fault creep and sudden fault displacement. Fault creep, a slow movement of one side of a fault relative to the other, can cause cracking and buckling of sidewalks and foundations even without perceptible ground shaking. Sudden fault displacement occurs during an earthquake event and may result in the collapse of buildings or other structures that are found along the fault zone when fault displacement exceeds an inch or two. The only protection against damage caused directly by fault displacement is to prohibit construction in the fault zone.

There are five faults that threat the City. These are shown in Table 4-12.

*Table 4-12 San Rafael – Faults of Concern and Peak Ground Accelerations**

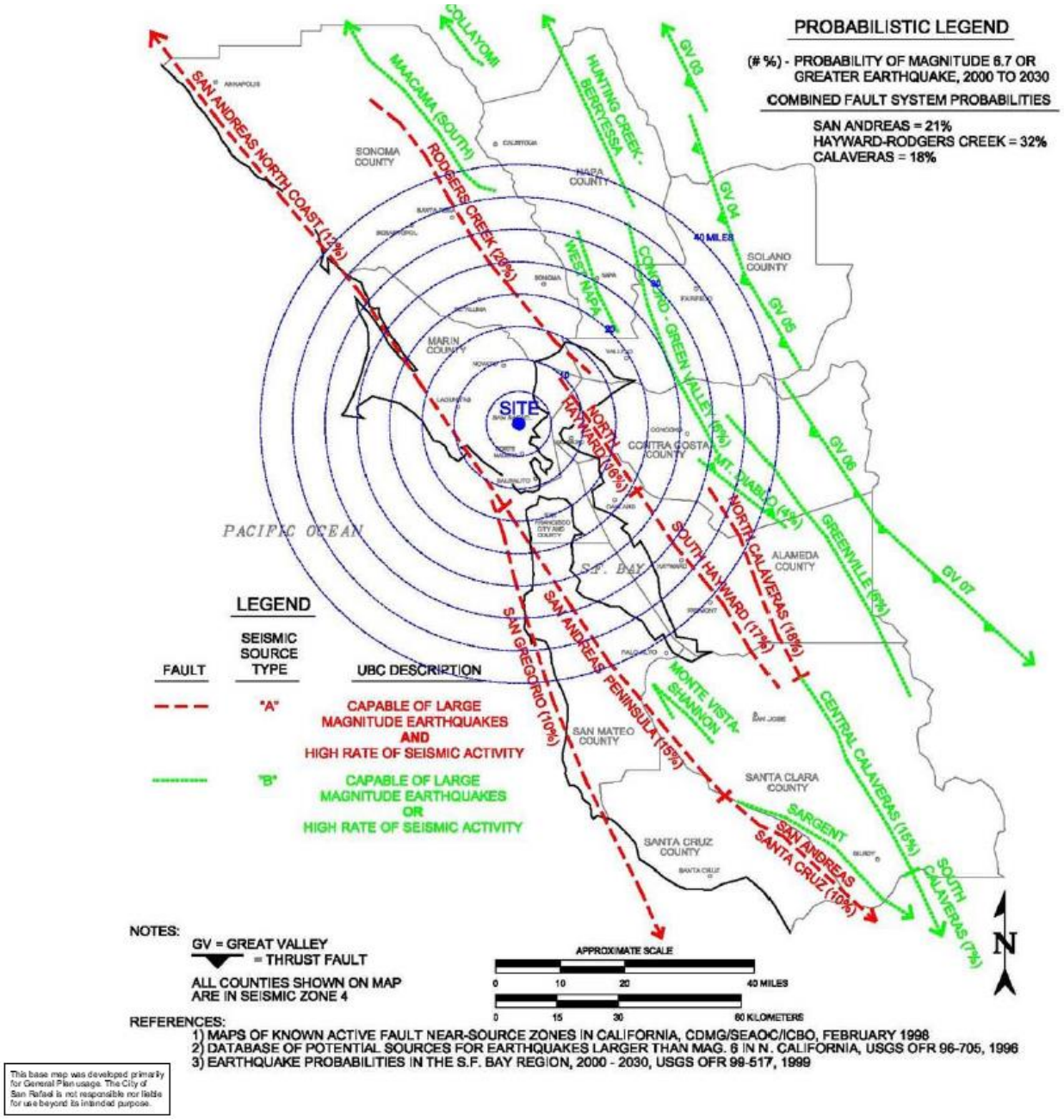
Name	Maximum Credible Magnitude	Distance to Fault	Median Peak Bedrock Acceleration	Median Peak Soft Soil Acceleration
San Andreas	7.9	14 km	0.36g	0.46g
Hayward	7.1	14 km	0.27g	0.37g
San Gregorio	7.3	21 km	0.22g	0.35g
Rodger Creek	7.0	21 km	0.20g	.033g
Calaveras	7.0	50 km	0.09g	0.21g

Source: National Earthquake Information Center, 2020 General Plan Background Report

*The calculated accelerations should only be considered as reasonable estimates. Many factors (soil conditions, distance, orientation to fault) can influence the actual ground surface accelerations

Figure 4-21 is a map of faults in the County with the potential for earthquake shaking sufficiently strong to trigger landslide and liquefaction.

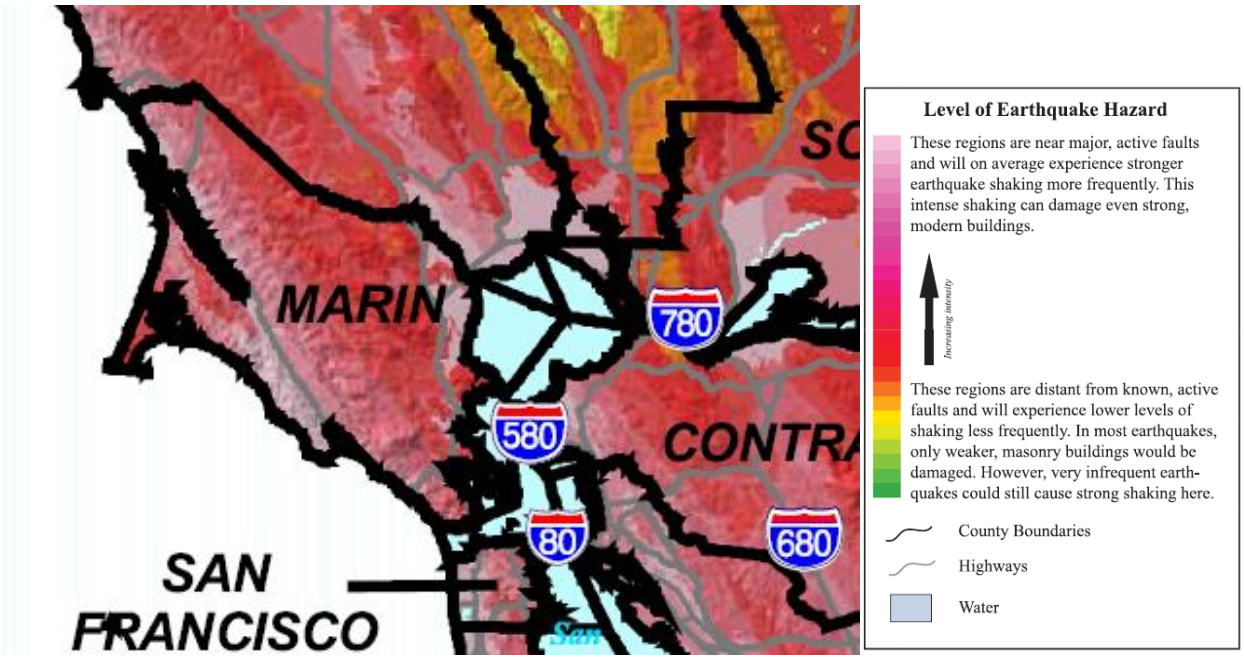
Figure 4-21 Active Faults in and around Marin County



Source: 2020 General Plan Background Report

Maps indicating the maximum expectable intensity of groundshaking for the County are available through several sources. Figure 4-22, prepared by the California Division of Mines and Geology, shows the expected relative intensity of ground shaking and damage in California from anticipated future earthquakes. The shaking potential is calculated as the level of ground motion that has a 2% chance of being exceeded in 50 years, which is the same as the level of ground-shaking with about a 2,500-year average repeat time. According to the map, San Rafael is located in an area of high earthquake shaking.

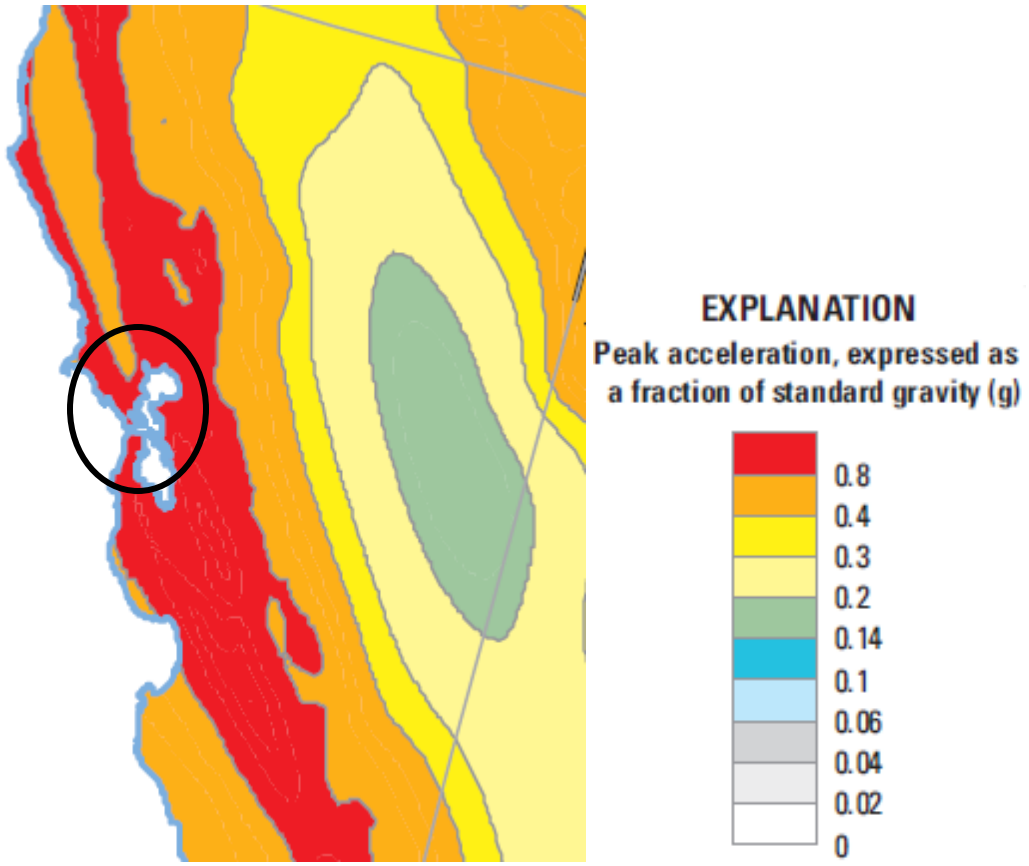
Figure 4-22 Maximum Expectable Earthquake Intensity



Source: California Division of Mines and Geology. Earthquake Shaking Potential for California, 2003.

The U.S. Geological Survey (USGS) issues National Seismic Hazard Maps as reports every few years. These maps provide various acceleration and probabilities for time periods. The following figures are from the 2014 hazard mapping. Figure 4-23 depicts the peak horizontal acceleration (%g) with 10% probability of exceedance in 50 years (a 500-year event) for the planning region. The figure demonstrates that the City falls in the 0.80%g areas (red). This data indicates that the expected severity of earthquakes in the region is very high, as damage from earthquakes typically occurs at peak accelerations of 0.3%g or greater.

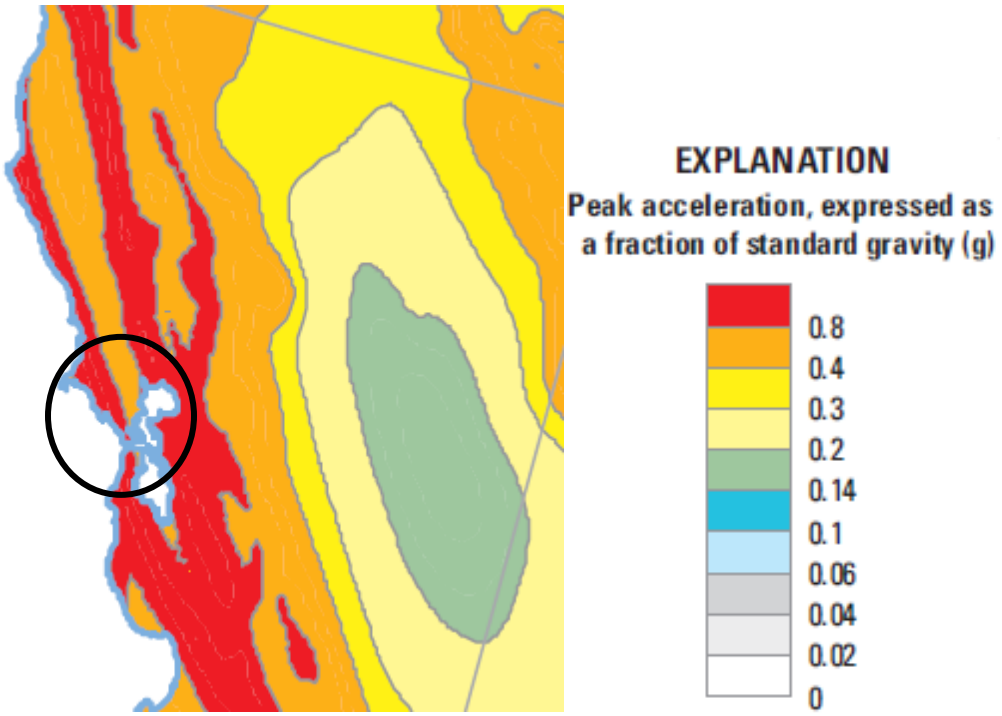
Figure 4-23 Peak Horizontal Acceleration with 10% Probability of Occurrence in 50 Years



Source: 2014 USGS National Seismic Hazard Maps

Figure 4-24 depicts the peak horizontal acceleration (%g) with 2% probability of exceedance in 50 years (a 2,500-year event) for the County. The figure demonstrates that the County falls in the 0.8%g area (red). This data indicates that the expected severity of earthquakes in the region is moderate, as damage from earthquakes typically occurs at peak accelerations of 0.3%g or greater.

Figure 4-24 Peak Horizontal Acceleration with 2% Probability of Occurrence in 50 Years



Source: 2014 USGS National Seismic Hazard Maps

Past Occurrences

Disaster Declaration History

There has been one federal and one state disaster declaration for earthquakes in Marin County. Both were related to the Loma Prieta earthquake in 1989. This can be seen in Table 4-13.

Table 4-13 City of San Rafael – Earthquake Disaster Declarations

Year	Disaster Name	Disaster Type	Disaster Cause	Disaster #	State Declaration #	Federal Declaration #
1989	Loma Prieta Earthquake	Earthquake	Earthquake	DR-845	10/18/89-10/30/89	10/18/1989

Source: Cal OES, FEMA

NCDC Events

The NCDC database does not track earthquakes.

USGS Events

In addition, the USGS National Earthquake Information Center database contains data on earthquakes in the San Rafael area. Table 4-14 shows the approximate distances earthquakes can be felt away from the epicenter. According to the table, a magnitude 5.0 earthquake could be felt up to 90 miles away. The

USGS database was searched for magnitude 5.0 or greater on the Richter Scale within 90 miles of the City of San Rafael. These results are shown on Table 4-14.

Table 4-14 Approximate Relationships between Earthquake Magnitude and Intensity

Richter Scale Magnitude	Maximum Expected Intensity (MM)*	Distance Felt (miles)
2.0 - 2.9	I – II	0
3.0 - 3.9	II – III	10
4.0 - 4.9	IV – V	50
5.0 - 5.9	VI – VII	90
6.0 - 6.9	VII – VIII	135
7.0 - 7.9	IX – X	240
8.0 - 8.9	XI – XII	365

*Modified Mercalli Intensity Scale.

Source: United State Geologic Survey, Earthquake Intensity Zonation and Quaternary Deposits, Miscellaneous Field Studies Map 9093, 1977.

Table 4-15 Magnitude 5.0 Earthquakes within 90 Miles of San Rafael

Date*	Richter Magnitude	Location
12/14/2016	5	8km NW of The Geysers, California
8/24/2014	6.02	South Napa Earthquake
1/12/2014	4.5	6km NW of The Geysers, California
3/14/2013	4.5	5km WSW of Cobb, California
3/1/2011	4.5	7km NW of The Geysers, CA
10/31/2007	5.6	San Francisco Bay area, California
8/3/2006	4.69	5km NNE of Sebastopol, CA
6/15/2006	4.54	13km E of San Martin, CA
2/18/2004	4.5	Northern California
9/3/2000	5	Northern California
1/11/2000	4.59	Northern California
8/18/1999	4.6	San Francisco Bay area, California
5/21/1996	4.7	San Francisco Bay area, California
6/4/1995	4.8	Northern California
8/11/1993	4.67	Northern California
1/16/1993	4.91	9km E of Gilroy, California
11/2/1989	4.7	Northern California
10/18/1989	7.2	Northern California
8/8/1989	5.4	Northern California
4/3/1989	4.5	San Francisco Bay area, California
11/10/1988	4.8	San Francisco Bay area, California

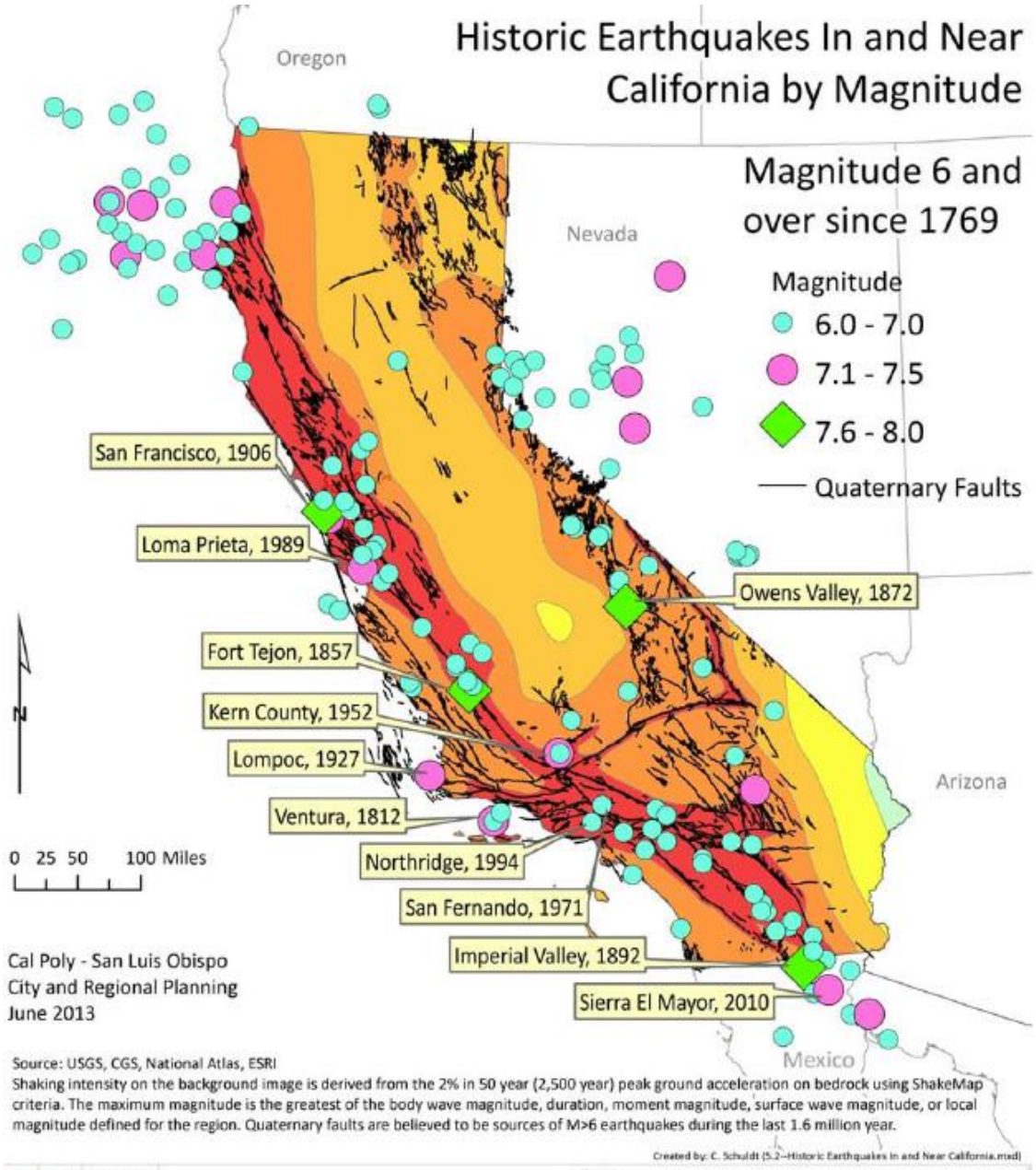
Date*	Richter Magnitude	Location
6/27/1988	5.3	Northern California
6/13/1988	5.3	San Francisco Bay area, California
3/31/1986	5.7	Northern California
4/24/1984	6.2	Northern California
8/18/1982	4.5	Northern California
1/15/1981	4.8	San Francisco Bay area, California
1/27/1980	5.4	San Francisco Bay area, California
1/25/1980	4.6	San Francisco Bay area, California
1/24/1980	5.8	San Francisco Bay area, California
8/6/1979	5.8	Northern California
5/8/1979	4.8	Northern California
10/3/1973	4.6	Northern California
3/22/1957	5.7	offshore Northern California
9/5/1955	5.8	Northern California

Source: USGS

*Search dates 1/1/1950 to 1/1/2017

The 2013 California State Hazard Mitigation Plan contained a map of large earthquakes in the State since 1769. That is shown in Figure 4-25.

Figure 4-25 Major Earthquakes in California since 1769



MMI	Damage	Effects
X	Very Heavy	Some well-built, wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.
IX	Heavy	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
VIII	Moderate to Heavy	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
VII	Moderate	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly-built or badly designed structures; some chimneys broken.
VI	Light	Felt by all, many frightened. Some heavy furniture moved; a few instance of fallen plaster. Damage slight.
V	Very Light	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.

Source: 2013 California State Hazard Mitigation Plan

City Planning Team Events

The HMPC noted the following events that affected the City and surrounding areas prior to 1950. This includes the earthquake on Table 4-16.

Table 4-16 Earthquake Events near San Rafael

Fault	Magnitude	Year	Distance from City
San Andreas	8.3	1906	18 miles
Rodgers Creek	6.2	1898	16 miles
San Hayward	6.8	1868	30 miles
San Andreas	7.0	1838	26 miles
Hayward	6.8	1836	21 miles

Source: 2020 General Plan Background Report

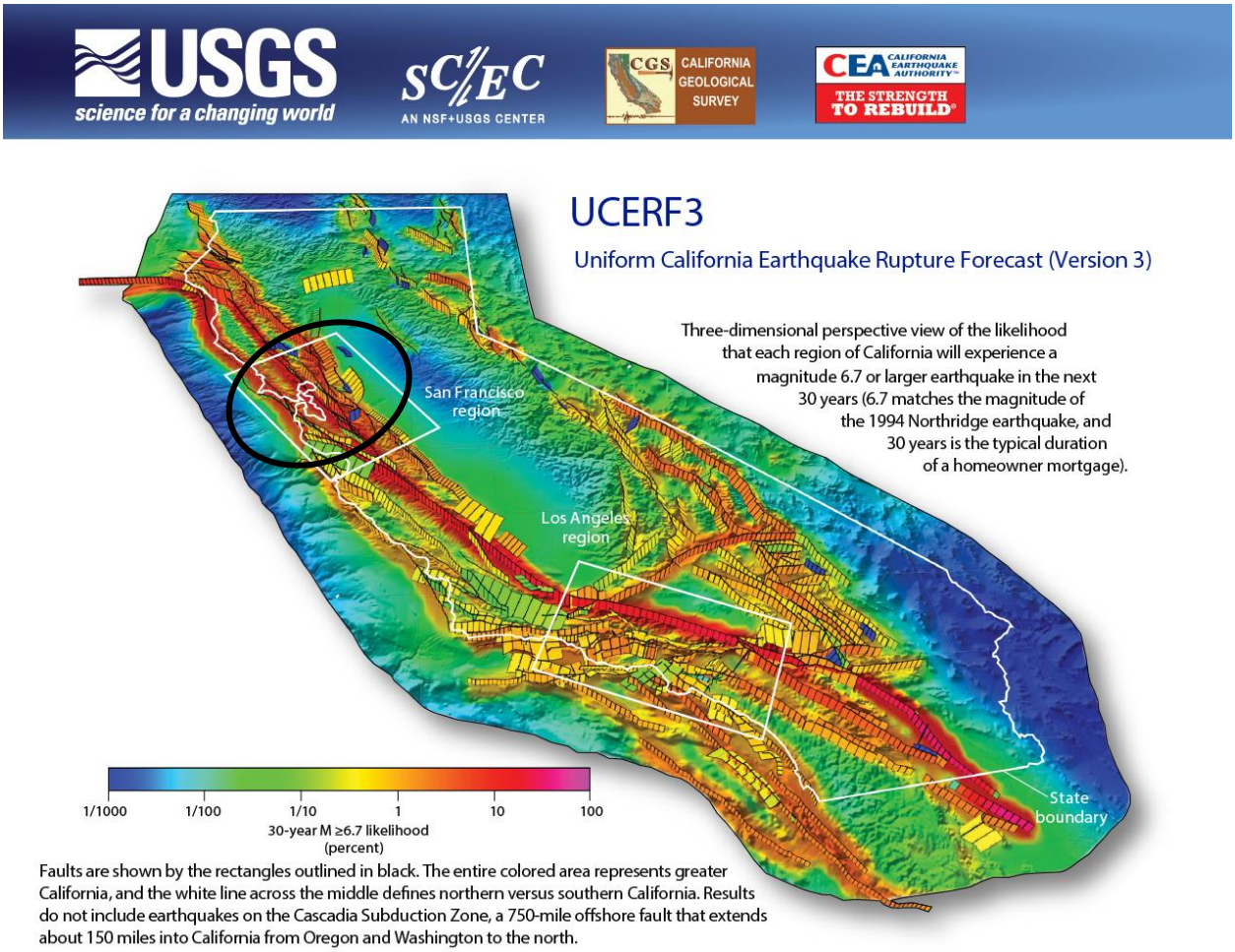
CAN THE CITY IDENTIFY ANY DAMAGES/IMPACTS ASSOCIATED WITH ANY OF THESE PAST OCCURRENCES?

Likelihood of Future Occurrence

Occasional (major earthquake)/Likely (minor earthquake) – Based on historical data and the location of the City relative to active and potentially active faults, San Rafael a may experience a significantly damaging earthquake occasionally. The 2020 General Plan Background Report noted that compared to other cities in the Bay Area, the estimated historic earthquake accelerations within the City have been relatively low. This is due to the fact that San Rafael is located an equal distance between the major faults and the epicenters of the historic earthquakes have been a fair distance from the City.

In 2014, the United States Geological Survey (USGS) and the California Geological Survey (CGS) released the time-dependent version of the Uniform California Earthquake Rupture Forecast (UCERF III) model. The UCERF III results have helped to reduce the uncertainty in estimated 30-year probabilities of strong ground motions in California. The UCERF map is shown in Figure 4-26 and indicates that San Rafael has a moderate to high risk of earthquake occurrence, which coincides with the likelihood of future occurrence rating of occasional.

Figure 4-26 Probability of Earthquake Magnitudes Occurring in 30 Year Time Frame



Source: United States Geological Survey Open File Report 2015-3009

Climate Change and Earthquake

According to the CAS, climate change is unlikely to increase earthquake frequency or strength.

4.2.9. Earthquake: Liquefaction Hazard Profile

Hazard/Problem Description

Liquefaction can be defined as the loss of soil strength or stiffness due to a buildup of pore-water pressure during a seismic event and is associated primarily with relatively loose, saturated fine- to medium-grained unconsolidated soils. Areas most prone to liquefaction are those that are water saturated (e.g., where the water table is less than 30 feet below the surface) and consist of relatively uniform sands that are loose to medium density. In addition to necessary soil conditions, the ground acceleration and duration of the earthquake must be of sufficient energy to induce liquefaction. Marin seismic ground shaking of relatively loose, granular soils that are saturated or submerged can cause the soils to liquefy and temporarily behave as a dense fluid. If this layer is at the surface, its effect is much like that of quicksand for any structure

located on it. If the liquefied layer is in the subsurface, the material above it may slide laterally depending on the confinement of the unstable mass. Liquefaction is caused by a sudden temporary increase in pore-water pressure due to seismic densification or other displacement of submerged granular soils. Liquefiable soil conditions are not uncommon in alluvial deposits in moderate to large canyons and could also be present in other areas of alluvial soils where the groundwater level is shallow (i.e., 50 feet below the surface). Bedrock units, due to their dense nature, are unlikely to present a liquefaction hazard.

Liquefaction during major earthquakes has caused severe damage to structures on level ground as a result of settling, titling, or floating. Such damage occurred in San Francisco on bay-filled areas during the 1989 Loma Prieta earthquake, even though the epicenter was several miles away. If liquefaction occurs in or under a sloping soil mass, the entire mass may flow toward a lower elevation. Also of particular concern in terms of developed and newly developing areas are fill areas that have been poorly compacted.

Typical effects of liquefaction include:

- Loss of bearing strength—the ground can liquefy and lose its ability to support structures.
- Lateral spreading—the ground can slide down very gentle slopes or toward stream banks riding on a buried liquefied layer.
- Sand boils—sand-laden water can be ejected from a buried liquefied layer and erupt at the surface to form sand volcanoes; the surrounding ground often fractures and settles.
- Flow failures—earth moves down steep slope with large displacement and much internal disruption of material.
- Ground oscillation—the surface layer, riding on a buried liquefied layer, is thrown back and forth by the shaking and can be severely deformed.
- Flotation—light structures that are buried in the ground (like pipelines, sewers and nearly empty fuel tanks) can float to the surface when they are surrounded by liquefied soil.
- Settlement—when liquefied ground re-consolidates following an earthquake, the ground surface may settle or subside as shaking decreases and the underlying liquefied soil becomes more dense.

Within San Rafael, areas underlain by alluvium are most likely to contain liquefiable soils. Although bay mud is not the type of soil that is susceptible to liquefaction, ancient stream meanders within the bay mud can leave isolated deposit of liquefiable soil. There are no know widespread deposits of potentially liquefiable soils in and around San Rafael. The probability of damage from liquefaction is moderate in alluvial areas, low in bay mud areas, and remote in the bedrock areas.

Past Occurrences

Disaster Declaration History

There have been no federal or state disaster declaration due to earthquake liquefaction.

NCDC Events

The NCDC does not track liquefaction events.

City Planning Team Events

ANY LIQUEFACTION EVENTS OR CONCERNS?

Likelihood of Future Occurrences

Occasional – The 2020 General Plan Background Report noted that the future probability of damage from liquefaction is moderate in alluvial areas, low in bay mud areas, and remote in the bedrock areas.

Climate Change and Earthquake

According to the CAS, climate change is unlikely to increase earthquake frequency or strength.

4.2.10. Flood: 100/500-year Hazard Profile

Hazard/Problem Description

According to Cal DWR, flooding is the rising and overflowing of a body of water onto normally dry land. Floods are among the most costly natural disasters in terms of human hardship and economic loss nationwide. Floods can cause substantial damage to structures, landscapes, and utilities as well as life safety issues. Floods can be extremely dangerous, and even six inches of moving water can knock over a person given a strong current. A car will float in less than two feet of moving water and can be swept downstream into deeper waters. This is one reason floods kill more people trapped in vehicles than anywhere else. During a flood, people can also suffer heart attacks or electrocution due to electrical equipment short outs. Floodwaters can transport large objects downstream which can damage or remove stationary structures. Ground saturation can result in instability, collapse, or other damage. Objects can also be buried or destroyed through sediment deposition. Floodwaters can also break utilities lines and interrupt services. Standing water can cause damage to crops, road, foundations, and electrical circuits. Direct impacts, such as drowning, can be limited with adequate warning and public education about what to do during floods. Where flooding occurs in populated areas, warning and evacuation will be of critical importance to reduce life and safety impacts from any type of flooding.

Health Hazards from Flooding

According to FEMA, certain health hazards are also common to flood events. While such problems are often not reported, three general types of health hazards accompany floods. The first comes from the water itself. Floodwaters carry anything that was on the ground that the upstream runoff picked up, including dirt, oil, animal waste, and lawn, farm and industrial chemicals. Pastures and areas where cattle and hogs are kept or their wastes are stored can contribute polluted waters to the receiving streams.

Floodwaters also saturate the ground, which leads to infiltration into sanitary sewer lines. When wastewater treatment plants are flooded, there is nowhere for the sewage to flow. Infiltration and lack of treatment can lead to overloaded sewer lines that can back up into low-lying areas and homes. Even when it is diluted by flood waters, raw sewage can be a breeding ground for bacteria such as e. coli and other disease causing agents.

The second type of health problem arises after most of the water has gone. Stagnant pools can become breeding grounds for mosquitoes, and wet areas of a building that have not been properly cleaned breed mold and mildew. A building that is not thoroughly cleaned becomes a health hazard, especially for small children and the elderly.

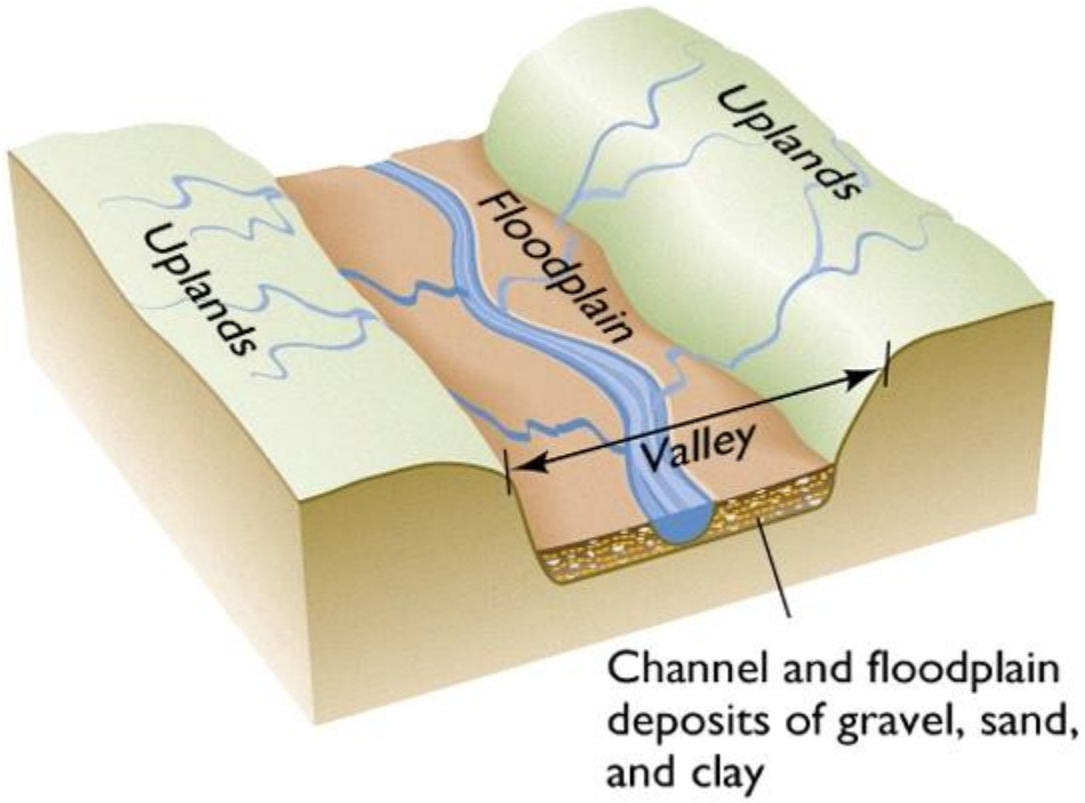
Another health hazard occurs when heating ducts in a forced air system are not properly cleaned after inundation. When the furnace or air conditioner is turned on, the sediments left in the ducts are circulated throughout the building and breathed in by the occupants. If a water system loses pressure, a boil order may be issued to protect people and animals from contaminated water.

The third problem is the long-term psychological impact of having been through a flood and seeing one's home damaged and irreplaceable keepsakes destroyed. The cost and labor needed to repair a flood-damaged home puts a severe strain on people, especially the unprepared and uninsured. There is also a long-term problem for those who know that their homes can be flooded again. The resulting stress on floodplain residents takes its toll in the form of aggravated physical and mental health problems.

Floodplains

The area adjacent to a channel is the floodplain (see Figure 4-27). Floodplains are illustrated on inundation maps, which show areas of potential flooding and water depths. In its common usage, the floodplain most often refers to that area that is inundated by the 100-year flood, the flood that has a one percent chance in any given year of being equaled or exceeded. The 100-year flood is the national minimum standard to which communities regulate their floodplains through the National Flood Insurance Program. The 200-year flood is one that has 0.5% chance of being equaled or exceeded each year. The 500-year flood is the flood that has a 0.2 percent chance of being equaled or exceeded in any given year. The potential for flooding can change and increase through various land use changes and changes to land surface, which result in a change to the floodplain. A change in environment can create localized flooding problems inside and outside of natural floodplains by altering or confining natural drainage channels. These changes are most often created by human activity.

Figure 4-27 Floodplain Schematic



Source: FEMA

There are three types of freshwater flood events in the San Rafael area: riverine, flash, and urban stormwater. Regardless of the type of flood, the cause is often the result of severe weather and excessive rainfall, either in the flood area or upstream reaches.

- **Riverine flooding** is the most common type of flood event and occurs when a watercourse exceeds its "bank-full" capacity. Riverine flooding generally occurs as a result of prolonged rainfall, or rainfall that is combined with already saturated soils from previous rain events. The duration of riverine floods may vary from a few hours to many days. Factors that directly affect the amount of flood runoff include precipitation amount, intensity and distribution, the amount of soil moisture, seasonal variation in vegetation, snow depth, and water-resistance of the surface due to urbanization. The warning time associated with slow rise floods assists in life and property protection.
- The term "**flash flood**" describes localized floods of great volume and short duration. In contrast to riverine flooding, this type of flood usually results from a heavy rainfall on a relatively small drainage area. Precipitation of this sort usually occurs in the winter and spring. Flash floods often require immediate evacuation within the hour.
- **Stormwater/Urban flood** events have increased as land has been converted from fields or woodlands to roads and parking lots and lost its ability to absorb rainfall. Urbanization increases runoff by two to six times that of natural terrain. This is discussed in the Localized Flooding section of this hazard profile below.

In addition, San Rafael is also subject to saltwater flooding and intrusions:

- **Coastal (Tidal) Flooding**: All lands bordering the San Francisco Bay are prone to tidal flooding. Coastal land such as sand bars, barrier islands, and deltas provide a buffer zone to help protect human life and real property relative to the sea much as floodplains provide a buffer zone along rivers and other bodies of water. Coastal floods usually occur as a result of abnormally high tides or tidal waves, storm surge, and heavy rains in combination with high tides, tropical storms and hurricanes.

The City of San Rafael is subject to both freshwater and tidal flooding. The two major tidal flooding areas are along the lower portions of Gallinas and San Rafael Creeks. The principal causes of freshwater flooding in the City of San Rafael are the local watercourses overtopping their banks during extreme rainfall, coupled with the inability of the topography and drainage system of the City to handle various torrential rains which have occurred. This is discussed in greater detail in Section 4.2.5.

The area is also at risk to flooding resulting from levee failures and to a lesser extent dam failures. Dam failure flooding is discussed separately in Section 4.2.6 of this document; levee failure flooding is discussed separately in Section 4.2.13 of this document. Regardless of the type of flood, the cause is often the result of severe weather and excessive rainfall, either in the flood area or upstream reach.

The 2020 General Plan Background Report noted that subsidence in the City may affect flooding:

> *Subsidence may result in flooding as ground levels are lowered. Flooding poses a serious threat to the East San Rafael area. Much of this area lies in the FEMA 100-year flood zone. Almost all of the development was constructed at or has subsided below the 100-year flood elevation. For roughly 40 years, the City of San Rafael has required new development to be placed on fill above the FEMA designated flood level of +6.0 feet NGVD… Where there is fill placed on bay mud, consolidation of the mud continues to occur over a very long period of time.*

The potential for flooding can change and increase through various land use changes and changes to land surface, resulting in a change to the floodplain. Environmental changes can create localized flooding problems in and outside of natural floodplains by altering or confining natural drainage channels. These changes are most often created by human activity.

Major Sources of Flooding

According to Cal DWR, California is divided into 10 hydrologic regions. Marin County and San Rafael are traversed by one hydrologic regions: San Francisco Bay. A map of the California's hydrological regions is provided in Figure 4-28.

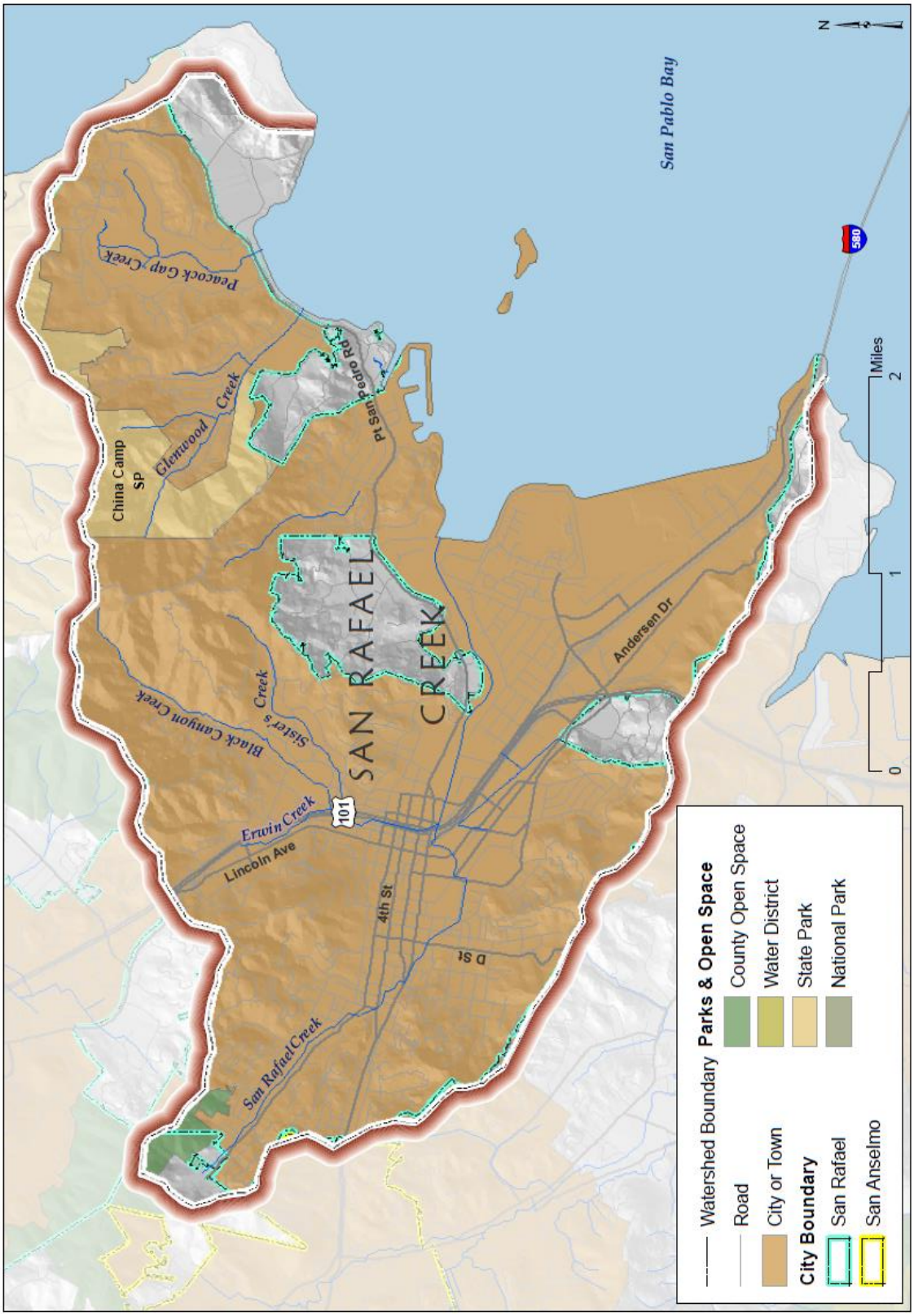
Figure 4-28 California Hydrologic Regions

Source: California Department of Water Resources

San Rafael Streams and Watersheds

The San Rafael watershed comprises 11 square miles and is densely developed from its hills to filled wetlands. The creek originates in the hills above Tamalpais Cemetery and flows through residential and industrialized areas before forming the San Rafael Canal in the vicinity of Highway 101. The upper stream corridor consists of short stretches of open stream channel, underground culverts, and trapezoidal open channels. The creek enters San Rafael Bay at Pickleweed Park. San Rafael Creek and Canal, once important commercial waterways in Marin, are currently used as marinas for recreational watercraft. Waterways and watersheds in the City are shown in Figure 4-29.

Figure 4-29 San Rafael – Waterways

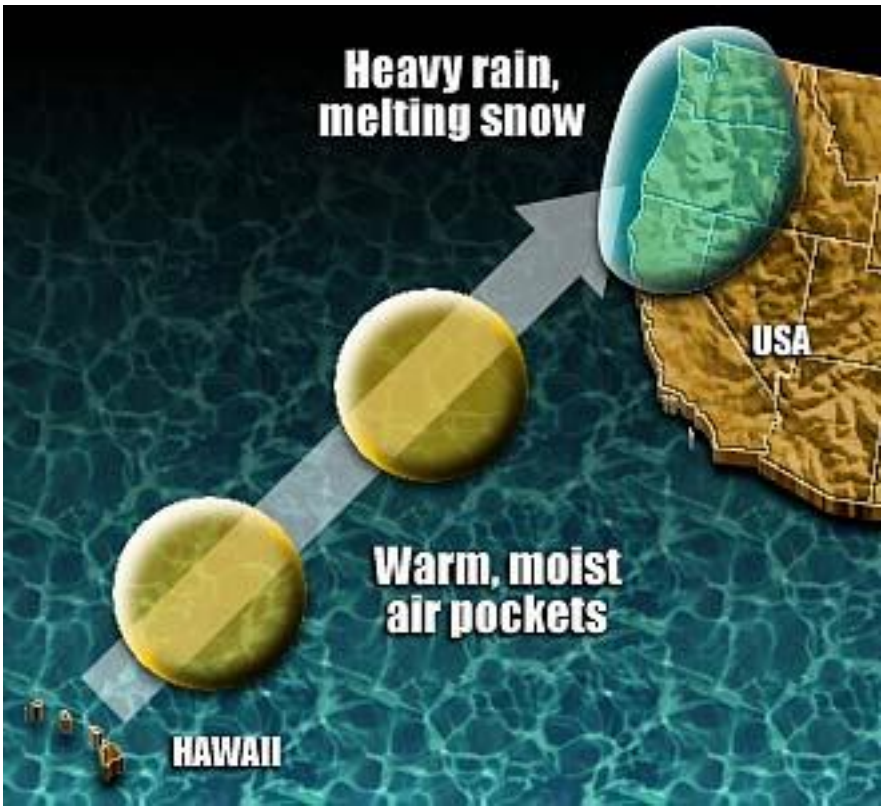


Source: Marin County Watershed Program

In San Rafael, the Flood Insurance Study (FIS) reports that flooding in the area can occur any time from fall to spring as a result of the occurrence of general rainstorms. General rain floods result from prolonged, heavy rainfall over tributary areas and are characterized by high peak flows and moderate duration and a large volume of runoff. Flooding is more severe when antecedent rainfall has resulted in saturated ground conditions, when the ground is frozen and infiltration is minimal, or when rain on snow in the higher elevations adds snowmelt to rain flood runoff. Summer thunderstorms can also lead to flooding. Flooding sources that could affect the City are shown in Figure 4-29.

A weather pattern traditionally referred to as the "Pineapple Express" contributes to the flooding potential of the area. Pineapple express brings warm air, rain to West. A relatively common weather pattern brings southwest winds to the Pacific Northwest or California, along with warm, moist air. The moisture sometimes produces many days of heavy rain, which can cause extensive flooding. The warm air also can melt the snow pack in the mountains, which further aggravates the flooding potential. In the colder parts of the year, the warm air can be cooled enough to produce heavy, upslope snow as it rises into the higher elevations of the Sierra Nevada or Cascades. Forecasters and others on the West Coast often refer to this warm, moist air as the "Pineapple Express" because it comes from around Hawaii where pineapples are grown. This is shown in Figure 4-30. This weather pattern is further discussed in Section 4.3.8 in the ArkStorm scenario, which is a more recent term for the pineapple express pattern.

Figure 4-30 Pineapple Express Weather Pattern



Source: USA TODAY research by Chad Palmer http://www.usatoday.com/weatherwpinappl.htm

Floodplain Mapping

FEMA established standards for floodplain mapping studies as part of the National Flood Insurance Program (NFIP). The NFIP makes flood insurance available to property owners in participating communities adopting FEMA-approved local floodplain studies, maps, and regulations. Floodplain studies that may be approved by FEMA include federally funded studies; studies developed by state, city, and regional public agencies; and technical studies generated by private interests as part of property annexation and land development efforts. Such studies may include entire stream reaches or limited stream sections depending on the nature and scope of a study. A general overview of floodplain mapping and associated products is provided in the following paragraphs.

Flood Insurance Study (FIS)

The FIS develops flood-risk data for various areas of the community that will be used to establish flood insurance rates and to assist the community in its efforts to promote sound floodplain management. The current Marin County FISs are dated March 16, 2016.

Digital Flood Insurance Rate Maps (DFIRM)

As part of its Map Modernization program, FEMA is converting paper FIRMS to digital FIRMs, DFIRMS. These digital maps:

- Incorporate the latest updates (LOMRs and LOMAs);
- Utilize community supplied data;
- Verify the currency of the floodplains and refit them to community supplied basemaps;
- Upgrade the FIRMs to a GIS database format to set the stage for future updates and to enable support for GIS analyses and other digital applications; and
- Solicit community participation.

DFIRMs for Marin County and San Rafael, dated March 16, 2016 and are used for this plan's flood hazard analysis. This is shown in Figure 4-52 in Section 4.3.8.

Department of Water Resource (DWR) Floodplain Mapping

Also to be considered when evaluating the flood risks in Marin County are various floodplain maps developed by Cal DWR for various areas throughout California, including Marin County and San Rafael.

DWR Best Available Maps

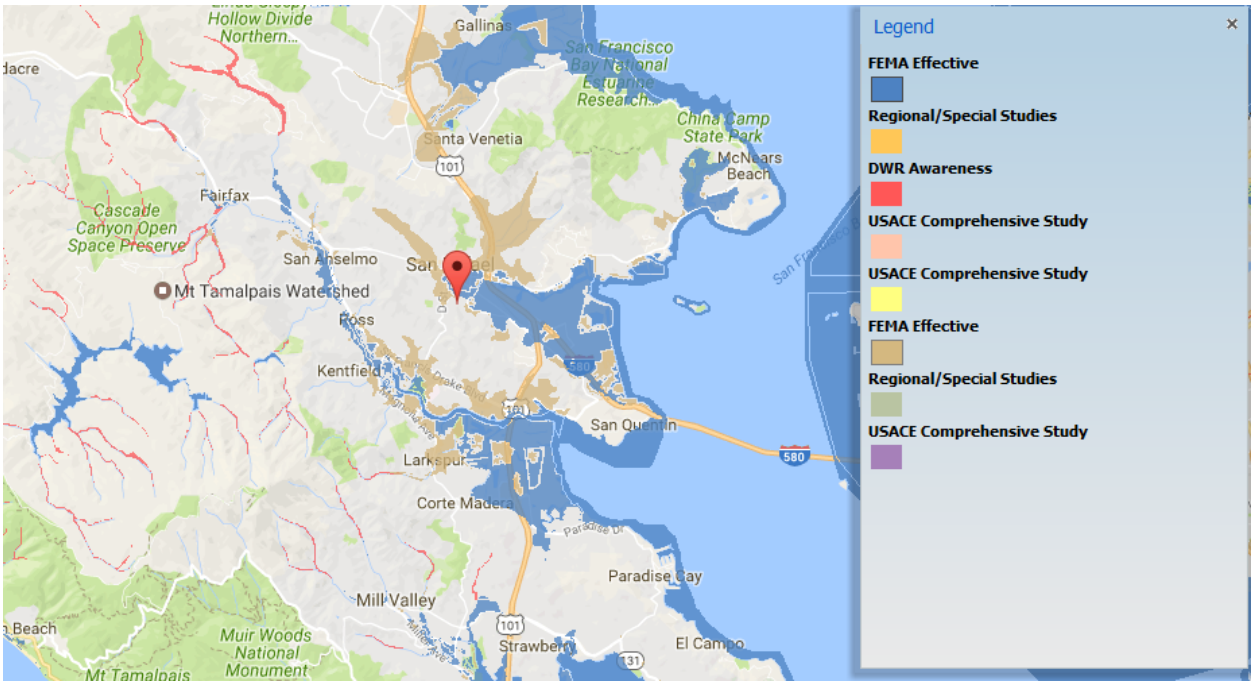
The FEMA regulatory maps provide just one perspective on flood risks in Marin County and San Rafael. Senate Bill 5 (SB 5), enacted in 2007, authorized the California DWR to develop the Best Available Maps (BAM) displaying 100- and 200-year floodplains for areas located within the Sacramento-San Joaquin (SAC-SJ) Valley watershed. SB 5 requires that these maps contain the best available information on flood hazards and be provided to cities and counties in the SAC-SJ Valley watershed. This effort was completed by DWR in 2008. DWR has expanded the BAM to cover all counties in the State and to include 500-year floodplains.

Different than the FEMA DFIRMs which have been prepared to support the NFIP and reflect only the 100-year event risk, the BAMs are provided for informational purposes and are intended to reflect current 100- and 500-year event risks using the best available data. The 100-year floodplain limits on the BAM are a composite of multiple 100-year floodplain mapping sources. It is intended to show all currently identified areas at risk for a 100-year flood event, including FEMA's 100-year floodplains. The BAM maps are comprised of different engineering studies performed by FEMA, Corps, and DWR for assessment of potential 100- and 500-year floodplain areas. These studies are used for different planning and/or regulatory applications. They are for the same flood frequency; however, they may use varied analytical and quality control criteria depending on the study type requirements.

The value in the BAMs is that they provide a bigger picture view of potential flood risk to the City of San Rafael than that provided in the FEMA DFIRMs. This provides the community and residents with an additional tool for understanding potential flood hazards not currently mapped as a regulated floodplain. Improved awareness of flood risk can reduce exposure to flooding for new structures and promote increased protection for existing development. Informed land use planning will also assist in identifying levee maintenance needs and levels of protection. By including the FEMA 100-year floodplain, it also supports identification of the need and requirement for flood insurance.

These floodplain maps for San Rafael can be seen in Figure 4-31.

Figure 4-31 San Rafael – Best Available Map



Source: California DWR

Legend explanation: Blue - FEMA 100-Year, Orange – Local 100-Year (developed from local agencies), Red – DWR 100-year (Awareness floodplains identify the 100-year flood hazard areas using approximate assessment procedures.), Pink – USACE 100-Year (2002 Sac and San Joaquin River Basins Comp Study), Yellow – USACE 200-Year (2002 Sac and San Joaquin River Basins Comp Study), Tan – FEMA 500-Year, Grey – Local 500-Year (developed from local agencies), Purple – USACE 500-Year (2002 Sac and San Joaquin River Basins Comp Study).

Past Occurrences

Disaster Declaration History

Marin County has experience multiple federal and state declarations related to flooding since 1950. 6 of the federal declarations were associated with flood events, 6 with severe storm, and 1 with coastal storm. 17 of the state declarations were associated with flood events. These are shown in Table 4-17.

Table 4-17 Marin County – Disaster Declarations from Flooding

Year	Disaster Name	Disaster Type	Disaster Cause	Disaster #	State Declaration #	Federal Declaration #
2006	2006 June Storms	Flood	Storms	DR 1646	–	6/5/2006
2005/2006	2005/06 Winter Storms	Flood	Storms	DR-1628	–	2/3/2006
2003	State Road Damage	Road Damage	Flood	GP 2003	1/1/2003	–
1998	1998 El Nino Floods	Flood	Storms	DR-1203	Proclaimed	2/19/1998
1997	1997 January Floods	Flood	Storms	DR-1155	1/2/97-1/31/97	1/4/1997
1995	Vision Fire	Fire	Fire	DC 95-05	10/95	–
1995	1995 Severe Winter Storms	Flood	Storms	DR-1044	1/6/95-3/14/95	1/13/1995
1986	1986 Storms	Flood	Storms	DR-758	2/18-86-3/12/86	2/18/1986
1983	Winter Storms	Flood	Flood	DR-677	12/8/82-3/21/83	2/9/1983
1982	1982 Winter Storms	Flood	Storms	DR-651	1/5/82-1/9/82	1/7/1982
1980	April Storms	Flood	Storms	–	4/1/1980	–
1978	Heavy Rains (Marin)	Flood	Storms	DC 78-02	1/1/1978	–
1973	Coastal Flooding	Flood	Storms	DR 364	1/23/73-2/28/73	2/3/1973
1970	1970 Northern California Flooding	Flood	Flood	DR 283	1/27/1970 - 3/2/1970	2/16/1970
1969	1969 Storms	Flood	Storms	DR-253	1/23/69-3/12/69	1/26/1969
1964	1964 Late Winter Storms	Flood	Storms	DR-183	-	12/24/1964
1963	1963 Floods	Flood	Storms	-	2/14/1964	–
1958	1958 April Storms and Floods	Flood	Storms	DR-52	4/5/1958	4/4/1958

Year	Disaster Name	Disaster Type	Disaster Cause	Disaster #	State Declaration #	Federal Declaration #
1958	1958 February Storms and Floods	Flood	Storms	CDO 58-03	2/26/1958	–
1955	1955 Floods	Flood	Flood	DR-47	12/22/1955	12/23/1955
1950	1950 Floods	Flood	Flood	OCD 50-01	11/21/1950	–

Source: Cal OES, FEMA

NCDC Events

The NCDC has been tracking severe weather since 1950. This database contains 47 flood related events that occurred in Marin County between January 1, 1950, and June 30, 2016. Table 4-3 summarizes these events. Events that specifically affected San Rafael are detailed below the table.

*Table 4-18 NCDC Weather Events for Marin County, 1950 to June 30, 2016**

Event Type	Number of Events	Deaths	Deaths (indirect	Injuries	Injuries (indirect)	Property Damage	Crop Damage
Coastal Flood	9	0	0	0	0	$340,000	$0
Flash Flood	16	0	0	0	0	$5,556,000	$500,000
Flood	22	0	0	0	0	$216,183,100	$0
Total	**47**	**0**	**0**	**0**	**0**	**$222,079,100**	**$500,000**

Source: NCDC

*Note: Losses reflect totals for all impacted areas, not just San Rafael or Marin County

- **December 2002** – There were three primary episodes of precipitation in December, the first a two-day storm on the 9th and 10th. With less than an inch and a half accumulation at any one location over the period, flooding problems were not an issue. However, the rainfall totals helped to further saturate the soil. The next and by far most serious storm episode begin on the 13th of the month and lasted on and off through the 21st. A very strong and moist jet stream developed across the Pacific Ocean and brought a series of storms into California. Wave after wave of locally heavy rain pounded the north bay counties for days. Flooding became a serious issue, not just for urban and small stream flooding, but for mainstem flooding as well. Most of the mainstem flooding was minor in nature but there were areas of moderate flooding, mostly agricultural land. The last storm episode occurred from the 28th to the 31st. A good 2 to 4 inches of rain did fall over the area during that time with the most significant amounts over the coastal mountains. Urban and small stream flooding did occur and there was great concern for possible mudslides due to the saturation of the soil. San Rafael had 24-hour rain totals of 4.51 inches (13th), 2.98 inches (14th), 1.16 inches (15th), and 2.72 inches (16th).

FIS Flood Events

The FIS noted the following flood events that affected San Rafael:

- As noted in the San Rafael Independent Journal of **April 3, 1958**, "San Rafael increased the season's rainfall total to 58.7 inches. Such a total has never been recorded here by April 3 in the past"

- The Independent Journal of **January 16, 1973**, carried the following description: Central Marin County was widely flooded, with Fourth Street in San Rafael the only major street in the City where traffic was moving at times today. Corte Madera and Larkspur also reported heavy flooding. By Wednesday, January 17, 1973, an initial assessment of storm damage had been completed. The Independent Journal reported the following: Two violent storms, which have brought trouble and despair to Marin County, were blamed yesterday by county officials for causing nearly $2 million damage countywide; an estimate likely to climb before the week is out.
- The **1982** flood had a different damage profile than previous floods. The greatest loss of property—and in this case loss of life—was due to mudslides. Twenty-one homes were destroyed in neighboring the City of San Rafael. One woman lost her life in a slide there. By Saturday, January 9, 1982, a somewhat accurate assessment had been made of the damages in the City of Larkspur and Marin County. The Independent Journal reported the following: A 32-hour assault by 12 inches of rain unleashed 'rivers of destruction' Monday in Marin County. Four people were killed. More than 100 homes were either totally destroyed or substantially damaged. Another 2,000 were swamped by flood waters that soaked into the furniture and deposited a layer of silt on the floors. The storm sent more than 2,000 Marin residents rushing to evacuation centers set up across the county. By Wednesday morning, total damage in Marin County was estimated at over $100 million. In Sonoma County, it was over $16 million. To the south in Ben Lomond in Santa Cruz County, 14 deaths were reported and the total was expected to rise. The reports moved President Ronald Reagan to authorize Federal aid for Marin and five other bay area counties that had already been declared disaster areas by Governor Edmond Brown, Jr.

City Planning Team Events

CAN THE CITY IDENTIFY ANY ADDITIONAL PAST FLOODING EVENTS, LOCATIONS, AND THEIR IMPACTS?

WHAT ABOUT IMPACTS FROM JANUARY 2017 STORMS?

- **January 20, 1921** – A citizen member of the HMPC reviewed documents from the Marin History Museum. An article was found regarding the 1921 floods.

  San Rafael was drenched with 4.5 inches of rain according to the record at the Bank of San Rafael. The marsh in East San Rafael was a sea of water as the creeks and sewers posited their streams down out of the hills to meet the tides of the bay. The flats in Kentfield were covered with several feet of water. Old residents declared that the rainfall for a few hours was the heaviest of their recollections. In the main, however, no damage was done.

- **December 21, 1955** – A citizen member of the HMPC reviewed documents from the Marin History Museum. An article was found regarding the 1955 floods. These floods led to a state and federal disaster declaration.

nt Journal Est. 1861
F MARIN COUNTY

WEATHER FORECAST
Bay Areas Rain tonight and Thursday; little temperature change; southerly winds 25-35 tonight and early Thursday.
Sierra Nevadas Intermittent rain through Thursday with snow at high levels.

EDNESDAY, DECEMBER 21, 1955 Glenwood 4-3020 5c PER COPY No. 231

Heavy Rain, High Winds Expected To Continue

SAN JOSE GROUP

Novato Site Eyed For Golf Course

An unidentified group of San ose men are thinking of con- tructing a golf course on publicly wned lands near Novato's Staf- rd Dam, it was revealed last ight.

The group was given permission survey 150 acres of the property hich North Marin Water District w leases to rancher James osal for grazing.

fforts to create a golf course private interests were disclosed Director Emil Renati at a eting of the North Marin Water trict board.

enati, apparently the only di- rector who knows the identity of the financial backers, refused to disclose the persons' identity. "It might jeopardize the project," was his excuse.

From another source the Independent-Journal learned that the persons interested in the Novato area golf course are from San Jose. They are cooperating with the Marin County Golfers Assn. which has apparently been unable to purchase the large Freitas C Ranch near Novato, long mentioned as a site for a golf course.

udge Orders Board o Sell Tam Bonds

erior Court Judge Jordan L. nelli has cleared the way for lpais Union High School Dis- o proceed with sale of bonds xpansion of district school ies.

Monday, Martinelli issued a f mandate directing the Ma- ard of Supervisors to sell illion dollars in bonds as re- d by trustees of the high district. The bonds are part 3460,000 issue authorized by

Martinelli. The supervisors were represented by Deputy Dist. Atty. E. Warren McGuire.

McGuire said this morning that McDougall and his group did not formally intervene in the lawsuit, and hence cannot, if they so desired, appeal the decision. The county has no intention of appealing, McGuire said.

High School Dist. Supt. Chester G. Carlisle said today that he expects it will take from 60 to 70

Sopping County Braces As Mop-Up Continues

Fresh rains fell over most of Northern California again today posing the threat of new flooding in Marin and along the swollen Russian and Eel rivers.

The Weather Bureau said rains were generally light this morning but were expected to get heavier with winds expected to reach 20-25 miles per hour, tonight and tomorrow.

The new rains hampered work in clearing up the debris left in the wake of a savage, three-day storm. Over much of the county, flood waters still stood in low-lying areas and, in some cases, in the streets.

NO ESTIMATE

There was no general estimate of damage throughout the county, though damage to property resulting from the overflow of Corte Madera Creek was estimated at $60,000 by the Army Corps of Engineers. Wind damage in the area was not estimated.

The Corte Madera Creek damage was primarily to residential property.

ROAD CLOSED

The road from Stinson Beach to Bolinas was still closed this noon as state highway road crews worked to clear dirt, rocks and debris that blocked the highway at several points just north of Stinson Beach. The only way to get from Stinson to Bolinas today was via Olema. The slides started yesterday.

The California Highway Patrol office reported that all other state highways in the county were open as of noon, and barring another heavy downpour, no serious

NMWD To Defy County Road Work Controls

North Marin Water District wi light many of the county publ works director's restrictions road work, NMWD directors d cided last night on advice of the attorney, Harold F. Riede.

The two score or more requi ments that Public Works Direct Marvin Brigham lists on his re encroachment permits have months been the source of qu rels between Brigham and Grimes, NMWD manager. T disputes flared up into an word exchange at the water trict's Dec. 6 meeting.

LAW 'UNREASONABLE'

Last night Riede told dire he finds the county's ordin 625 "not valid, unreasonable"

Source: Marin History Museum, courtesy of Ray Lorber

- **January 3, 1982** – A citizen member of the HMPC reviewed documents from the Marin History Museum. An article was found regarding the 1982 floods.

Independent Journal

WORST STILL DUE: MORE RAIN, WIND

Hundreds Of Families Leave Homes Submerged By Flood

'High Seas' Rescue Of Bus Passengers

Source: Marin History Museum, courtesy of Ray Lorber

Likelihood of Future Occurrence

Occasional/Unlikely— The term "100-year flood" is misleading. It is not the flood that will occur once every 100 years. Rather, the 100-year flood is the flood that has a one percent chance in any given year of being equaled or exceeded. Thus, the 100-year flood could occur more than once in a relatively short period of time.

Climate Change and Flood

According to the CAS, climate change may affect flooding in the County. While average annual rainfall may increase or decrease slightly, the intensity of individual rainfall events is likely to increase during the 21st century. It is possible that average soil moisture and runoff could decline, however, due to increasing temperature, evapotranspiration rates, and spacing between rainfall events. Reduced snowpack and increased number of intense rainfall events in the Northern Sierra are likely to put additional pressure on water infrastructure which could increase the chance of flooding associated with breaches or failures of flood control structures such as levees and dams.

4.2.11. Localized Flooding Hazard Profile

Hazard/Problem Description

The General Plan Background Report noted that prior to European settlement of the present San Rafael area in the 1800s, the San Rafael Bay consisted of a significant zone of bayland habitats, including tidal flats and an expansive tidal marsh. Similar geomorphology and tidal habitat distributions occurred in the north at the mouths of the Gallinas Creek and Miller Creek watersheds. This, high Bay tides regularly inundated much of these areas. This is especially true during King Tides. These low lying, bayland habitats were gradually reclaimed for agriculture and urban development. Former tidal flats and tidal marshes were diked and filled, often to elevations that were insufficient to preclude periodic flood damages. Commercial and residential construction increased the proportion of the watershed covered by impervious surfaces and drained by underground storm drainage systems. This resulted in an increased efficiency in runoff generation during rainstorms.

According to the City Planning Team, localized, stormwater flooding also occurs throughout the County. Urban storm drainpipes and pump stations have a finite capacity. When rainfall exceeds this capacity, or the system is clogged, water accumulates in the street until it reaches a level of overland release. This type of flooding may occur when intense storms occur over areas of development.

DIDN'T SEE ANYTHING IN EOP, STORMWATER PLAN, GENERAL PLAN, OR GENERAL PLAN BACKGROUND REPORT. WHERE WOULD WE FIND THIS? CAN THE PLANNING TEAM PROVIDE INPUT?

According to the City, numerous parcels and roads throughout San Rafael not included in the FEMA 100- and 500-year floodplains are subject to flooding in heavy rains. These are delineated in Table 4-56 in Section 4.3.9. In addition to flooding, damage to these areas during heavy storms includes pavement deterioration, washouts, mudslides, debris areas, and downed trees. The frequency and type of damage or flooding that occurs varies from year to year, depending on the quantity of runoff.

Past Occurrences

The past occurrences of localized flooding are included in the 100-/500-year flood hazard profile in Section 4.2.10.

Likelihood of Future Occurrence

Highly Likely—With respect to the localized, stormwater flood issues, the potential for flooding may increase as storm water is channelized due to land development. Such changes can create localized flooding problems in and outside of natural floodplains by altering or confining natural drainage channels. Urban storm drainage systems have a finite capacity. When rainfall exceeds this capacity or systems clog, water accumulates in the street until it reaches a level of overland release. With increasing urbanization of San Rafael, combined with older infrastructure, this type of flooding will continue to occur during heavy rains.

Climate Change and Localized Flood

While average annual rainfall may decrease slightly, the intensity of individual rainfall events is likely to increase during the 21st century, increasing the likelihood of overwhelming stormwater systems built to historical rainfall averages. This makes localized flooding more likely.

4.2.12. Landslide, Mudslides, Hillside Erosion, and Debris Flows Hazard Profile

Hazard/Problem Description

Like its earthquake-generating faults, California's mountainous terrain is also a consequence of dynamic geologic processes in operation as the North American Plate grinds past the Pacific Plate. The 2013 State of California Hazard Mitigation Plan noted that more than one third of California is mountainous terrain that generally trends parallel to the coast, forming a barrier that captures moisture from offshore storms originating in the Gulf of Alaska and Mexico. This is true in and around San Rafael. Steep topography, weak rocks, heavy winter rains, and occasional earthquakes all lead to slope failures more frequently than would otherwise occur under gravity alone.

According to the CGS, a landslide is a general term for a variety of mass-movement processes that generate a down-slope movement of mud, soil, rock, and/or vegetation. Landslides are classified into many different types based on form and type of movement. They range from slow-moving rotational slumps and earth flows, which can slowly distress structures but are less threatening to personal safety, to fast-moving rock avalanches and debris flows that are a serious threat to structures and have been responsible for most fatalities during landslide events. For the purposes of this plan, the term landslide includes mudslides, debris flows, and rockfalls that tend to occur suddenly; as well as hillside erosion, which is a similar process that tends to occur on smaller scales and more gradually, but can exacerbate landslide events.

Natural conditions that contribute to landslide, mudslides, hillside erosion, and debris flows include the following:

- Degree of slope
- Water (heavy rain, river flows, or wave action)
- Unconsolidated soil or soft rock and sediments
- Lack of vegetation (no stabilizing root structure)
- Previous wildfires and other forest disturbances

- Road building, excavation and grading
- Earthquake

In addition, many human activities tend to make the earth materials less stable and, thus, increase the chance of ground movement. Human activities contribute to soil instability through grading of steep slopes or overloading them with artificial fill, by extensive irrigation, construction of impermeable surfaces, excessive groundwater withdrawal, and removal of stabilizing vegetation.

The 2020 General Plan Background Report noted that landslides constitute a significant geologic hazard to structures, roads, and utilities in San Rafael. These hazards exist independent of earthquake. Principal natural factors affecting slope stability are the geologic materials underlying the slope, steepness of slope, and the presence of active or intermittent forces, such as rain, groundwater, and earthquakes. Generally, the presence of existing landslides is indicative of unstable underlying material. Some man-made factors that may trigger landslides are improper drainage and grading activity such as cuts or fills. Prominent topogaraphic features include scarps (terrace like benches that commonly have topographic sags or depressions on them), disrupted ground surfaces (bulging at the toe), and anomalous drainage patterns.

Flows and slides are the most common type of land movement in the City.

- Flow are the most hazardous type of landslide and are common in San Rafael. A typical flow landslide occurs suddenly, when surface coils become totally saturated in intense rainstorms and break away from the hillside. The highly fluid nature of these flows causes them to follow gulches and creek canyons to the base of the slope. Flow landslide typically involve saturated, sandy, and silty soils that has little clay content. Such soils are principally derived from sandstone bedrock and are accumulate3d in hillside swales. Flow landslides are more likely to occur when 4" of rain has fallen in 10 hours or less.
- Slides are also common landslides in San Rafael. The great majority of these damaging landslides develop on slopes underlain by Franciscan Melange and within pre-existing landslide deposits. Landslide movement is also commonly initiated by concentrated surface water or groundwater. These landslides are slower moving than flows.

Destructive landslides, mudslides, and debris flows usually occur very suddenly with little or no warning time and are short in duration. Slides have caused significant damage or destroyed homes, streets, and utilities from their heaving soils and slow downslope development. The 2013 State Plan noted that although the area affected by a single landslide is less than that of earthquakes, landslides are pervasive in California's mountainous terrain and occur far more often.

Previous Occurrences

Disaster Declaration History

There are no recorded federal or state disasters related to landslide, mudslide, or debris flows.

NCDC Events

The NCDC contains 6 events that have affected Marin County. However, only one of these events was reported to have had direct effects on the City of San Rafael:

- **April 1, 2006** – Persistent heavy rainfall caused a massive number of landslides across the Sonoma and Marin County valleys area during the first half of April. In Marin County, the hardest hit areas were Mill Valley, Fairfax and San Rafael. In Mill Valley a man was killed after he was buried in a mudslide in his backyard.

City Planning Team Events

It was reported that in January of 1982, heavy rains fell in much of Marin County during an El Nino event. 12 inches of rain fell in a 32-hour period. This caused mudslides throughout the County and in San Rafael. According to the Marin Independent Journal, four people died, including residents in Tiburon, Sausalito and San Rafael whose homes collapsed in mudslides. In this storm, damage and destruction occurred from both being struck by flows as well as being undermined by the soil that slid.

CAN THE CITY IDENTIFY ANY PAST EVENTS, SPECIFIC LANDSLIDE PRONE LOCATIONS, AND PAST IMPACTS?

JANUARY 2017 IMPACTS?

- **February 12, 1925** – A citizen member of the HMPC reviewed documents from the Marin History Museum. An article was found regarding the 1925 landslides.

ARIN JO

SAN RAFAEL, CALIFORNIA THURSDAY, FEBRUARY 12, 1925

HEAVIEST WIND AND RAIN STORM IN YEARS CAUSES MUCH DAMAGE IN CO.

Washouts, Landslides, Falling Trees, Overflowing Sewers, Experienced Through This Section

The Northwestern Pacific Railroad Company whose trains have been delayed for several days due to washouts and landslides along the route to Sausalito, resumed hourly service this morning over the Greenbrae cut-off ,and are operating two trains. The first train left Union Depot at 6:20 a. m. and carried a large number of San Francisco commuters who have been held on this side of the bay since yesterday morning.

Officials of the company state that the electric train service via San Anselmo will be in operation this evening. A great many men are now at work making repairs. The first mails since Tuesday night arrived in this city this morning at 8:00 a. m. via Tiburon, on steam trains. A great portion of the usual second class matter had not reached here at noon.

The railroad company has made arrangements to have trucks handle the mail out of San Rafael for points in the county which cannot be reached because of the heavy washouts along the tracks.

Trains are passing over the left hand tracks through the Greenbrae tunnel due to a washout on the right hand side. The officials says that the tunnel is safe. The steam trains are passing through about two feet of water just outside of the Eastern limits of the city.

Due to the dangerous conditions of the tracks to the north no trains are running in that direction.

During the high water of Tuesday night and Wednesday morning a short passenger train of two cars tipped over near Novato. The train was moving along slowly in two feet of water when the accident happened. The few passengers went to Novato and took the stage into San Rafael. According to M. L. Gilogly, General Manager of the North-

Source: Marin History Museum, courtesy of Ray Lorber

- **January 2017** – During one of the storms in January 2017, a landslide occurred at 92 Bret Harte Road, which took out the retaining wall and top of a sewer manhole. There is also a sewer pipe the crosses a gully that's being eroded away causing the sewer to be unsupported and creating unsafe access for maintenance crew.

Source: City of San Rafael

- **February 7, 2017** – A house in the 200 block of Mountain View Avenue in San Rafael was struck by a landslide and was later destroyed, and two homes on either side were evacuated and red-tagged as the mud crept toward them.

Source: San Francisco Chronicle

Likelihood of Future Occurrences

Likely—Landslides in the form of debris flow, or mudslides, have occurred in the past in and near San Rafael. Rockfalls and landslides occur more frequently in the winter and spring months, when high levels of precipitation and runoff combine with saturated soils, which leads to general slope instability. Landslides often can occur as a result of other hazard events, such as severe storms, floods, wildfires, or earthquakes. Due to the topography in and around San Rafael and the rainfall the City receives, it is likely future occurrences of landslide, mudslide, and debris flow will occur.

Climate Change and Landslide/Debris Flows

According to the CAS, increased precipitation may result from climate change. Increased precipitation makes areas more vulnerable to landslide potential. More information on precipitation increases can be found in Section 4.2.3.

4.2.13. Levee Failure Hazard Profile

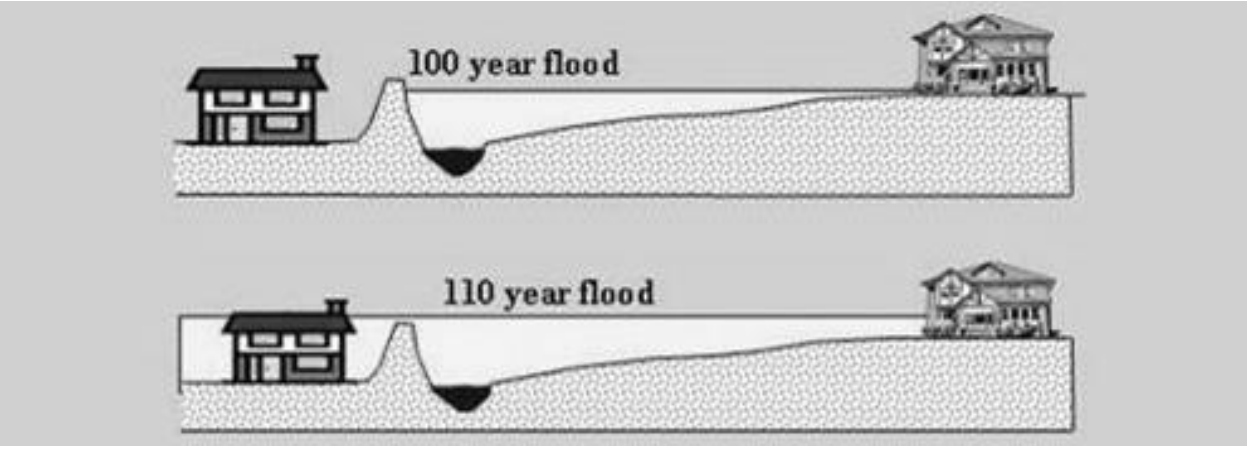
Hazard/Problem Description

The FIS refers to a levee as a raised area that runs along the banks of a river or canal. Levees reinforce the banks and help prevent flooding. By confining the flow, levees can also increase the speed of the water. Levees can be natural or man-made. A natural levee is formed when sediment settles on the river bank,

raising the level of the land around the river. To construct a man-made levee, workers pile dirt or concrete along the river banks, creating an embankment. This embankment is flat at the top, and slopes at an angle down to the water. For added strength, sandbags are sometimes placed over dirt embankments.

Levees provide strong flood protection, but they are not failsafe. Levees are designed to protect against a specific flood level and could be overtopped during severe weather events. Levees reduce, not eliminate, the risk to individuals and structure behind them. Overtopping failure occurs when the flood water level rises above the crest of a levee.

Figure 4-32 Flooding from Levee Overtopping



Source: Levees In History: The Levee Challenge. Dr. Gerald E. Galloway, Jr., P.E., Ph.D., Water Policy Collaborative, University of Maryland, Visiting Scholar, USACE, IWR.
http://www.floods.org/ace-files/leveesafety/lss_levee_history_galloway.ppt

The 2016 FIS noted that there are no levees in the City of San Rafael that are certified as protecting against the 1% annual chance flood. It was noted that local interests have constructed approximately 75 miles of levees in the county. These levees are concentrated in the low-lying areas around Richardson Bay and the Cities of San Rafael and Novato.

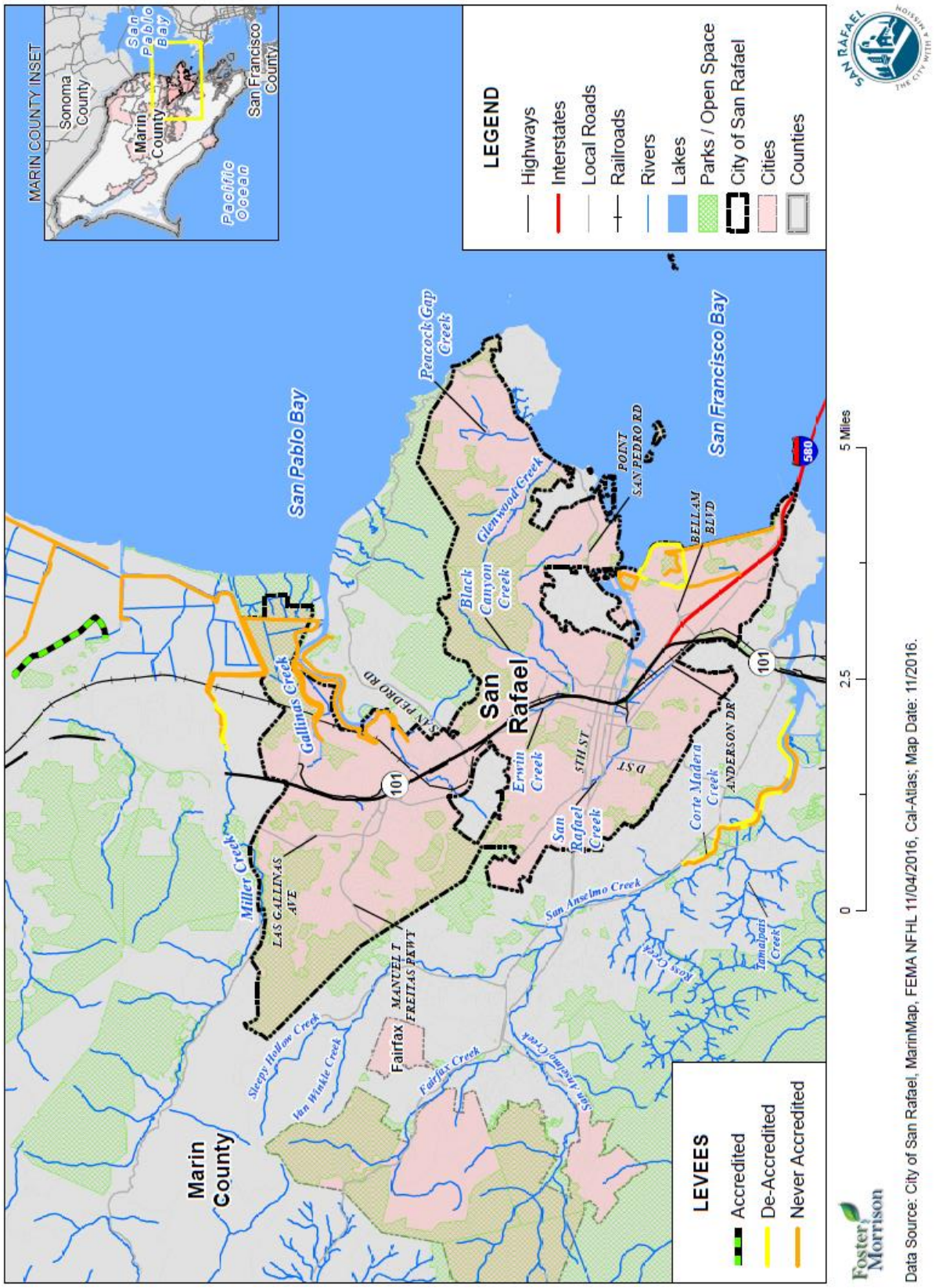
The 2020 General Plan Background Report noted that levee systems were haphazardly constructed in piecemeal fashion and levee and floodplain fills commonly made inadequate allowance for ground settlement on the compressible bay muds. Some of these levee systems were constructed to contain floodwaters during significant rainstorms and/or coincident high tides, and stormwater pumping stations have been installed to dewater floodplain areas that cannot drain naturally (via gravity) when storm drain outlets are inundated.

Portions of the levee system that protects East San Rafael from tidal flooding have been raised and reinforced by the City over the past 25 years. Current City standards match those of the Corp, which require new levees to be constructed to an elevation of +10 ft. National Geodetic Vertical Datum (NGVD) after settlement. This design elevation includes the surcharging effects of wave runup and future sea level rise on the predicted 100-yr high tide. However, some of the privately owned and maintained levee segments do not meet these improved standards. The average crest elevation of these levee segments is roughly +8 ft. NGCD. With continued settlements of these levee segments, the risk of infrequent, yet potentially

severe, tidal flooding due to levee overtopping in adjacent low-lying lands will increase. The City has recently completed improvements to area stormwater pumping station facilities that bring flood protection levels due to stromwater influx to roughly that of the 100-yr storm. However, significant tidal flooding associated with levee failures and/or overtopping would likely overwhelm existing pumping facilities.

Leveed areas of San Rafael are shown on Figure 4-33.

Figure 4-33 Leveed Areas of San Rafael



Past Occurrences

Disaster Declaration History

There have been no federal or state disaster declarations related to levee failure.

NCDC Events

There are no recorded levee failure events in the NCDC database for San Rafael.

City Planning Team Events

The HMPC noted that there have been no past occurrences of levee failure. The Planning Team noted that the Spinnaker Point area has experienced mud boils in area levees about 15 years ago during storm events that resulting in a failure causing some area to be inundated. There was no information of whether properties, structures, roads, or other assets were inundated or otherwise damaged.

Likelihood of Future Occurrences

Occasional – Given that there are no past occurrences of levee failure in the City levee failure is unlikely. However, if the levees are not maintained over time or sea level rise worsens, likelihood of future occurrence may increase.

Climate Change and Levee Failure

According to the CAS, increased precipitation in the County could result in the possible overtopping of levees. This may be more true in San Rafael, where the levees are not certified to provide a 100-year level of protection. Since the levees in the City also protect from high tide, sea level rise may be a greater issue in the future.

4.2.14. Tsunami Hazard Profile

Hazard/Problem Description

The 2013 State of California Hazard Mitigation Plan defined a tsunami as a wave triggered by any form of land displacement along the edge or bottom of an ocean or lake. This can be submarine landslides or submarine dip slip fault ruptures that result in seafloor uplift or down-drop. This mass movement translates to a tsunami or gravity wave within the overlying water. The coastline of California and the San Francisco Bay are at risk to tsunami.

Tsunamis travel radially outward from the point of initiation. The size of a tsunami is proportional to the mass movement that generated the tsunami. The speed of a tsunami is proportional to the depth of the water in which the tsunami originated. Tsunamis can travel at great speeds but in the open ocean result in relatively little wave height above the mean sea level as the energy is distributed throughout the water column. The wave length of a tsunami is much longer than wind generated waves, making it hard to detect in the open ocean.

As a tsunami approaches the shore and the depth of the water column decreases, the energy in the wave pushes the wave crest above the water surface resulting in a large wave height. Wave run-up is the elevation above mean sea level on dry land that a tsunami reaches. Run-up is what causes inundation of coastal areas that are below the run-up height. Identifying tsunami hazards requires 1) evaluating the potential for submarine mass movement both locally and at great ocean distances, and 2) identifying coastal regions within the direct or indirect path of a potential tsunami wave that are below the run-up height.

There are two types of tsunamis—local and distant. Local tsunamis are more threatening because they afford at-risk populations only a few minutes to find safety. California is vulnerable to, and must consider, both types.

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.

A bay front levee currently protects portions of the City from high tides and waves. The crest elevation of the levee varies from +8.0 to +13.0 NGCD. The lower elevation portions of the levees could be overtopped by tsunami. However, considering the variable tides, distance of structures from the levee, and short duration of a tsunami, the potential for significant damage is low.

Past Occurrences

Disaster Declaration History

There has been one state disaster declaration and no federal disaster declarations due to tsunami. On March 27, 1964, a 9.2 magnitude earthquake in Alaska sent a tsunami surging down the western coastline of the United States, causing $1 million damage in Marin as 8-foot waves bounced boats around Loch Lomond Marina in San Rafael and knocked out pilings at Lawson's Landing near the mouth of Tomales Bay. No deaths were recorded in the City of San Rafael, but 11 deaths were reported in Crescent City due to this event.

NCDC Events

The NCDC database has no recorded tsunami events for Marin County or San Rafael.

City Planning Team Events

The 2020 General Plan Background Report noted that between 1867 and 1969, at least 19 tsunamis were recorded at the Golden Gate tide gauge. The highest recorded tsunami at this gauge was 7.5 feet from the 1964 event discussed in the disaster history above.

Twelve hours after the earthquake struck near Sendai, Japan, in **March 2011**, subdued but large tsunami waves arrived on Marin's Pacific coastline and wrapped themselves around San Francisco Bay as far as San Rafael's Loch Lomond Marina. Fortunately, financial damage was minimal, and no deaths or injuries were reported.

Although there are no known recorded deaths from tsunami action in Marin County, there were small tsunami impacts in **1946** and **1960**.

WHAT TYPE OF IMPACTS HAS THE CITY EXPERIECED RELATED TO THESE PAST EVENTS?

OTHER ISSUES/PAST EVENTS THE CITY CAN IDENTIFY?

Likelihood of Future Occurrences

Unlikely – Strong earthquakes occurring near San Rafael or elsewhere on the Pacific "Ring of Fire," especially Alaska, give San Rafael citizens little warning of the overwhelming waves that move up to 600 mph. A massive earthquake in the central Aleutian Islands of Alaska could send 30-foot waves to the Marin coast within about five hours. Since earthquakes of this magnitude are rare, the likelihood of future occurrence is unlikely.

Climate Change and Tsunami

Earthquakes are the main cause of tsunamis in the Pacific Ocean. According to the CAS, climate change is unlikely to increase earthquake frequency or strength.

4.2.15. Wildfire Hazard Profile

Hazard/Problem Description

According to the 2016 Marin County Community Wildfire Protection Plan (CWPP) wildland fire is an ongoing concern for Marin County and San Rafael. Generally, the fire season can beyear around, with the more extreme portions of the season extending from early spring through late fall of each year during the hotter, dryer months. Drought may extend the fire season in Marin County. Fire conditions arise from a combination of high temperatures, low moisture content in the air and fuel, accumulation of vegetation, and high winds.

Wildland Urban Interface

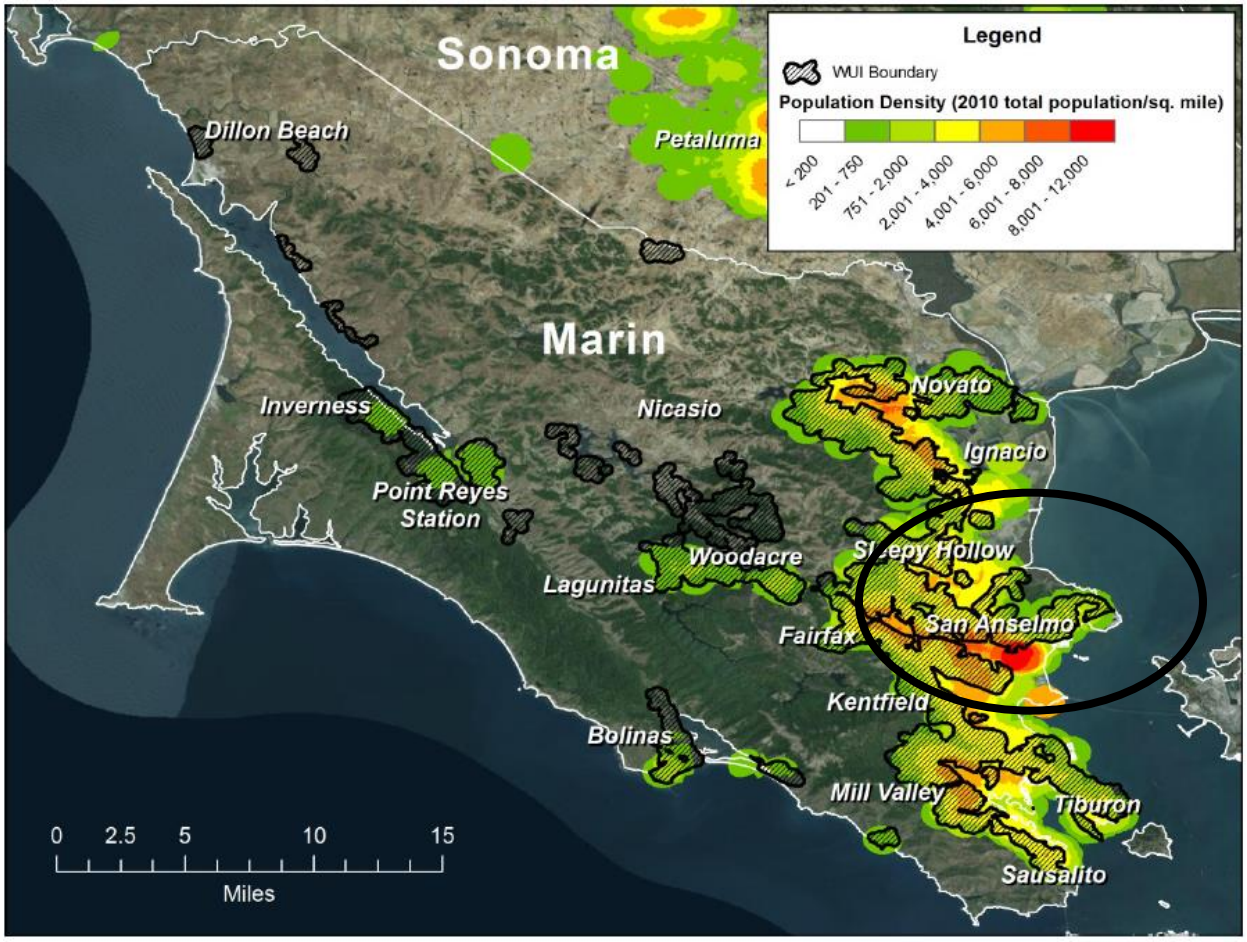
Throughout California, communities are increasingly concerned about wildfire safety as increased development in the foothills and mountain areas and subsequent fire suppression practices have affected the natural cycle of the ecosystem. While wildfire risk is predominantly associated with wildland urban interface (WUI) areas, significant wildfires can also occur in heavily populated areas. The wildland urban interface is a general term that applies to development adjacent to landscapes that support wildland fire. Wildland fires affect grass, forest, and brushlands, as well as any structures located within them.

WUI fires are often the most damaging. WUI fires occur where the natural forested landscape and urban-built environment meet or intermix. Even relatively small acreage fires may result in disastrous damages. The damages can be widely varying, but are primarily reported as damage to infrastructure, built environment, loss of socio-economic values and injuries to people.

WUI locations in and around San Rafael are shown in Figure 4-34. The WUI zone map 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, 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. 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.

Figure 4-34 Marin County WUI Map



Source: 2016 Marin County CWPP

The pattern of increased damages is directly related to increased urban spread into historical forested areas that have wildfire as part of the natural ecosystem. Many WUI fire areas have long histories of wildland fires that burned only vegetation in the past. However, with new development, a wildland fire following a historical pattern may now burn these newly developed areas. WUI fires can occur where there is a distinct

boundary between the built and natural areas or where development or infrastructure has encroached or is intermixed in the natural area. WUI fires may include fires that occur in remote areas that have critical infrastructure easements through them, including electrical transmission towers, railroads, water reservoirs, communications relay sites or other infrastructure assets.

Potential losses from wildfire include human life, structures and other improvements, natural and cultural resources, quality and quantity of water supplies, cropland, timber, and recreational opportunities. Economic losses could also result. Smoke and air pollution from wildfires can be a severe health hazard. Also of significant concern to the City are the secondary impacts associated with a large burn area. Problems occur with landslides, debris flows, erosion, and other issues that lead to a significant loss of watershed. These problems can be compounded by climate conditions.

Consequently, wildland fires that burn in natural settings with little or no development are part of a natural ecological cycle and may actually be beneficial to the landscape. Century old policies of fire exclusion and aggressive suppression have given way to better understanding of the importance fire plays in the natural cycle of certain forest types.

Warning times are usually adequate to ensure public safety, provided that evacuation recommendations and orders are heeded in a timely manner. While in most cases wildfires are contained within a week or two of outbreak, in certain cases, they have been known to burn for months, or until they are completely extinguished by fall rains.

Wildfire in San Rafael

According to the CWPP, wildfire is an ongoing concern for Marin County and the incorporated communities. Generally, the fire season extends from early spring to late fall. However, with the ongoing drought (as of the writing of this plan), the fire season has recently transformed into a year around event. Fire conditions arise from a combination of hot weather, an accumulation of vegetation, and low moisture content in the air. These conditions when combined with high winds and years of drought increase the potential for a wildfire to occur. Urban wildfires often occur in those areas where development has expanded into the rural areas. A fire along this urban/rural interface can result in major losses of property and structures. Generally, there are three major factors that sustain wildfires and allow for predictions of a given area's potential to burn. These factors include fuel, topography, and weather.

- **Fuel**—Fuel is the material that feeds a fire and is a key factor in wildfire behavior. Fuel is generally classified by type and by volume. Fuel sources are diverse and include everything from dead tree needles and leaves, twigs, and branches to dead standing trees, live trees, brush, and cured grasses. 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 PRESENT IN CITY?) 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.

- **Topography**—An area's terrain and land slopes affect its susceptibility to wildfire spread. Both fire intensity and rate of spread increase as slope increases due to the tendency of heat from a fire to rise via convection. The arrangement of vegetation throughout a hillside can also contribute to increased fire activity on slopes. Marin County and the City of San Rafael is topographically diverse, with rolling hills, valleys and ridges that trend from northwest to southeast.
- **Weather**—Weather components such as temperature, relative humidity, wind, and lightning also affect the potential for wildfire. 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 and the City 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. Drought conditions contribute to concerns about wildfire vulnerability. During periods of drought, the threat of wildfire increases.

Past Occurrences

Disaster Declaration History

There have been zero federal and two state disaster declaration events that have occurred in Marin County. These are shown in Table 4-20. Neither of these fires threatened the City of San Rafael directly.

Table 4-19 Marin County and San Rafael – Wildfire Disaster History

Year	Disaster Name	Disaster Type	Disaster Cause	Disaster #	State Declaration	Federal Declaration
1995	Vision Fire	Fire	Fire	DC 95-05	10/95	–
1965	1965 Fires	Fire	Fire	–	9/18/1965	–

Source:

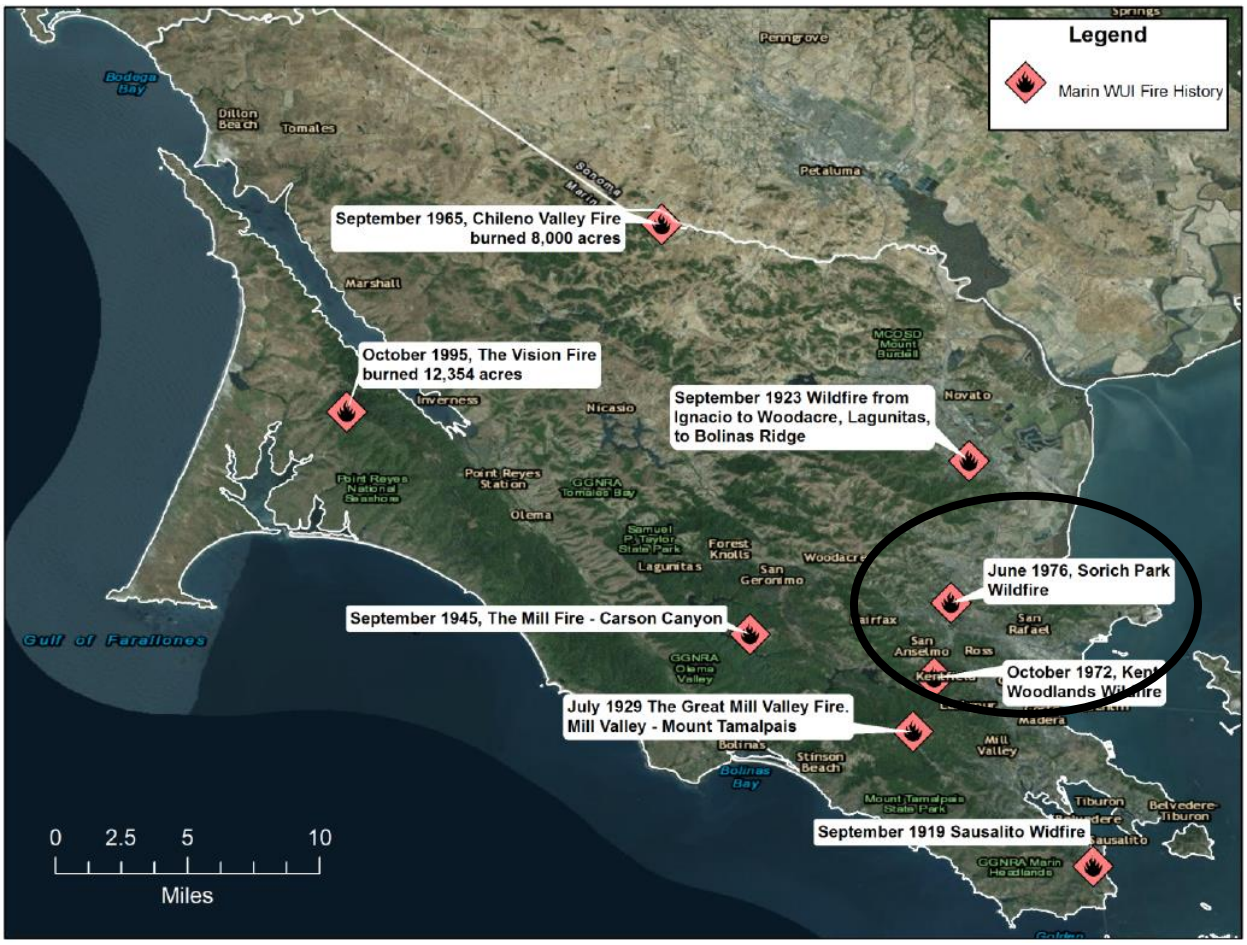
NCDC Events

While the NCDC contains three events for Marin County, none of these threatened the City of San Rafael.

Marin County CWPP Events

Throughout its history, Marin County has experienced many wildland fires. Figure 4-35 shows a map of large fires that have occurred in Marin's WUI. Figure 4-35 shows fire history for the County, with the City circled in black.

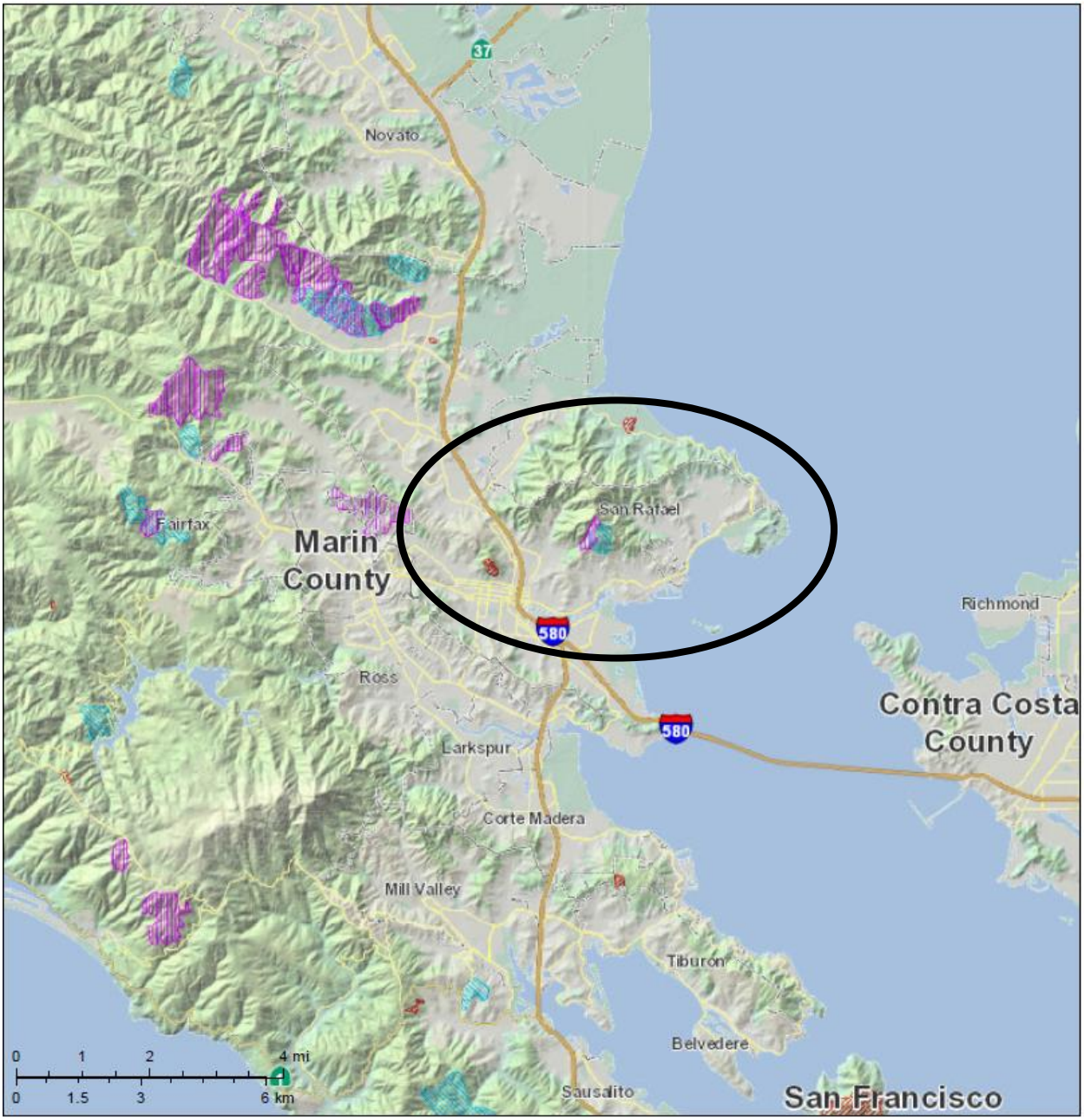
Figure 4-35 Marin County Wildfire History



Source: 2016 Marin County CWPP

Additionally, a map of past fires in and near the City of San Rafael was created for the Association of Bay Area Governments Resilience Program. That map is shown in Figure 4-36.

Figure 4-36 Eastern Marin County and San Rafael – Wildfire History



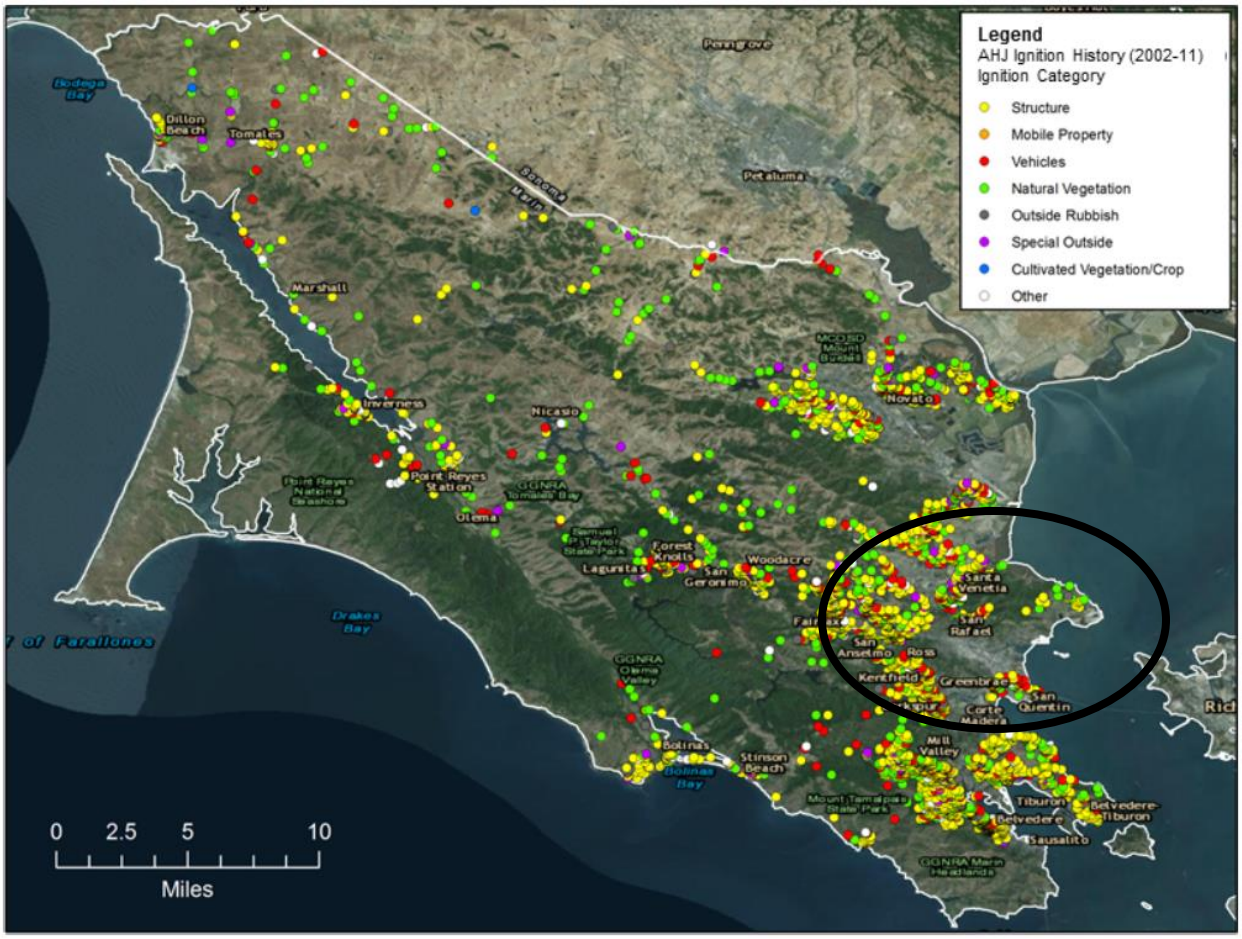
Legend

- 1950 - 1955
- 1955 - 1975
- 1975 - 1995
- 1995 - 2014

Source; Association of Bay Area Governments Resilience Program

Ignition data for all authorities having jurisdiction (AHJ) were acquired and analyzed to evaluate ignition trends within the county. Figure 4-37 shows a map of the ignition history for all AHJ for 2002 through 2011, classified by ignition category.

Figure 4-37 San Rafael Wildfire Ignition Data – 2002 to 2011



Source: 2016 Marin County CWPP

City Planning Team Events

CAN THE CITY IDENTIFY ANY PAST WILDFIRE EVENTS AND THEIR DAMAGES/IMPACTS TO THE CITY?

WHAT OTHER CITY WILDFIRE DATA CAN WE GET TO INCLUDE HERE AND BUILD UPON THE CWPP? WE HAVE THE CITY WUI MAP – WHAT ELSE? WILDFIRE HISTORY MAP? LOGS OF PAST EVENTS?

- **July 1957 Downtown Fire** – A citizen member of the HMPC reviewed documents from the Marin History Museum. An article was found regarding the 1957 fires. San Rafael last night in the worst property loss in the city's history. Damage is estimated at more than a million dollars. Heat from the raging blaze was so intense that steel street light poles were bent like molten candles. The fire raged

down both sides of Fourth St., in the main business section, between D and E Streets. More than 250 firefighters and 50 pieces of equipment from throughout Marin County, military establishments, and San Francisco converged to battle the blaze. No one was seriously injured. The 80 year old Odd Fellows Hall, a two-story landmark here throughout the memory of older residents, was destroyed as the flames raged over the area. Persons living in a three-square block area in the Fourth St. section were ordered out of their homes as police and firemen sent out a general alarm alerting the entire city. The California Highway Patrol closed U.S. Highway 101 as the city's streets became jammed with traffic. Power lines fell early in the blaze, blacking out six business blocks around the fire area. One house was destroyed. The business establishments burned out included a knitting shop, Leonardi Brothers Upholstering, the paint company, Brown Furniture Co., Cottage Book Shop, Johnson's Furniture Store, Phillips Florists, Civiletti Sewing Machine Shop, the pet shop, Western Union offices, Christian Science Reading Room, Morwear Paint Co., Anthony Beauty Salon, Ed's Auto Parts, Vari Mart, Marin Orthopedic Co., Les Oliver's Paint Shop, a skin diving equipment concern, and a title company.

Source: Marin History Museum, courtesy of Ray Lorber

- **May 1971 Courthouse Fire** – A citizen member of the HMPC reviewed documents from the Marin History Museum. An article was found regarding the 1971 fires. The old Marin County courthouse, practically abandoned since the newer, more famous courthouse was opened two years ago, was destroyed by fire Tuesday night. A fire chief said arson was suspected. “Exactly what caused the fire is a hell of a good guess,” Fire Chief Vance Trivett said. But he said the blaze was' “definitely set on purpose.” The building was hit by a minor arson fire last week. Flames shot 30 feet inlo the air and the fire attracted about 2,000 spectators, who were restrained by police. About 25 firemen fought the blaze

for three hours. There were no injuries. Trivett had Jed some of his men through the century-old, three-story building earlier in the afternoon on a routine fire inspection. At the time, Trivett said the fire hazard in the wood structure ' scared me to death." Only a few offices had been maintained in the building since most of the court procedures were moved to the new Frank Lloyd Wright designed County Civic Center north of town two years ago. The new building was the site last summer of a shootout in which four persons, including a judge, were killed and is now the site of the legal proceedings against black militant Angela Davis. The old courthouse was insured for $310,000, but was thought to be worth about $730,000. "It was just totaled," a Fire Department spokesman said "Flames went up all the way through the roof." The fire apparently broke out in the old sheriff's office on the ground floor.

Source: Marin History Museum, courtesy of Ray Lorber

- **July 13, 1990 Fire** – A citizen member of the HMPC reviewed documents from the Marin History Museum. An article was found regarding the 1990 fires. Fire erupted on the top floor of a four-story 1889 convent near Dominican College, forcing the evacuation of 30 nuns from the Marin County landmark. The blaze quickly went to greater-alarm status and snarled traffic along U.S. I 01 near the college, a San Rafael Fire Department spokesman said, adding that about 100 firefighters from the city and 10 surrounding communities brought the blaze under control. Members of the Dominican Sisters of San Rafael fled safely from the convent, original home to the founding Sisters of the college, said Michelle Liapes, staff writer for the institution, who was watching the flames from a window. "It's a very beautiful building and a landmark in the Marin area."

Source: Marin History Museum, courtesy of Ray Lorber

Likelihood of Future Occurrence

Likely—The season when wildfire is most likely to occur generally runs from late April through October. This is due to hot, dry conditions during this time of year. Drought, foehn winds, and other fire weather can increase the likelihood of wildfire in the City each year.

Climate Change and Wildfire

According to the CAS, warmer temperature can exacerbate drought conditions. Drought often kills plants, which serve as fuel for wildfires. Warmer temperatures could increase the number of wildfires and pest outbreaks, such as the western pine beetle.

The 2016 CWPP noted that recent research indicates higher summer temperatures will likely increase the annual window of high fire risk. Future changes in fire frequency and severity are difficult to predict; however, regional climate change associated with elevated greenhouse gas concentrations could alter large weather patterns and produce conditions conducive to extreme fire behavior. A warmer climate will bring drier winters, higher spring temperatures, and early snowmelt. Combined with drought conditions, this leads to drier soils in early summer, drier vegetation, and an increase in the number of days in the year with flammable fuels, all which further raise the likelihood of fires.

Further, according to the California Adaptation Planning Guide: Understanding Regional Characteristics, a slight increase in fire occurrence is projected for the Bay Area Region. While the fire risk is only anticipated to increase moderately, it is the increases in fire damages that are projected due to high populations in fire vulnerable areas. In addition to direct impacts and damages to property and infrastructure from fire, other impacts include temporary or permanent displacement of affected populations and increase in respiratory illnesses due to air pollution resulting from wildfires.

4.2.16. Natural Hazards Summary

Table 4-20 summarizes the results of the hazard identification and hazard profile for the City based on the hazard identification data and input from the HMPC. For each hazard profiled in Section 4.2, this table includes the likelihood of future occurrence and whether the hazard is initially considered a priority hazard for the City based on the hazard profiles.

Table 4-20 Hazard Identification and Initial Determination of Priority Hazards

Hazard	Likelihood of Future Occurrence	Priority Hazard
Climate Change	Highly Likely	Y
Coastal Flooding and sea level rise	Likely	Y
Dam Failure	Unlikely	N
Drought and Water Shortage	Likely	Y
Earthquake	Occasional/Likely	Y
Earthquake: Liquefaction	Occasional/Likely	Y
Flood: (100/500 year)	Occasional/Unlikely	Y
Flood: Localized/Stormwater	Highly Likely	Y
Landslide, Mudslides, Hillside Erosion, and Debris Flows	Likely	Y
Levee Failure	Occasional	Y
Severe Weather: Extreme Heat	Highly Likely	Y
Severe Weather: Heavy Rains and Storms	Highly Likely	Y
Tsunami	Unlikely	Y
Wildfire	Likely	Y

4.3 Vulnerability Assessment

Requirement §201.6(c)(2)(ii): [The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community.

Requirement §201.6(c)(2)(ii)(A): The plan should describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas.

Requirement §201.6(c)(2)(ii)(B): [The plan should describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) of this section and a description of the methodology used to prepare the estimate.

Requirement §201.6(c)(2)(ii)(C): [The plan should describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

With San Rafael's hazards identified and profiled, the HMPC conducted a vulnerability assessment to describe the impact that each priority hazard would have on the City. The vulnerability assessment quantifies, to the extent feasible using best available data, assets at risk to natural hazards and estimates potential losses.

This vulnerability assessment followed the methodology described in the FEMA publication *Understanding Your Risks—Identifying Hazards and Estimating Losses*. The vulnerability assessment first describes the total vulnerability of the City and values at risk and then discusses vulnerability by hazard.

Data Sources

Data used to support this vulnerability assessment included the following:

- ABAG 2013 Population Projections
- CAL FIRE GIS datasets
- USFS GIS datasets
- City staff
- ArkStorm at Tahoe - Stakeholder Perspectives on Vulnerabilities and Preparedness for an Extreme Storm Event in the Greater Lake Tahoe, Reno and Carson City Region. 2014.
- California Adaptation Planning Guide
- Cal-Adapt
- CAL FIRE GIS datasets
- California Department of Finance, E-1 Report
- California Department of Finance, E-4 Report
- California Department of Finance, P-1 Report
- California Department of Fish and Wildlife's Natural Diversity Database
- California Department of Food and Agriculture
- California Native Plant Society

- California Office of Historic Preservation
- Canal - An Immigrant Gateway in San Rafael at Risk. Case Study on Gentrification and Displacement Pressures in The Canal Neighborhood of San Rafael, CA
- City of San Rafael GIS data
- City of San Rafael 2020 General Plan
- City of San Rafael 2020 General Plan Background Report
- Civic Center Station Area Plan
- Downtown Station Area Plan
- Existing plans and studies
- FEMA's HAZUS-MH 2.2 GIS-based inventory data
- FEMA Digital Flood Insurance Rate Map. March 16, 2016.
- FEMA Marin County Flood Insurance Study. March 16, 2016.
- Liu, J.C., Mickley, L.J., Sulprizio, M.P. et al. Climatic Change. 138: 655. doi:10.1007/s10584-016-1762-6. 2016.
- Kenward, Alyson PhD, Adams-Smith, Dennis, and Raja, Urooj. Wildfires and Air Pollution – The Hidden Health Hazards of Climate Change. Climate Central. 2013.
- Marin Bay Shoreline Sea Level Rise Vulnerability Assessment
- Marin County GIS data (hazards and base layers)
- Marin County Parcel and Assessor's Data
- Marin County Community Wildfire Protection Plan
- MarinMap Landslide Layer (from 1999 USGS analysis)
- MarinMap Liquefaction Layer (from NEHRP Earthquake Program)
- MarinMap Tsunami Layer (University of South California Tsunami Research Center)
- National Drought Mitigation Center – Drought Impact Reporter
- National Park Service – Historic American Buildings Survey and Historic American Engineering Record
- Personal interviews with planning team members and staff from the County and participating jurisdictions
- Public Health Alliance of Southern California
- State Department of Water Resource's Delta Atlas
- Statewide GIS datasets from other agencies such as Cal OES, FEMA, USGS, CGS, Cal Atlas, and others
- US Census Bureau 2010 Household Population Estimates
- US Fish and Wildlife Service
- US Fish and Wildlife Service's National Wetlands Inventory maps
- Written descriptions of inventory and risks provided by San Rafael
- Personal interviews and discussions with planning team members and staff from the City

4.3.1. San Rafael's Vulnerability and Assets at Risk

As a starting point for analyzing the City's vulnerability to identified hazards, the HMPC used a variety of data to define a baseline against which all disaster impacts could be compared. If a catastrophic disaster was to occur in the City, this section describes significant assets at risk. Data and analysis used in this baseline assessment included:

- General City vulnerability data

- Total values at risk;
- City critical facilities;
- Natural, cultural, and historical resources (this analysis is for the Planning Area, which includes and the Sphere of Influence); and
- Growth and development/redevelopment trends.

Total Values at Risk

Parcel Inventory and Assessed Values

This analysis captures the values associated with assessed assets located within the City of San Rafael. The 2016 GIS parcel layer and the Marin County Assessor data, obtained from the Marin County, Marin Map online service, was used for as the basis of this analysis. This data provided by Marin Map represents best available data.

Understanding the total assessed value of the City of San Rafael is a starting point to understanding the overall value of identified assets at risk in the City. When the total assessed values are combined with potential values associated with other community assets such as public and private critical infrastructure, historic and cultural resources, and natural resources, the big picture emerges as to what is potentially at risk and vulnerable to the damaging effects of natural hazards within the City.

Methodology

Marin County's 2016 Assessor Data and the City's GIS parcel data obtained from Marin Map were used as the basis for the inventory of assessed values for both improved and unimproved parcels within the City. This data provides the land and improved values assessed for each parcel, along with key information such as property use. Other GIS data, such as jurisdictional boundaries, roads, streams, and area features, was also obtained from Marin Map to support mapping and analysis of City assets at risk. City Limits and Spheres of Influence (SOI) data from Marin Map were used to identify and attribute those parcels located within the City boundaries and those within the City's SOI. Parcels within the City's SOI are considered to be part of unincorporated Marin County and were not included in the general analysis for the City of San Rafael, but were used for evaluating potential areas for future development within the City. The Marin County GIS parcel data contained 96,213 parcels, and 17,796 parcels of those we determined to be within the City of San Rafael jurisdictional boundary.

Data Limitations & Notations

Although based on best available data, the resulting information should only be used as an initial guide to overall values in the City. In the event of a disaster, structures and other infrastructure improvements are at the greatest risk of damage. Depending on the type of hazard and resulting damages, the land itself may not suffer a significant loss. For that reason, the values of structures and other infrastructure improvements are of greatest concern. As such, it is critical to note a specific limitation to the assessed values data within the City, created by Proposition 13. Instead of adjusting property values annually, no adjustments are made until a property transfer occurs. As a result, overall property value information is most likely low and may not reflect current market or true potential loss values for properties within the City.

Property Use Categories

Marin County Assessor Use Codes provide detailed descriptive information about how each property is generally used, such as residential, commercial, or industrial. The Use Codes were categorized into the following property use categories found within the Marin County Assessor data: Agricultural, Commercial, Exempt, Industrial, Non-categorized, and Residential. Since the City of San Rafael is the only jurisdiction participating in the LHMP, the Use Codes were refined a step further to better reflect assessed values specific to the City. The final property use categories for the City of San Rafael include:

- Agricultural
- Commercial
- Exempt
- Industrial
- Residential

Non-categorized was eliminated as a category as there were no parcels with this Use Code within the City of San Rafael. Once Use Codes were grouped into categories, the number of total and improved parcels and land and improved values were inventoried for the City by property use.

Estimated Content Replacement Values

San Rafael's assigned property use categories were used to develop estimated content replacement values (CRVs) that are potentially at loss from hazards. FEMA's standard CRV factors were utilized to develop more accurate loss estimates for all mapped hazard analyses. FEMA's CRV factors estimate value as a percent of improved structure value by property use. Table 4-21 shows the breakdown of the different property uses in San Rafael and their estimated CRV factors.

Table 4-21 San Rafael – Content Replacement Factors by Property Use

San Rafael Property Use Categories	Hazus Property Use Categories	Hazus Content Replacement Values
Agricultural	Agricultural	100%
Commercial	Commercial	100%
Exempt	Exempt	100%
Industrial	Industrial	150%
Residential	Residential	50%

Source: Hazus

San Rafael Values at Risk Results

Values associated with land, and improved structure values were identified and summed in order to determine total assessed values at risk in the City of San Rafael. Together, the land value and improved structure value make up the majority of assessed values associated with each identified parcel or asset. Improved parcel counts were based on the assumption that a parcel was improved if a structure value was present. Information on other values such as personal property values were not readily available for inclusion in this effort. Table 4-22 is a summary table that shows the total values or exposure for the City

of San Rafael by property use. Table 4-23 breaks down Table 4-22 into greater detail, showing the detailed property types that make up the property use categories.

Table 4-22 San Rafael – Total Values by Property Use Summary

Property Use	Total Parcel Count	Improved Parcel Count	Total Land Value	Improved Structure Value	Total Value
Agricultural	1	0	$1	$0	$1
Commercial	1,195	1,061	$840,120,112	$1,511,469,668	$2,351,589,780
Exempt	771	162	$98,876,453	$398,660,660	$497,537,113
Industrial	275	250	$122,560,491	$146,221,175	$268,781,666
Residential	15,554	14,978	$4,410,798,709	$4,649,883,102	$9,060,681,811
Grand Total	**17,796**	**16,451**	**$5,472,355,766**	**$6,706,234,605**	**$12,178,590,371**

Source: Marin County 2016 Parcel/Assessor Data

Table 4-23 San Rafael – Total Values by Property Use Detail

Property Use	Total Parcel Count	Improved Parcel Count	Total Land Value	Improved Structure Value	Total Value
Agricultural					
Open Space - Unimproved	1	0	$1	$0	$1
Total	**1**	**0**	**$1**	**$0**	**$1**
Commercial					
Commercial - Improved	1,064	1,061	$806,493,808	$1,511,469,668	$2,317,963,476
Commercial - Unimproved	131	0	$33,626,304	$0	$33,626,304
Total	**1,195**	**1,061**	**$840,120,112**	**$1,511,469,668**	**$2,351,589,780**
Exempt					
Exemption - Improved	161	161	$97,372,758	$398,585,726	$495,958,484
Exemption - Vacant	6	0	$1,461,598	$0	$1,461,598
Tax Exempt	143	0	$0	$0	$0
Tax Exempt - Open Space	445	1	$42,097	$74,934	$117,031
Valued By S.B.E.	1	0	$0	$0	$0
(blank)	15	0	$0	$0	$0
Total	**771**	**162**	**$98,876,453**	**$398,660,660**	**$497,537,113**
Industrial					
Industrial - Improved	251	250	$119,067,320	$146,221,175	$265,288,495
Industrial - Unimproved	24	0	$3,493,171	$0	$3,493,171
Total	**275**	**250**	**$122,560,491**	**$146,221,175**	**$268,781,666**
Residential					
Common Area	124	9	$38,508	$258,827	$297,335

Property Use	Total Parcel Count	Improved Parcel Count	Total Land Value	Improved Structure Value	Total Value
Mobile Homes	166	161	$0	$8,282,460	$8,282,460
Multiple-Residential - Improved	1,135	1134	$516,983,571	$773,576,167	$1,290,559,738
Multiple-Residential - Unimproved	30	1	$7,571,495	$966,975	$8,538,470
Rural - Unimproved	2	0	$1,836	$0	$1,836
Single Family Attached	3,465	3,463	$522,969,589	$762,085,276	$1,285,054,865
Single-Residential - Improved	10,211	10,209	$3,328,389,175	$3,104,440,018	$6,432,829,193
Single-Residential - Unimproved	421	1	$34,844,535	$273,379	$35,117,914
Total	**15,554**	**14,978**	**$4,410,798,709**	**$4,649,883,102**	**$9,060,681,811**
Grand Total	**17,796**	**16,451**	**$5,472,355,766**	**$6,706,234,605**	**$12,178,590,371**

Source: Marin County 2016 Parcel/Assessor Data

Table 4-24 shows the total values of the City as shown in Table 4-22, but with estimated content replacement values (CRVs) included (using CRV multipliers from Table 4-21). This table is important as potential losses to the City include structure contents. In addition, loss estimates contained in the hazard vulnerability sections below will use calculations based on the total values in Table 4-24.

Table 4-24 San Rafael – Total Values by Property Use with Content Replacement Values

Property Use	Total Parcel Count	Improved Parcel Count	Total Land Value	Improved Structure Value	Estimated Contents Value	Total Value
Agricultural	1	0	$1	$0	$0	$1
Commercial	1,195	1,061	$840,120,112	$1,511,469,668	$1,511,469,668	$3,863,059,448
Exempt	771	162	$98,876,453	$398,660,660	$398,660,660	$896,197,773
Industrial	275	250	$122,560,491	$146,221,175	$219,331,763	$488,113,429
Residential	15,554	14,978	$4,410,798,709	$4,649,883,102	$2,324,941,551	$11,385,623,362
Grand Total	**17,796**	**16,451**	**$5,472,355,766**	**$6,706,234,605**	**$4,454,403,642**	**$16,632,994,013**

Source: Marin County 2016 Parcel/Assessor Data

Critical Facilities

A critical facility is vital to the City's ability to provide essential services and protect life and property. Loss of a critical facility would result in a severe economic or catastrophic impact. For the City of San Rafael, critical facilities include the following categories:

- Community Space
- Hazardous
- Medical
- Public Safety
- Transportation

- Utility

To support hazard analysis of critical facilities, San Rafael GIS developed a critical facilities layer that pulled mapped critical facilities from existing GIS layers and organized them into a new critical facilities layer. Each facility was assigned one of the six different categories. The final critical facilities layer used for this analysis included facilities located in both the city limits or directly adjacent to the City. These can be seen in Figure 4-38 and detailed in Table 4-24.

A fully detailed list of all critical facilities and important infrastructure in the Planning Area can be found in Appendix F.

Figure 4-38 San Rafael – Critical Facility Locations by Category

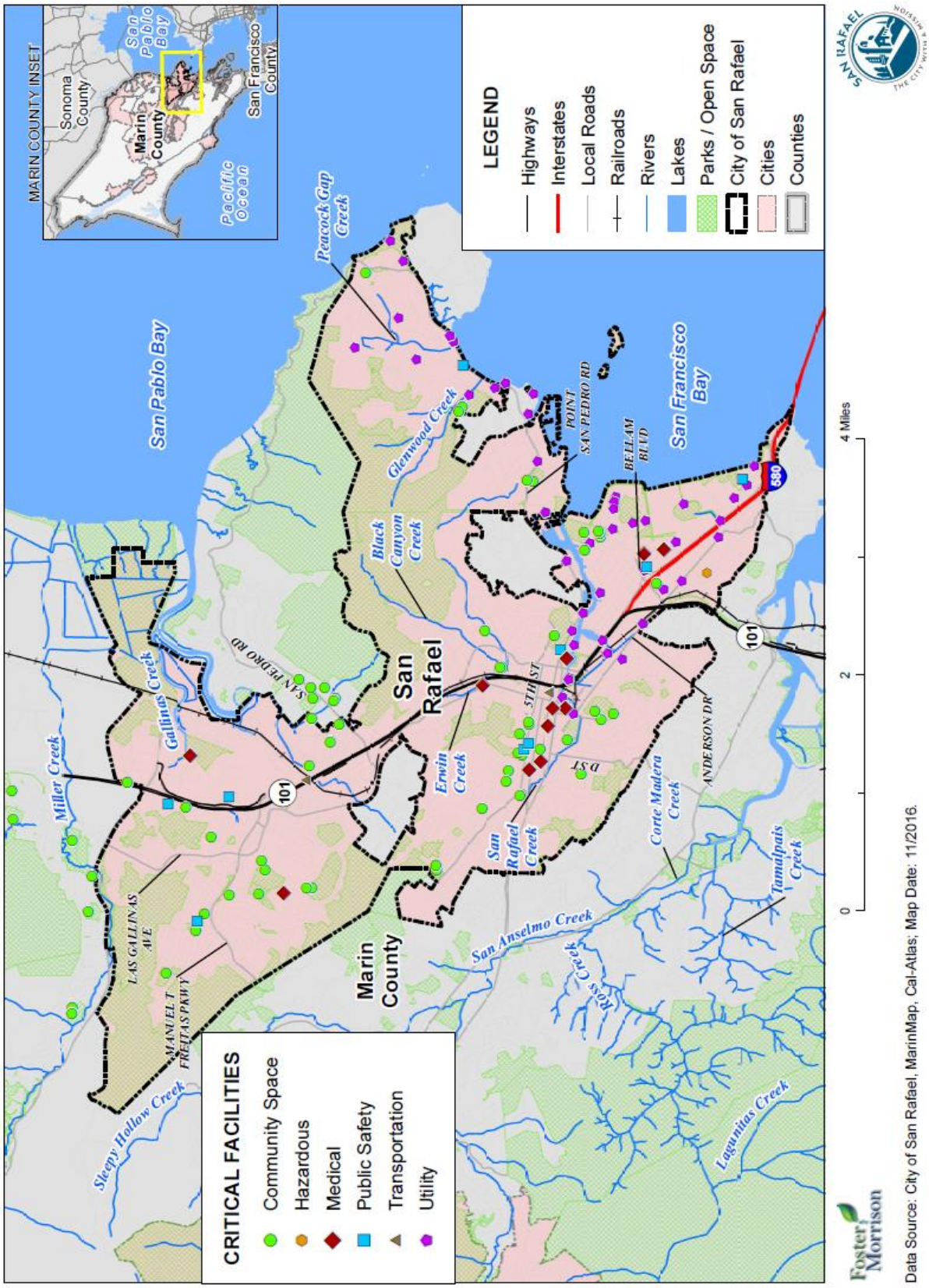


Table 4-25 San Rafael – Critical Facility Inventory

Facility Type	Facility Count
San Rafael	
Community Space	51
Hazardous	1
Medical	12
Public Safety	9
Transportation	2
Utility	53
Total	**128**
Adjacent to San Rafael	
Community Space	14
Hazardous	0
Medical	0
Public Safety	0
Transportation	0
Utility	3
Total	**17**
San Rafael Totals	
Community Space	65
Hazardous	1
Medical	12
Public Safety	9
Transportation	2
Utility	56
Grand Total	**145**

Source: City of San Rafael GIS

Natural, Historical, and Cultural Resources

Assessing the vulnerability of the City to disaster also involves inventorying the natural, historic, and cultural assets of the area. This step is important for the following reasons:

- The community may decide that these types of resources warrant a greater degree of protection due to their unique and irreplaceable nature and contribution to the overall economy.
- If these resources are impacted by a disaster, knowing so ahead of time allows for more prudent care in the immediate aftermath, when the potential for additional impacts are higher.
- The rules for reconstruction, restoration, rehabilitation, and/or replacement are often different for these types of designated resources.

- Natural resources can have beneficial functions that reduce the impacts of natural hazards, such as wetlands and riparian habitat, which help absorb and attenuate floodwaters.

Natural Resources

The General Plan Background Report noted that the City of San Rafael is located on the east side of the coastal hills of the Marin Peninsula in an area once covered with oak savanna woodlands intermixed with grasslands and chaparral. Prior to European settlement, Coast redwoods and Douglas firs common on the hills to the west and Mt. Tamalpais to the southwest may have naturally occurred sparingly on north-facing slopes and along some drainageways. San Rafael, Gallinas, and Miller Creeks supported riparian vegetation in the form of willows, cottonwoods, and possibly white alders. Large expanses of tidal marshes were located along San Rafael and San Pablo Bays. These habitats historically supported a great diversity of wildlife species. Grizzly bears roamed the hills and foraged in the riparian thickets of the area's creeks. Other mammals present in this portion of the Marin Peninsula would have included black-tailed deer, mountain lions, bobcats, gray foxes, ringtails, and raccoons. The tidal marshes supported enormous populations of waterfowl that, when in flight, could have darkened the sky at midday. Steelhead and other fish spawned in the three creeks.

Seven major biotic habitats have been identified within the City. These natural terrestrial communities (and percentages of total lands) are identified and described as:

- **Non-native-grasslands (12%)** – Non-native grasslands commonly occur in the south facing exposed hillsides and in patches among oak savanna/woodlands throughout the City. Non-native grassland provides important habitat to many terrestrial vertebrates in the Planning Area. Some of these species are grassland residents. A good many more use a variety of other habitats as well. Some are migrants that use the grasslands of the area for only a portion of each year. Resident and migratory birds occur here also. Small mammals are common to non-native grasslands.
- **Oak savanna/woodland (35%)** – This is a common biotic habitat within the City. The canopy cover ranges from open and savanna-like to almost closed in other portions within the Planning Area. True oak savanna is found in the hillsides north of Lucas Valley Road, while mixed woodlands commonly occur on north-facing slopes and throughout much of China Camp State Park. In many p1aces, mixed oak woodland habitat intermingles with annual grassland ·and chaparral habitats. Vegetation in the understory includes a mix of woody shrubs and annual grasses and forb.
- **Chaparral (1%)** – This habitat occurs mainly on south-facing or exposed slopes within the Planning Area. Hard chaparral occurs mainly in the hillsides above Lucas Valley Road, while northern coastal scrub occurs in patches throughout the Planning Area. Shrubs and low vegetation provide cover, nesting and foraging habitat for a variety of birds. Chaparral of the Planning Area provides important habitat for a variety of mammals.
- **Riparian (3%)** – Riparian habitats are located along banks of creeks. (i.e., Gallinas, Miller, and San Rafael), streams, and swales, and around the edges of seeps within the Planning Area. Riparian habitat can support a wide variety of water-dependent flora and fauna. Riparian habitat provides diverse cover, foraging, movement corridors, and nesting habitat a well as a fresh water source. In urbanized areas, riparian habitat often serve as movement corridors for wildlife, as well as provide flood control needs for the area.
- **Wetlands, (6%)** – North coas1nl salt marshes, mudflats, diked salt marshes, seasonal brackish or freshwater marshes and ponds, and stream channels and irrigation ditches are collectively called

wetlands. Salt marshes are important habitats within the landscape matrix and are one of the most productive areas on earth, involving complex interactions between terrestrial and aquatic organisms and their environment. Northern coastal salt marsh creates a continuous band of marsh along San Pablo Bay within the Planning Area. Diked salt marsh occurs in northern and eastern areas of the Planning Area. It is important to note that these wetlands are, in some areas, disturbed by farm operations related to the cultivation of hay. Seasonal freshwater wetlands occur in isolated locations throughout the non-native grassland habitats of the Planning Area. Seasonal wetlands, like diked salt marsh, provide important habitat for numerous species of shorebirds and migrating waterfowl. Several drainage ditches and irrigation canals bisect cultivated fields in the northern and eastern areas of the Planning Area.

- **Agricultural lands (4%)** – Agricultural Lands dominate the northern and eastern portion of the Planning Area. Some cultivated fields within the Planning Area support small· amounts of diked salt marsh vegetation as described above. These fields provide habitat for a variety of terrestrial vertebrates.
- **Urbanized lands (39%)** – This habitat in aggregate is the largest biotic habitat of the Planning Area. Urbanized areas include buildings, roads, gardens, and orchards within the Planning Area. Urbanized lands, although severely altered from the natural habitats they once were, support many animal species adapted to the presence of humans. Generally, plant species of this habitat are cultivated exotics or weedy annuals. A limited number of native and non-native animal species may be attracted to this habitat for cover, and natural and human-influenced sources of food. As development expands into the natural areas for wildlife (e.g., grasslands and woodlands), there is a growing concern of wildlife adapting to humans at the urban/ rural interface. As the amount of natural habitat decreases, there will be more human/wildlife encounters at the urban/rural interface and this has implications to both humans and wildlife because a) wildlife may carry rabies or other diseases, b) wildlife may be a hazard to traffic, c) there may be increased predation on gardens and pets, and d) the food web may potentially be altered in the natural habitat.

In addition, other special biotic areas of significance include eucalyptus and redwood groves, and Marin Islands.

- **Eucalyptus groves** – Mature eucalyptus groves line several roads and other developed areas, and also occur as patches in oak savanna/woodlands within the Planning Area. Because the eucalyptus is non-native, it is not compatible with the native flora in that the litter inhibits new plant growth and the slow decay process may pose a fire hazard. These groves serve as windbreaks and can provide habitat for roosting and nesting birds.
- **Redwood groves** – Mature redwood groves occur in north-facing slopes and valleys within the Planning Arca, which contain natural seepage or springs. Redwood groves can be found in the Los Ranchitos hillside, Gerstle Park hillside, West End canyons and hillsides, Meyer Road at the end of C Street, upper Irwin Street, end of Mountain View Avenue, and other isolated areas of Black Canyon, China Camp, and Santa Venetia hillsides, and Coleman Drive. These native groves provide habitat for roosting and nesting birds.
- **Marin Islands** – Two islands, called East Marin and West Marin Islands, are found in San Rafael Bay. Because of their isolated nature and close proximity to wetlands, these special areas arc of high habitat value. These islands provide habitat for roosting and nesting birds. A number of shorebirds and waterfowl could roost or nest in these isolated and protected islands. The West Main Island is an important shorebird and waterfowl rookery in the San Francisco Bay Area.

In addition to the seven major terrestrial biotic habitats, the Planning Area has a significant aquatic resource. These aquatic resource areas include the San Pablo and San Rafael Bays, sloughs, canals, creeks, and other water areas within the Planning Area. The bays, slough, and water areas can be important: spawning

grounds and/ or nursery areas for fishes and as a feeding area for both resident and migratory birds, as well as a permanent habitat for many aquatic organisms. A number of sport, commercial, listed, and candidate fishes are found in the Bay.

Natural and Beneficial Functions

Wetlands are habitats in which soils are intermittently or permanently saturated or inundated. Wetland habitats vary from rivers to seasonal ponding of alkaline flats and include swamps, bogs, marshes, vernal pools, and riparian woodlands. Wetlands are considered to be waters of the United States and are subject to the jurisdiction of the U.S. Army Corps of Engineers as well as the California Department of Fish and Wildlife (CDFW). Where the waters provide habitat for federally endangered species, the U.S. Fish and Wildlife Service may also have authority.

Wetlands are a valuable natural resource for communities providing beneficial impact to water quality, wildlife protection, recreation, and education, and play an important role in hazard mitigation. Wetlands provide drought relief in water-scarce areas where the relationship between water storage and streamflow regulation is vital, and reduce flood peaks and slowly release floodwaters to downstream areas. When surface runoff is dampened, the erosive powers of the water are greatly diminished. Furthermore, the reduction in the velocity of inflowing water as it passes through a wetland helps remove sediment being transported by the water.

Wetlands are often found in floodplains and depressional areas of a watershed. Many wetlands receive and store floodwaters, thus slowing and reducing downstream flow. Wetlands perform a variety of ecosystem functions including food web support, habitat for insects and other invertebrates, fish and wildlife habitat, filtering of waterborne and dry-deposited anthropogenic pollutants, carbon storage, water flow regulation (e.g., flood abatement), groundwater recharge, and other human and economic benefits.

Wetlands, and other riparian and sensitive areas, provide habitat for insects and other invertebrates that are critical food sources to a variety of wildlife species, particularly birds. There are species that depend on these areas during all parts of their lifecycle for food, overwintering, and reproductive habitat. Other species use wetlands and riparian areas for one or two specific functions or parts of the lifecycle, most commonly for food resources. In addition, these areas produce substantial plant growth that serves as a food source to herbivores (wild and domesticated) and a secondary food source to carnivores.

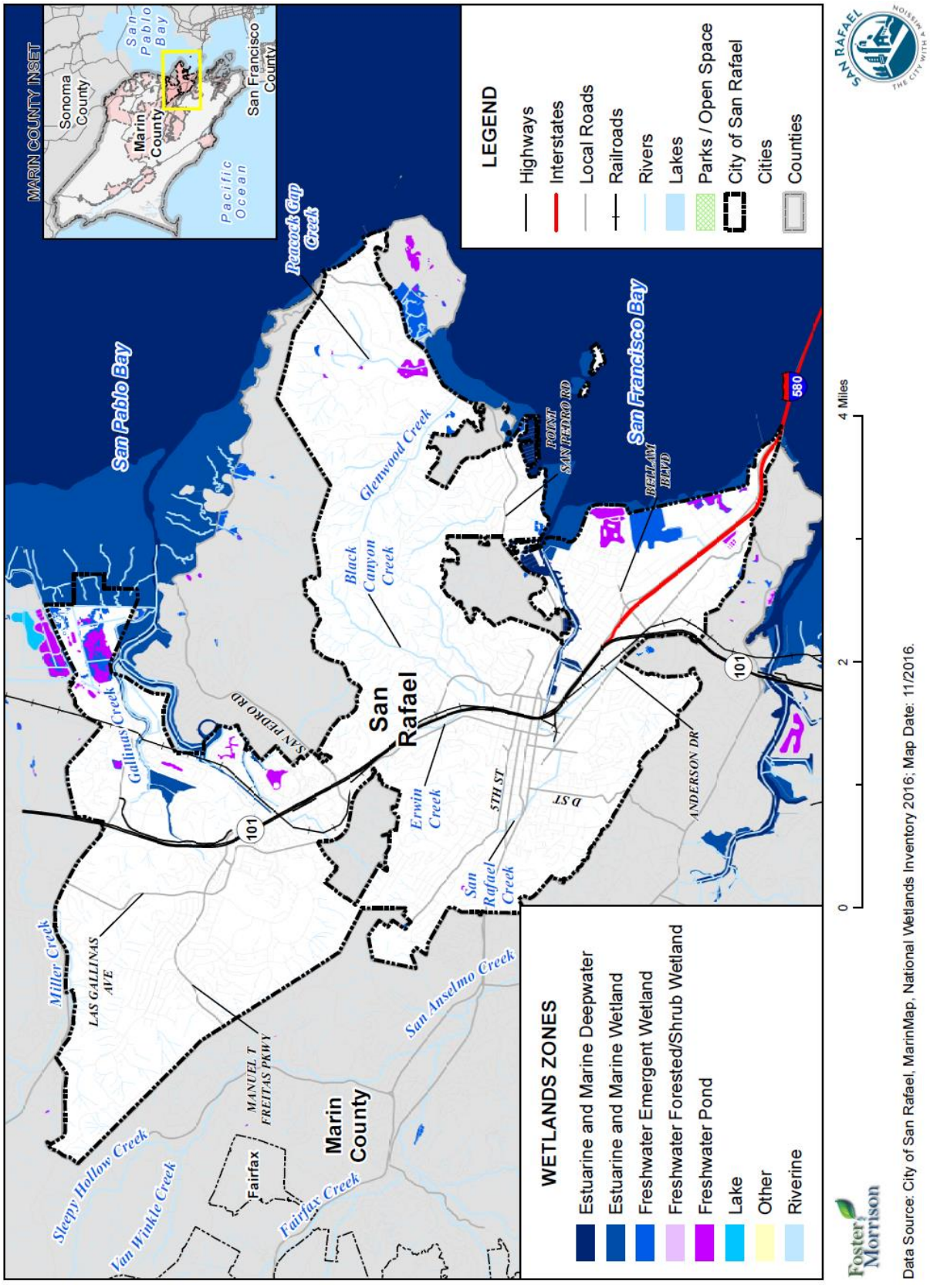
Wetlands slow the flow of water through the vegetation and soil, and pollutants are often held in the soil. In addition, because the water is slowed, sediments tend to fall out, thus improving water quality and reducing turbidity downstream.

These natural floodplain functions associated with the natural or relatively undisturbed floodplain that moderates flooding, such as wetland areas, are critical for maintaining water quality, recharging groundwater, reducing erosion, redistributing sand and sediment, and providing fish and wildlife habitat. Preserving and protecting these areas and associated functions are a vital component of sound floodplain management practices for the City.

Natural site features such as wetlands with native plants and hydric soils have long disappeared and they no longer can function as they should. Landowners are encouraged to plant native plants on their property.

These plants will assist with absorption and filtration of water. They will help to hold soils to keep erosion and siltation from occurring in the waterway. Landowners are also encouraged to remove any obstructions which might restrict water conveyance during high water events. Wetlands in San Rafael are shown in Figure 4-39.

Figure 4-39 San Rafael – Wetlands



Critical Species

To further understand natural resources that may be particularly vulnerable to a hazard event, as well as those that need consideration when implementing mitigation activities, it is important to identify at-risk species (i.e., endangered species) in the Planning Area. An endangered species is any species of fish, plant life, or wildlife that is in danger of extinction throughout all or most of its range. A threatened species is a species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. Both endangered and threatened species are protected by law and any future hazard mitigation projects are subject to these laws. Candidate species are plants and animals that have been proposed as endangered or threatened but are not currently listed.

There are many federal endangered, threatened, or candidate species in or near San Rafael. These species are listed in Table 4-26.

Table 4-26 San Rafael – Threatened and Endangered Species

Scientific Name	Common Name	Federal Status	State Status	CDFW Status	CA Rare Plant Rank
Animals – Amphibians					
Ambystoma californiense	California tiger salamander	Threatened	Threatened	WL	-
Dicamptodon ensatus	California giant salamander	None	None	SSC	-
Rana boylii	foothill yellow-legged frog	None	None	SSC	-
Rana draytonii	California red-legged frog	Threatened	None	SSC	-
Taricha torosa	Coast Range newt	None	None	SSC	-
Animals – Arachnids					
Talanites ubicki	Ubick's gnaphosid spider	None	None	-	-
Calicina diminua	Marin blind harvestman	None	None	-	-
Microcina tiburona	Tiburon micro-blind harvestman	None	None	-	-
Animals – Birds					
Aquila chrysaetos	golden eagle	None	None	FP WL	-
Buteo swainsoni	Swainson's hawk	None	Threatened	-	-
Circus cyaneus	northern harrier	None	None	SSC	-
Elanus leucurus	white-tailed kite	None	None	FP	-
Haliaeetus leucocephalus	bald eagle	Delisted	Endangered	FP	-
Pandion haliaetus	osprey	None	None	WL	-
Eremophila alpestris actia	California horned lark	None	None	WL	-
Fratercula cirrhata	tufted puffin	None	None	SSC	-
Bucephala islandica	Barrow's goldeneye	None	None	SSC	-
Dendrocygna bicolor	fulvous whistling-duck	None	None	SSC	-
Histrionicus histrionicus	harlequin duck	None	None	SSC	-

Scientific Name	Common Name	Federal Status	State Status	CDFW Status	CA Rare Plant Rank
Chaetura vauxi	Vaux's swift	None	None	SSC	-
Cypseloides niger	black swift	None	None	SSC	-
Ardea alba	great egret	None	None	-	-
Ardea herodias	great blue heron	None	None	-	-
Egretta thula	snowy egret	None	None	-	-
Nycticorax nycticorax	black-crowned night heron	None	None	-	-
Charadrius alexandrinus nivosus	western snowy plover	Threatened	None	SSC	-
Charadrius montanus	mountain plover	None	None	SSC	-
Aimophila ruficeps canescens	southern California rufous-crowned sparrow	None	None	WL	-
Artemisiospiza belli belli	Bell's sage sparrow	None	None	WL	-
Melospiza melodia maxillaris	Suisun song sparrow	None	None	SSC	-
Melospiza melodia pusillula	Alameda song sparrow	None	None	SSC	-
Melospiza melodia samuelis	San Pablo song sparrow	None	None	SSC	-
Passerculus sandwichensis beldingi	Belding's savannah sparrow	None	Endangered	-	-
Spizella breweri	Brewer's sparrow	None	None	-	-
Falco columbarius	merlin	None	None	WL	-
Falco peregrinus anatum	American peregrine falcon	Delisted	Delisted	FP	-
Gavia immer	common loon	None	None	SSC	-
Haematopus bachmani	black oystercatcher	None	None	-	-
Progne subis	purple martin	None	None	SSC	-
Oceanodroma homochroa	ashy storm-petrel	None	None	SSC	-
Agelaius tricolor	tricolored blackbird	None	Candidate Endangered	SSC	-
Baeolophus inornatus	oak titmouse	None	None	-	-
Geothlypis trichas sinuosa	saltmarsh common yellowthroat	None	None	SSC	-
Setophaga petechia	yellow warbler	None	None	SSC	-
Pelecanus erythrorhynchos	American white pelican	None	None	SSC	-
Pelecanus occidentalis californicus	California brown pelican	Delisted	Delisted	FP	-
Phalacrocorax auritus	double-crested cormorant	None	None	WL	-
Coturnicops noveboracensis	yellow rail	None	None	SSC	-
Laterallus jamaicensis coturniculus	California black rail	None	Threatened	FP	-
Rallus longirostris levipes	light-footed clapper rail	Endangered	Endangered	FP	-
Rallus longirostris obsoletus	California clapper rail	Endangered	Endangered	FP	-
Numenius americanus	long-billed curlew	None	None	WL	-

Scientific Name	Common Name	Federal Status	State Status	CDFW Status	CA Rare Plant Rank
Asio flammeus	short-eared owl	None	None	SSC	-
Athene cunicularia	burrowing owl	None	None	SSC	-
Strix occidentalis caurina	northern spotted owl	Threatened	Threatened	SSC	-
Strix occidentalis occidentalis	California spotted owl	None	None	SSC	-
Selasphorus rufus	rufous hummingbird	None	None	-	-
Animals – Crustaceans					
Caecidotea tomalensis	Tomales isopod	None	None	-	-
Syncaris pacifica	California freshwater shrimp	Endangered	Endangered	-	-
Linderiella occidentalis	California linderiella	None	None	-	-
Animals – Fish					
Archoplites interruptus	Sacramento perch	None	None	SSC	-
Lavinia symmetricus ssp. 2	Tomales roach	None	None	SSC	-
Pogonichthys macrolepidotus	Sacramento splittail	None	None	SSC	-
Eucyclogobius newberryi	tidewater goby	Endangered	None	SSC	-
Hypomesus transpacificus	Delta smelt	Threatened	Endangered	-	-
Spirinchus thaleichthys	longfin smelt	Candidate	Threatened	SSC	-
Thaleichthys pacificus	eulachon	Threatened	None	-	-
Entosphenus tridentatus	Pacific lamprey	None	None	SSC	-
Oncorhynchus kisutch	coho salmon - central California coast ESU	Endangered	Endangered	-	-
Oncorhynchus mykiss irideus	steelhead - central California coast DPS	Threatened	None	-	-
Oncorhynchus mykiss irideus	steelhead - Central Valley DPS	Threatened	None	-	-
Oncorhynchus mykiss irideus	steelhead - northern California DPS	Threatened	None	-	-
Oncorhynchus tshawytscha	chinook salmon - Central Valley spring-run ESU	Threatened	Threatened	-	-
Oncorhynchus tshawytscha	chinook salmon - Central Valley fall / late fall-run ESU	None	None	SSC	-
Animals – Insects					
Bombus caliginosus	obscure bumble bee	None	None	-	-
Bombus occidentalis	western bumble bee	None	None	-	-
Cicindela hirticollis gravida	sandy beach tiger beetle	None	None	-	-
Ischnura gemina	San Francisco forktail damselfly	None	None	-	-
Lichnanthe ursina	bumblebee scarab beetle	None	None	-	-
Hydrochara rickseckeri	Ricksecker's water scavenger beetle	None	None	-	-
Adela oplerella	Opler's longhorn moth	None	None	-	-

Scientific Name	Common Name	Federal Status	State Status	CDFW Status	CA Rare Plant Rank
Callophrys mossii bayensis	San Bruno elfin butterfly	Endangered	None	-	-
Callophrys mossii marinensis	Marin elfin butterfly	None	None	-	-
Plebejus icarioides missionensis	Mission blue butterfly	Endangered	None	-	-
Plebejus icarioides parapheres	Point Reyes blue butterfly	None	None	-	-
Trachusa gummifera	San Francisco Bay Area leaf-cutter bee	None	None	-	-
Danaus plexippus pop. 1	monarch - California overwintering population	None	None	-	-
Speyeria zerene myrtleae	Myrtle's silverspot butterfly	Endangered	None	-	-
Coelus globosus	globose dune beetle	None	None	-	-
Animals – Mammals					
Aplodontia rufa phaea	Point Reyes mountain beaver	None	None	SSC	-
Zapus trinotatus orarius	Point Reyes jumping mouse	None	None	SSC	-
Microtus californicus sanpabloensis	San Pablo vole	None	None	SSC	-
Reithrodontomys raviventris	salt-marsh harvest mouse	Endangered	Endangered	FP	-
Enhydra lutris nereis	southern sea otter	Threatened	None	FP	-
Taxidea taxus	American badger	None	None	SSC	-
Scapanus latimanus insularis	Angel Island mole	None	None	-	-
Antrozous pallidus	pallid bat	None	None	SSC	-
Corynorhinus townsendii	Townsend's big-eared bat	None	None	SSC	-
Lasionycteris noctivagans	silver-haired bat	None	None	-	-
Lasiurus blossevillii	western red bat	None	None	SSC	-
Lasiurus cinereus	hoary bat	None	None	-	-
Myotis ciliolabrum	western small-footed myotis	None	None	-	-
Myotis thysanodes	fringed myotis	None	None	-	-
Myotis volans	long-legged myotis	None	None	-	-
Myotis yumanensis	Yuma myotis	None	None	-	-
Animals – Mollusks					
Helminthoglypta nickliniana awania	Peninsula coast range shoulderband	None	None	-	-
Helminthoglypta stiversiana williamsi	Williams' bronze shoulderband	None	None	-	-
Tryonia imitator	mimic tryonia (=California brackishwater snail)	None	None	-	-
Margaritifera falcata	western pearlshell	None	None	-	-
Vespericola marinensis	Marin hesperian	None	None	-	-
Pomatiopsis binneyi	robust walker	None	None	-	-

Scientific Name	Common Name	Federal Status	State Status	CDFW Status	CA Rare Plant Rank
Anodonta oregonensis	Oregon floater	None	None	-	-
Animals – Reptiles					
Emys marmorata	western pond turtle	None	None	SSC	-
Community – Terrestrial					
Central Dune Scrub	Central Dune Scrub	None	None	-	-
Coastal and Valley Freshwater Marsh	Coastal and Valley Freshwater Marsh	None	None	-	-
Coastal Brackish Marsh	Coastal Brackish Marsh	None	None	-	-
Coastal Terrace Prairie	Coastal Terrace Prairie	None	None	-	-
Northern Coastal Salt Marsh	Northern Coastal Salt Marsh	None	None	-	-
Northern Maritime Chaparral	Northern Maritime Chaparral	None	None	-	-
Northern Vernal Pool	Northern Vernal Pool	None	None	-	-
Serpentine Bunchgrass	Serpentine Bunchgrass	None	None	-	-
Plants – Bryophytes					
Fissidens pauperculus	minute pocket moss	None	None	-	1B.2
Entosthodon kochii	Koch's cord moss	None	None	-	1B.3
Mielichhoferia elongata	elongate copper moss	None	None	-	4.3
Triquetrella californica	coastal triquetrella	None	None	-	1B.2
Plants – Lichens					
Thamnolia vermicularis	whiteworm lichen	None	None	-	2B.1
Plants – Vascular					
Cicuta maculata var. bolanderi	Bolander's water-hemlock	None	None	-	2B.1
Lilaeopsis masonii	Mason's lilaeopsis	None	Rare	-	1B.1
Perideridia gairdneri ssp. gairdneri	California Gairdner's yampah	None	None	-	4.2
Blennosperma nanum var. robustum	Point Reyes blennosperma	None	Rare	-	1B.2
Cirsium andrewsii	Franciscan thistle	None	None	-	1B.2
Cirsium hydrophilum var. vaseyi	Mt. Tamalpais thistle	None	None	-	1B.2
Erigeron biolettii	streamside daisy	None	None	-	3
Erigeron supplex	supple daisy	None	None	-	1B.2
Grindelia hirsutula var. maritima	San Francisco gumplant	None	None	-	3.2
Helianthella castanea	Diablo helianthella	None	None	-	1B.2
Hemizonia congesta ssp. congesta	congested-headed hayfield tarplant	None	None	-	1B.2

Scientific Name	Common Name	Federal Status	State Status	CDFW Status	CA Rare Plant Rank
Hesperevax sparsiflora var. brevifolia	short-leaved evax	None	None	-	1B.2
Holocarpha macradenia	Santa Cruz tarplant	Threatened	Endangered	-	1B.1
Lasthenia californica ssp. bakeri	Baker's goldfields	None	None	-	1B.2
Lasthenia californica ssp. macrantha	perennial goldfields	None	None	-	1B.2
Lasthenia conjugens	Contra Costa goldfields	Endangered	None	-	1B.1
Layia carnosa	beach layia	Endangered	Endangered	-	1B.1
Lessingia hololeuca	woolly-headed lessingia	None	None	-	3
Lessingia micradenia var. micradenia	Tamalpais lessingia	None	None	-	1B.2
Micropus amphibolus	Mt. Diablo cottonweed	None	None	-	3.2
Microseris paludosa	marsh microseris	None	None	-	1B.2
Pentachaeta bellidiflora	white-rayed pentachaeta	Endangered	Endangered	-	1B.1
Stebbinsoseris decipiens	Santa Cruz microseris	None	None	-	1B.2
Amsinckia lunaris	bent-flowered fiddleneck	None	None	-	1B.2
Phacelia insularis var. continentis	North Coast phacelia	None	None	-	1B.2
Plagiobothrys glaber	hairless popcornflower	None	None	-	1A
Arabis blepharophylla	coast rockcress	None	None	-	4.3
Cardamine angulata	seaside bittercress	None	None	-	2B.1
Erysimum concinnum	bluff wallflower	None	None	-	1B.2
Erysimum franciscanum	San Francisco wallflower	None	None	-	4.2
Streptanthus batrachopus	Tamalpais jewelflower	None	None	-	1B.3
Streptanthus glandulosus ssp. niger	Tiburon jewelflower	Endangered	Endangered	-	1B.1
Streptanthus glandulosus ssp. pulchellus	Mt. Tamalpais bristly jewelflower	None	None	-	1B.2
Campanula californica	swamp harebell	None	None	-	1B.2
Stellaria littoralis	beach starwort	None	None	-	4.2
Calystegia collina ssp. oxyphylla	Mt. Saint Helena morning-glory	None	None	-	4.2
Calystegia purpurata ssp. saxicola	coastal bluff morning-glory	None	None	-	1B.2
Dichondra occidentalis	western dichondra	None	None	-	4.2
Carex buxbaumii	Buxbaum's sedge	None	None	-	4.2
Carex leptalea	bristle-stalked sedge	None	None	-	2B.2
Carex lyngbyei	Lyngbye's sedge	None	None	-	2B.2
Carex praticola	northern meadow sedge	None	None	-	2B.2

Scientific Name	Common Name	Federal Status	State Status	CDFW Status	CA Rare Plant Rank
Eleocharis parvula	small spikerush	None	None	-	4.3
Rhynchospora californica	California beaked-rush	None	None	-	1B.1
Arctostaphylos montana ssp. montana	Mt. Tamalpais manzanita	None	None	-	1B.3
Arctostaphylos virgata	Marin manzanita	None	None	-	1B.2
Amorpha californica var. napensis	Napa false indigo	None	None	-	1B.2
Astragalus breweri	Brewer's milk-vetch	None	None	-	4.2
Astragalus nuttallii var. nuttallii	ocean bluff milk-vetch	None	None	-	4.2
Astragalus pycnostachyus var. pycnostachyus	coastal marsh milk-vetch	None	None	-	1B.2
Hosackia gracilis	harlequin lotus	None	None	-	4.2
Lupinus tidestromii	Tidestrom's lupine	Endangered	Endangered	-	1B.1
Thermopsis macrophylla	Santa Ynez false lupine	None	Rare	-	1B.3
Trifolium amoenum	two-fork clover	Endangered	None	-	1B.1
Quercus parvula var. tamalpaisensis	Tamalpais oak	None	None	-	1B.3
Iris longipetala	coast iris	None	None	-	4.2
Juncus acutus ssp. leopoldii	southwestern spiny rush	None	None	-	4.2
Monardella sinuata ssp. nigrescens	northern curly-leaved monardella	None	None	-	1B.2
Calochortus tiburonensis	Tiburon mariposa-lily	Threatened	Threatened	-	1B.1
Calochortus umbellatus	Oakland star-tulip	None	None	-	4.2
Fritillaria lanceolata var. tristulis	Marin checker lily	None	None	-	1B.1
Fritillaria liliacea	fragrant fritillary	None	None	-	1B.2
Lilium maritimum	coast lily	None	None	-	1B.1
Limnanthes douglasii ssp. sulphurea	Point Reyes meadowfoam	None	Endangered	-	1B.2
Hesperolinon congestum	Marin western flax	Threatened	Threatened	-	1B.1
Sidalcea calycosa ssp. rhizomata	Point Reyes checkerbloom	None	None	-	1B.2
Sidalcea hickmanii ssp. viridis	Marin checkerbloom	None	None	-	1B.1
Sidalcea malviflora ssp. purpurea	purple-stemmed checkerbloom	None	None	-	1B.2
Toxicoscordion fontanum	marsh zigadenus	None	None	-	4.2
Calandrinia breweri	Brewer's calandrinia	None	None	-	4.2
Cistanthe maritima	seaside cistanthe	None	None	-	4.2
Abronia umbellata var. breviflora	pink sand-verbena	None	None	-	1B.1

Scientific Name	Common Name	Federal Status	State Status	CDFW Status	CA Rare Plant Rank
Clarkia concinna ssp. raichei	Raiche's red ribbons	None	None	-	1B.1
Cypripedium californicum	California lady's-slipper	None	None	-	4.2
Piperia elegans ssp. decurtata	Point Reyes rein orchid	None	None	-	1B.1
Piperia michaelii	Michael's rein orchid	None	None	-	4.2
Castilleja affinis var. neglecta	Tiburon paintbrush	Endangered	Threatened	-	1B.2
Castilleja ambigua var. ambigua	johnny-nip	None	None	-	4.2
Castilleja ambigua var. humboldtiensis	Humboldt Bay owl's-clover	None	None	-	1B.2
Castilleja leschkeana	Point Reyes paintbrush	None	None	-	1A
Chloropyron maritimum ssp. palustre	Point Reyes salty bird's-beak	None	None	-	1B.2
Chloropyron molle ssp. molle	soft salty bird's-beak	Endangered	Rare	-	1B.2
Kopsiopsis hookeri	small groundcone	None	None	-	2B.3
Triphysaria floribunda	San Francisco owl's-clover	None	None	-	1B.2
Collinsia corymbosa	round-headed Chinese-houses	None	None	-	1B.2
Collinsia multicolor	San Francisco collinsia	None	None	-	1B.2
Agrostis blasdalei	Blasdale's bent grass	None	None	-	1B.2
Alopecurus aequalis var. sonomensis	Sonoma alopecurus	Endangered	None	-	1B.1
Calamagrostis crassiglumis	Thurber's reed grass	None	None	-	2B.1
Calamagrostis ophitidis	serpentine reed grass	None	None	-	4.3
Elymus californicus	California bottle-brush grass	None	None	-	4.3
Pleuropogon hooverianus	North Coast semaphore grass	None	Threatened	-	1B.1
Pleuropogon refractus	nodding semaphore grass	None	None	-	4.2
Collomia diversifolia	serpentine collomia	None	None	-	4.3
Gilia capitata ssp. chamissonis	blue coast gilia	None	None	-	1B.1
Gilia capitata ssp. tomentosa	woolly-headed gilia	None	None	-	1B.1
Gilia millefoliata	dark-eyed gilia	None	None	-	1B.2
Leptosiphon acicularis	bristly leptosiphon	None	None	-	4.2
Leptosiphon grandiflorus	large-flowered leptosiphon	None	None	-	4.2
Leptosiphon rosaceus	rose leptosiphon	None	None	-	1B.1
Navarretia leucocephala ssp. bakeri	Baker's navarretia	None	None	-	1B.1
Navarretia rosulata	Marin County navarretia	None	None	-	1B.2
Polemonium carneum	Oregon polemonium	None	None	-	2B.2
Chorizanthe cuspidata var. cuspidata	San Francisco Bay spineflower	None	None	-	1B.2

Scientific Name	Common Name	Federal Status	State Status	CDFW Status	CA Rare Plant Rank
Chorizanthe cuspidata var. villosa	woolly-headed spineflower	None	None	-	1B.2
Chorizanthe valida	Sonoma spineflower	Endangered	Endangered	-	1B.1
Eriogonum luteolum var. caninum	Tiburon buckwheat	None	None	-	1B.2
Polygonum marinense	Marin knotweed	None	None	-	3.1
Heteranthera dubia	water star-grass	None	None	-	2B.2
Aspidotis carlotta-halliae	Carlotta Hall's lace fern	None	None	-	4.2
Delphinium bakeri	Baker's larkspur	Endangered	Endangered	-	1B.1
Delphinium luteum	golden larkspur	Endangered	Rare	-	1B.1
Ranunculus lobbii	Lobb's aquatic buttercup	None	None	-	4.2
Ceanothus decornutus	Nicasio ceanothus	None	None	-	1B.2
Ceanothus gloriosus var. exaltatus	glory brush	None	None	-	4.3
Ceanothus gloriosus var. gloriosus	Point Reyes ceanothus	None	None	-	4.3
Ceanothus gloriosus var. porrectus	Mt. Vision ceanothus	None	None	-	1B.3
Ceanothus masonii	Mason's ceanothus	None	Rare	-	1B.2
Ceanothus pinetorum	Kern ceanothus	None	None	-	4.3
Ceanothus rigidus	Monterey ceanothus	None	None	-	4.2
Horkelia cuneata var. sericea	Kellogg's horkelia	None	None	-	1B.1
Horkelia marinensis	Point Reyes horkelia	None	None	-	1B.2
Horkelia tenuiloba	thin-lobed horkelia	None	None	-	1B.2
Dirca occidentalis	western leatherwood	None	None	-	1B.2

Source: California Natural Diversity Database

Legend: CDFW: WL – Watch List; SSC – Species of Special Concern; FP – Fully Protected

Legend: CA Rare Plan Rank:

1A Plants presumed extinct in California and rare/extinct elsewhere

1B.1 Plants rare, threatened, or endangered in California and elsewhere; seriously threatened in California

1B.2 Plants rare, threatened, or endangered in California and elsewhere; fairly threatened in California

1B.3 Plants rare, threatened, or endangered in California and elsewhere; not very threatened in California

2A Plants presumed extirpated in California, but more common elsewhere

2B.1 Plants rare, threatened, or endangered in California, but more common elsewhere; seriously threatened in California

2B.2 Plants rare, threatened, or endangered in California, but more common elsewhere; fairly threatened in California

2B.3 Plants rare, threatened, or endangered in California, but more common elsewhere; not very threatened in California

3.1 Plants about which we need more information; seriously threatened in California

3.2 Plants about which we need more information; fairly threatened in California

3.3 Plants about which we need more information; not very threatened in California

4.1 Plants of limited distribution; seriously threatened in California

4.2 Plants of limited distribution; fairly threatened in California

4.3 Plants of limited distribution; not very threatened in California

Historic and Cultural Assets

San Rafael has a large stock of historically significant homes, public buildings, and landmarks. To inventory these resources, the HMPC collected information from a number of sources. The California Department of Parks and Recreation Office of Historic Preservation (OHP) was the primary source of information. The OHP is responsible for the administration of federally and state mandated historic preservation programs to further the identification, evaluation, registration, and protection of California's irreplaceable archaeological and historical resources. OHP administers the National Register of Historic Places, the California Register of Historical Resources, California Historical Landmarks, and the California Points of Historical Interest programs. Each program has different eligibility criteria and procedural requirements.

- The **National Register of Historic Places** is the nation's official list of cultural resources worthy of preservation. The National Register is part of a national program to coordinate and support public and private efforts to identify, evaluate, and protect historic and archeological resources. Properties listed include districts, sites, buildings, structures, and objects that are significant in American history, architecture, archeology, engineering, and culture. The National Register is administered by the National Park Service, which is part of the U.S. Department of the Interior.
- The **California Register of Historical Resources** program encourages public recognition and protection of resources of architectural, historical, archeological, and cultural significance and identifies historical resources for state and local planning purposes; determines eligibility for state historic preservation grant funding; and affords certain protections under the California Environmental Quality Act. The Register is the authoritative guide to the state's significant historical and archeological resources.
- **California Historical Landmarks** are sites, buildings, features, or events that are of statewide significance and have anthropological, cultural, military, political, architectural, economic, scientific or technical, religious, experimental, or other value. Landmarks #770 and above are automatically listed in the California Register of Historical Resources.
- **California Points of Historical Interest** are sites, buildings, features, or events that are of local (city or county) significance and have anthropological, cultural, military, political, architectural, economic, scientific or technical, religious, experimental, or other value. Points designated after December 1997 and recommended by the State Historical Resources Commission are also listed in the California Register.

Historical resources included in the programs above are identified in Table 4-27.

Table 4-27 San Rafael – Historic Resources

Name/Landmark Plaque Number	National Register	State Landmark	California Register	Point of Interest	Date Listed	Town
Boyd House (N317)	X		X	X	12/17/1974	San Rafael
Bradford House (N871)	X				6/6/1980	San Rafael
China Camp (N765)	X				4/26/1979	San Rafael

Name/Landmark Plaque Number	National Register	State Landmark	California Register	Point of Interest	Date Listed	Town
Dixie Schoolhouse (N199)	X	X			12/26/1972	San Rafael
Dollar, Robert, Estate (N195)	X				12/11/1972	San Rafael
Dollar, Robert, House (N1705)	X			X	7/23/1991	San Rafael
Marin County Civic Center (999)	X	X			5/8/1991	San Rafael
Mcnear, Erskine, B., House (N988)	X				1/11/1982	San Rafael
Mission San Rafael Arcángel (220)	X	X		X	6/20/1935	San Rafael
San Rafael Improvement Club (N1274)	X	X			3/29/1984	San Rafael
St. Vincent's School for Boys (630)	X			X	1/29/1958	San Rafael

Source: California Office of Historic Preservation

It should be noted that as defined by the National Environmental Policy Act (NEPA), any property over 50 years of age is considered a historic resource and is potentially eligible for the National Register. Thus, in the event that the property is to be altered, or has been altered, as the result of a major federal action, the property must be evaluated under the guidelines set forth by NEPA. Structural mitigation projects are considered alterations for the purpose of this regulation.

Growth and Development/Redevelopment Trends

As part of the planning process, the HMPC looked at changes in growth and development, both past and future, and examined these changes in the context of hazard-prone areas, and how the changes in growth and development affect loss estimates and vulnerability. Information from the 2015-2023 City of San Rafael Housing Element, 2020 General Plan Background Report, and the California Department of Finance (DOF) form the basis of this discussion.

An important consideration from an emergency response perspective is the tourist population and temporal shifts in the transient population during the summer, particularly in the western coastal areas of the County. On warm days during the summer, the transient tourist population more than doubles as people come to the county's parks, beaches, and recreation areas. There is often heavy traffic on roadways to and from west Marin County and along Highway 1. This also affects the City of San Rafael, but to a lesser extent than the County.

Past Growth and Current Population

Historically the number of City residents has increased from a population of just under 14,000 in 1950 to currently 60,582 in July of 2016 as estimated by the California Department of Finance. During this period

growth has been constant, with the greatest amount of growth between 1950 and 1970. Previously these trends were related to job creation and loss. The City has seen consistent growth since 1950. Population numbers since 1950 are shown in Table 4-28.

Table 4-28 San Rafael – Past and Current Populations

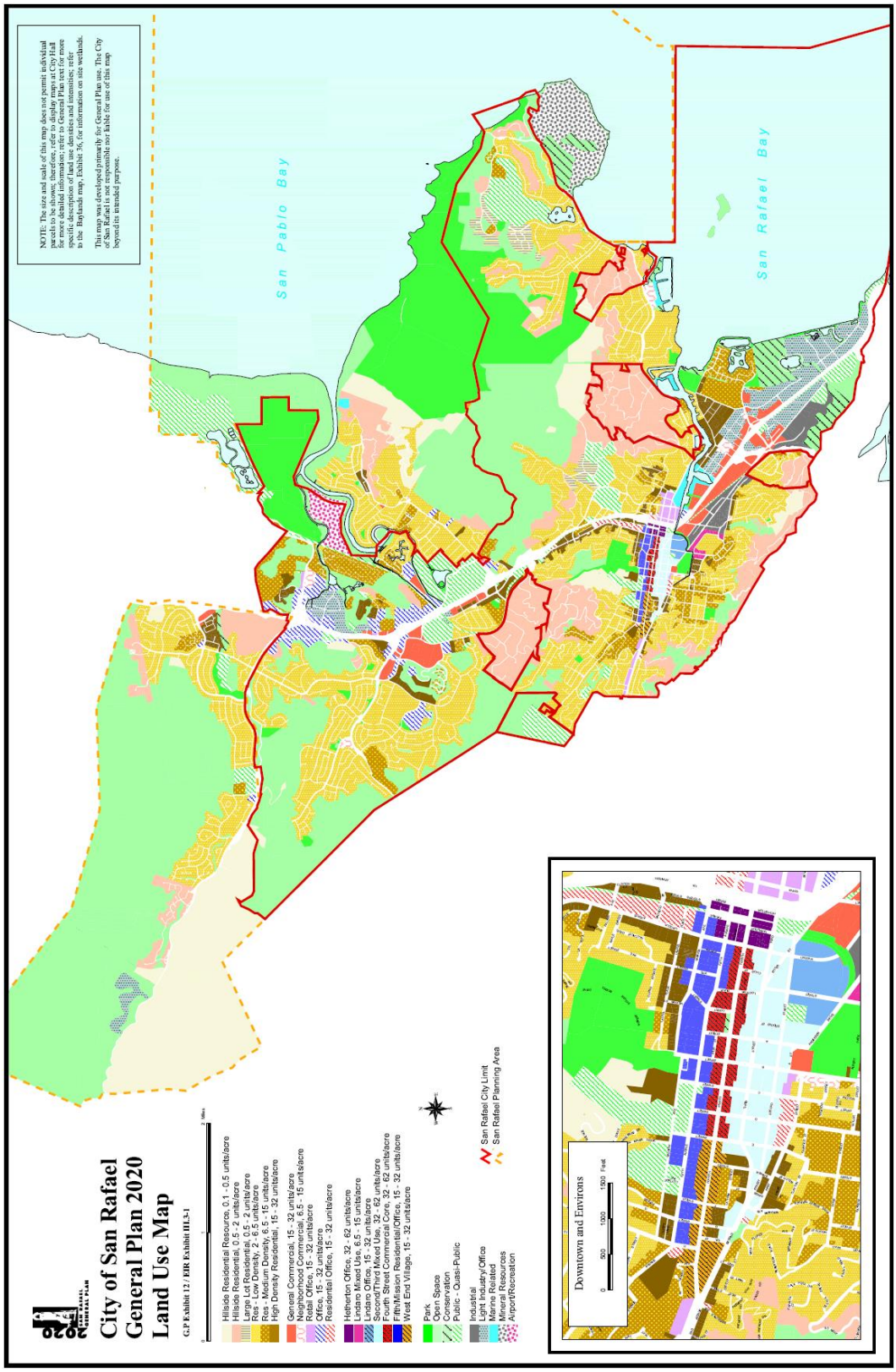
Year	Population	Numerical Change	Percent Change
1950	13,852	–	–
1960	20,460	6,608	47.7%
1970	38,977	18,517	90.5%
1980	44,700	5,723	14.7%
1990	48,404	3,704	8.3%
2000	56,063	10,659	22.0%
2010	57,713	1,650	2.9%
2016	60,582	2,869	5.0%

Source: 2020 General Plan Background Report, US Census Bureau, California Department of Finance E-1 Report

Land Use

The Land Use Map designates the land use pattern envisioned for the City. The designations on the map must be consistent with the General Plan in relationship to each land use category. The Zoning Ordinance sets forth regulations and standards for development to ensure that the policies, goals, and objectives of the General Plan are carried out. Rezoning can be initiated by the City Council, Planning Commission, or by an individual property owner. Land use in the City is shown on Figure 4-40.

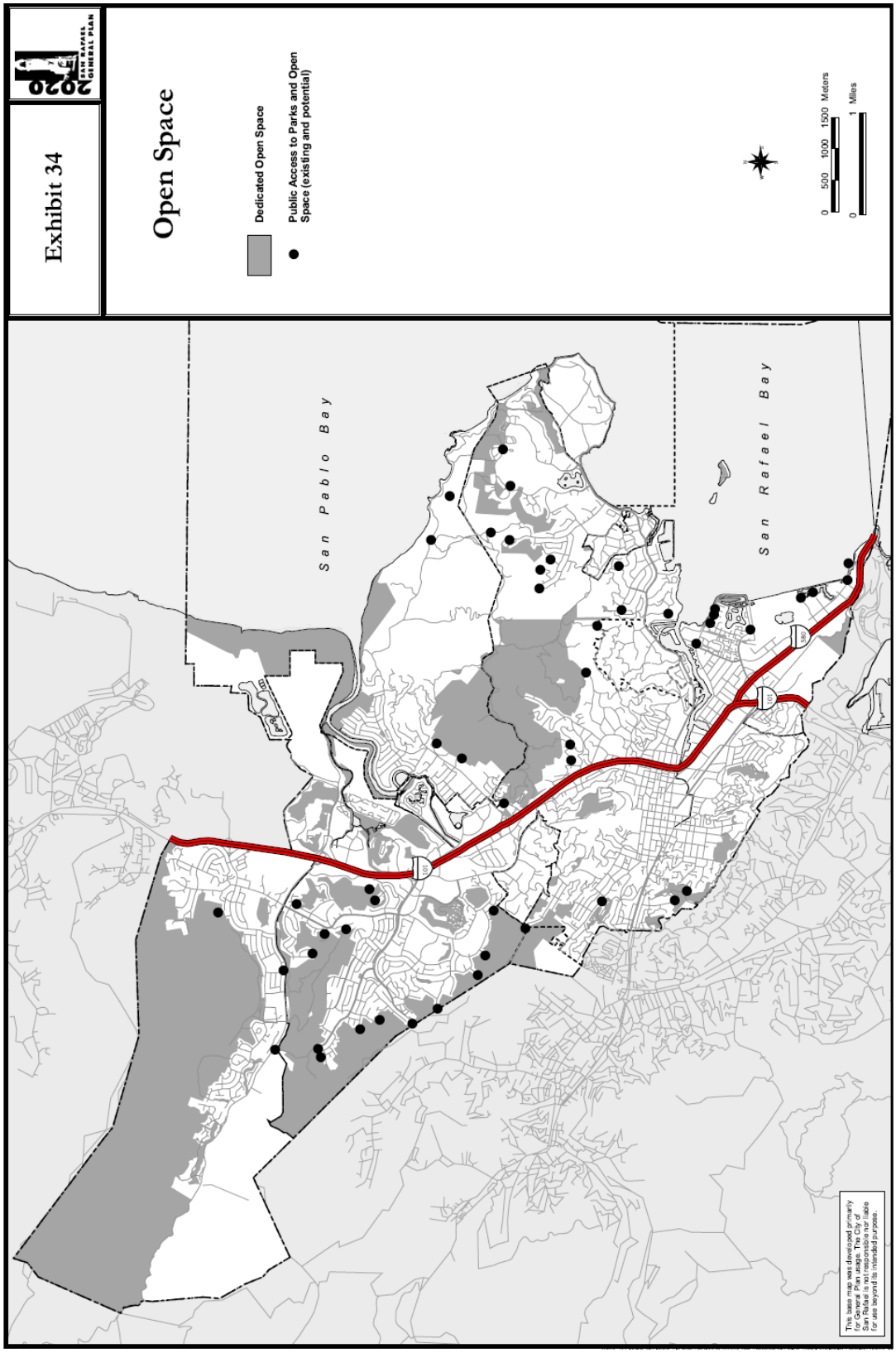
Figure 4-40 San Rafael – Land Use Map



Source: City of San Rafael 2020 General Plan

It should be noted that the City has large tracts of land that are designated as Open Space. In 1972, voters approved a tax levy and the formation of the Marin County Open Space District to acquire and maintain open space, park and recreational lands. In that same year, there was also a San Rafael voter-approved bond measure, where individual neighborhoods passed bonds to purchase open space in the area. Since then tremendous progress has been made in securing and protecting open space throughout the County. San Rafael has largely met its initial objectives by securing 3,285 acres of open space within the City limits and almost 7,300 acres in the Planning Area. Dedicated open space for the City is shown on Figure 4-41.

Figure 4-41 San Rafael Planning Area – Open Space Areas



Source: 2020 San Rafael General Plan Open Space Element

Special Populations

The Canal neighborhood is a dense, Latin American ethnic enclave in San Rafael, CA where most households are low-income (a quarter of families fall below the poverty level) and 71% of residents have only a high school degree or less. The area has grown over the last 20 years, largely due to immigration: Hispanics have increased from 47% of the population in 1990 to 80% in 2013. But housing stock has not grown as quickly, owing to how built out the neighborhood is already. This, along with high rents, has resulted in significant overcrowding in this majority-renter community, where most renter households pay more than a third of their income on rent. The Canal neighborhood falls in the floodplain.

Future Development/Redevelopment

In terms of future trends, the Association of Bay Area Governments (ABAG) projects that San Rafael will continue to experience the highest population growth rate within Marin County. These projections were included in the 2020 General Plan appendices. ABAG 2013 Projections estimates the City's population will reach 68,700 by the year 2040, an increase of nearly 11,000 residents from 2010 and representing approximately one-third of the projected growth countywide. This is shown in Table 4-29.

Table 4-29 San Rafael – Population Projections 2010-2040

Jurisdiction	2010	2020	2030	2040	Difference 2010-2040	% Change 2010-2040
San Rafael	57,713	60,800	64,400	68,700	10,987	19%

Source: ABAG 2013 Projections

Station Area Plans (Infill near Transit)

The City of San Rafael completed two separate Station Area Plans for the areas around the two proposed SMART stations in San Rafael. These plans set the stage to create mixed-use, livable areas around the future Downtown and Civic Center rail stations supported by a mix of transit opportunities, including passenger rail service. The two plans are:

- Downtown Station Area Plan
- Civic Center Station Area Plan

Other Redevelopment

The City of San Rafael is seeing redevelopment growth opportunity areas in two other locations: CAN THE CITY ELABORATE ON THE TYPES AND NATURE OF DEVELOPMENT HERE.

- The Northgate Area
- Dutra McNair Quarry

Future Development/Redevelopment GIS Analysis

As described above, the City Planning Department identified three future redevelopment areas for the City. These three are the Downton/Civic Center area, the Northgate area, and the Quarry area (which is outside

the current City limits), and are the subject of the GIS analysis. Mapping of these areas are included in Figure 4-42 and detailed in Table 4-30.

Figure 4-42 San Rafael – Future Development/Redevelopment Areas

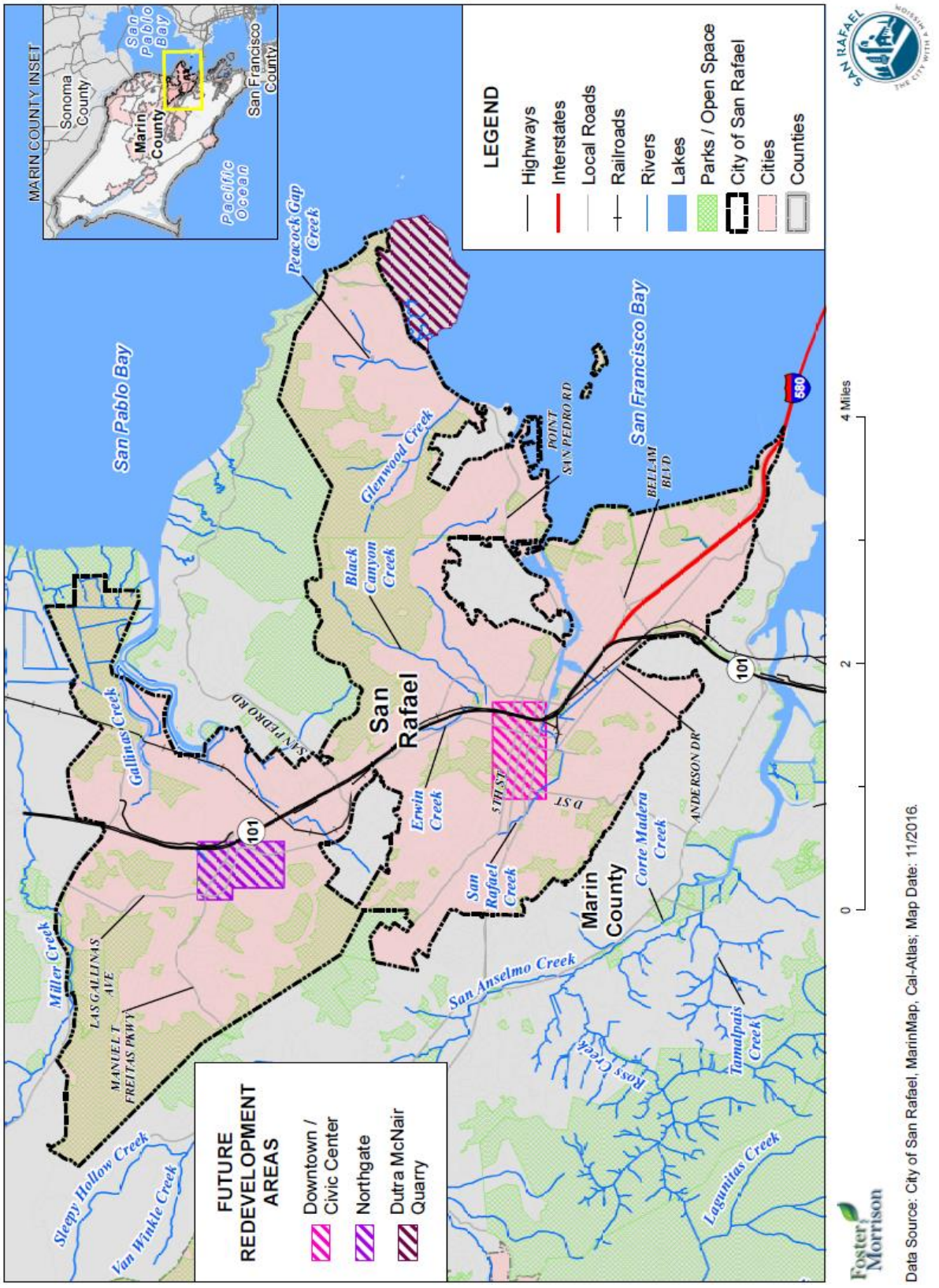


Table 4-30 San Rafael – Future Development/Redevelopment Areas by Property Use, Parcels, and Acres

Property Use	Total Parcel Count	Improved Parcel Count	Total Acres
Downtown / Civic Center			
Commercial	326	298	74
Commercial - Improved	301	298	69
Commercial - Unimproved	25	0	5
Exempt	71	22	24
Exemption - Improved	22	22	8
Tax Exempt	48	0	14
(blank)	1	0	2
Residential	279	267	34
Common Area	1	0	0
Multiple-Resid. - Improved	104	104	19
Multiple-Resid. - Unimproved	4	1	1
Single Family Attached	59	59	1
Single-Resid. - Improved	104	103	12
Single-Resid. - Unimproved	7	0	1
Totals	**676**	**587**	**131**
Northgate			
Commercial	43	39	100
Commercial - Improved	39	39	86
Commercial - Unimproved	4	0	14
Exempt	6	2	6
Exemption - Improved	2	2	3
Exemption - Vacant	1	0	0
Tax Exempt	3	0	3
Residential	92	87	26
Multiple-Resid. - Improved	4	4	7
Multiple-Resid. - Unimproved	3	0	0
Single Family Attached	24	24	1
Single-Resid. - Improved	59	59	11
Single-Resid. - Unimproved	2	0	6
Totals	**141**	**128**	**132**

Property Use	Total Parcel Count	Improved Parcel Count	Total Acres
Dutra McNair Quarry			
–	0	0	0
Totals	**0**	**0**	**0**
All Future Redevelopment			
Commercial	369	337	174
Commercial - Improved	340	337	155
Commercial - Unimproved	29	-	19
Exempt	77	24	29
Exemption - Improved	24	24	11
Exemption - Vacant	1	-	0
Tax Exempt	51	-	17
(blank)	1	-	2
Residential	371	354	60
Common Area	1	-	0
Multiple-Resid. - Improved	108	108	26
Multiple-Resid. - Unimproved	7	1	2
Single Family Attached	83	83	2
Single-Resid. - Improved	163	162	23
Single-Resid. - Unimproved	9	-	7
Totals	**817**	**715**	**263**

Source: San Rafael GIS, Marin County 2016 Parcel/Assessor's Data

4.3.2. San Rafael's Vulnerability to Specific Hazards

The Disaster Mitigation Act regulations require that the HMPC evaluate the risks associated with each of the hazards identified in the planning process. This section summarizes the possible impacts and quantifies, where data permits, the City's vulnerability to each of the hazards identified as a priority hazard in Section 4.2.16 Natural Hazards Summary. The priority hazards evaluated further as part of this vulnerability assessment include:

- Climate Change
- Coastal Flooding and Sea Level Rise
- Drought and Water Shortage
- Earthquake
- Earthquake: Liquefaction
- Flood: 100/500 year
- Flood: Localized Stormwater Flooding
- Landslide, Mudslides, Hillside Erosion, and Debris Flows
- Levee Failure
- Severe Weather: Extreme Heat

- Severe Weather: Heavy Rains and Storms
- Tsunami
- Wildfire

An estimate of the vulnerability of the City to each identified hazard, in addition to the estimate of likelihood of future occurrence, is provided in each of the hazard-specific sections that follow. Vulnerability is measured in general, qualitative terms and is a summary of the potential impact based on past occurrences, spatial extent, and damage and casualty potential. It is categorized into the following classifications:

- **Extremely Low**—The occurrence and potential cost of damage to life and property is very minimal to nonexistent.
- **Low**—Minimal potential impact. The occurrence and potential cost of damage to life and property is minimal.
- **Medium**—Moderate potential impact. This ranking carries a moderate threat level to the general population and/or built environment. Here the potential damage is more isolated and less costly than a more widespread disaster.
- **High**—Widespread potential impact. This ranking carries a high threat to the general population and/or built environment. The potential for damage is widespread. Hazards in this category may have occurred in the past.
- **Extremely High**—Very widespread with catastrophic impact.

Vulnerability can be quantified in those instances where there is a known, identified hazard area, such as a mapped floodplain. In these instances, the numbers and types of buildings subject to the identified hazard can be counted and their values tabulated. Other information can be collected in regard to the hazard area, such as the location of City critical facilities, historic structures, and valued natural resources (e.g., an identified wetland or endangered species habitat). Together, this information conveys the impact, or vulnerability, of an area to that hazard.

The HMPC identified five hazards in the City for which specific geographical hazard areas have been defined and for which sufficient data exists to support a quantifiable vulnerability analysis. These five hazards are earthquake, flood, landslide, tsunami, and wildfire. Because these hazards have discrete hazard risk areas, their risk varies throughout the City. For earthquake: liquefaction, flood, landslide, tsunami, and wildfire, the HMPC inventoried the following, to the extent possible, to quantify vulnerability in identified hazard areas:

- General hazard-related impacts, including impacts to life, safety, and health
- Values at risk (i.e., types, numbers, and value of land and improvements)
- Population at risk
- Cultural and natural resources at risk
- Critical facilities at risk
- Overall community impact
- Future development/redevelopment trends within the identified hazard area

HMPC used FEMA's loss estimation software, HAZUS-MH, to analyze the City's vulnerability to earthquakes.

A Sea Level Rise vulnerability assessment was performed for the City in the Marin Bay Shoreline Sea Level Rise Vulnerability Assessment. That vulnerability assessment is included in this LHMP.

The vulnerability and potential impacts from priority hazards that do not have specific mapped areas nor the data to support additional vulnerability analysis are discussed here in more general terms.

4.3.3. Climate Change Vulnerability Assessment

Likelihood of Future Occurrence—Highly Likely
Vulnerability—Medium

The California Adaptation Planning Guide (APG) prepared by California OES and CNRA was developed to provide guidance and support for local governments and regional collaboratives to address the unavoidable consequences of climate change.

The APG: Defining Local and Regional Impacts focuses on understanding the ways in which climate change can affect a community. According to this APG, climate change impacts (temperature, precipitation, sea level rise, ocean acidification, and wind) affect a wide range of community structures, functions and populations. These impacts further defined by regional and local characteristics are discussed by secondary impacts and seven sectors found in local communities: Public Health, Socioeconomic, and equity impacts; Ocean and Coastal Resources; Water Management; Forest and Rangeland; Biodiversity and Habitat; Agriculture; and Infrastructure.

San Rafael Climate Change Impacts

The APG: Understanding Regional Characteristics identified the following impacts specific to the Bay Area Region of which San Rafael is part of:

- Increased temperature
- Reduced precipitation
- Sea level rise – coastal inundation and erosion
- Inland flooding
- Reduced agricultural productivity (e.g., wine grapes)
- Public health – heat & air pollution
- Reduced tourism

Future Development/Redevelopment

San Rafael and Marin County in general could see population fluctuations as a result of climate impacts relative to those experienced in other regions, and these fluctuations are expected to impact demand for housing and other development. For example, sea level rise may disrupt economic activity and housing in coastal communities, resulting in migration to inland urban areas like the City of San Rafael. Other interior western states may experience an exodus of population due to challenges in adapting to heat even more extreme than that which is projected to occur here. While there are currently no formal studies of specific migration patterns expected to impact the Bay Area region, climate-induced migration was recognized

within the UNFCCC Conference of Parties Paris Agreement of 2015 and is expected to be the focus of future studies.

Climate change, coupled with shifting demographics and market conditions, could impact both the location of desired developments and the nature of development. Demand may increase for smaller dwellings that are less resource intensive, more energy efficient, easier to maintain and can be more readily adapted or even moved in response to changing conditions. Compact, mixed-use and infill developments that can help residents avoid long commutes and vulnerabilities associated with the transportation system will likely continue to grow in popularity. The value of open space and pressure to preserve it will likely increase, due in part to its restorative, recreational, environmental and habitat benefits but also for its ability to sequester carbon, help mitigate the accumulation of greenhouse gas in the atmosphere and slow down the global warming trend. Higher flood risks, especially if coupled with increased federal flood insurance rates, may decrease market demand for housing and other types of development in floodplains, while increased risk of wildfires may do the same for new developments in the urban-wildland interface. Flood risks may also inspire new development and building codes that elevate structures while maintaining streetscapes and neighborhood characteristics.

Climate change will stress water resources. Water is an issue in every region, but the nature of the potential impacts varies. Drought, related to reduced precipitation, increased evaporation, and increased water loss from plants, is an important issue in many U.S. regions, especially in the West. Floods, water quality problems, and impacts on aquatic ecosystems and species are likely to be amplified by climate change. Declines in mountain snowpack are important in Marin County, the Sierra Nevada Mountains and across the state, where snowpack provides vital natural water storage and supply. The ability to secure and provide water for new development requires on-going monitoring and assurances. It is recommended that the ability to provide a reliable water supply from the appropriate water purveyor, continue to be in the conditions for project approval, and such assurances shall be verified and in place prior to issuing building permits.

Climate change will affect transportation. The transportation network is vital to the county and the region's economy, safety, and quality of life. While it is widely recognized that emissions from transportation have impacts on climate change, climate will also likely have significant impacts on transportation infrastructure and operations. Examples of specific types of impacts include softening of asphalt roads and warping of railroad rails; damage to roads; flooding of roadways, rail routes, and airports from extreme events; and interruptions to flight plans due to severe weather.

Climate change will affect land uses and planning. Climate change coupled with shifting demographics and market conditions, could impact both the location of desired developments and the nature of development. Demand may increase for smaller dwellings that are less resource intensive, more energy efficient, easier to maintain and can be more readily adapted or even moved in response to changing conditions. Compact, mixed-use and infill developments that can help residents avoid long commutes and vulnerabilities associated with the transportation system will likely continue to grow in popularity. The value of open space, urban greening, green infrastructure, tree canopy expansion and pressure to preserve it will likely increase, due in part to its restorative, recreational, environmental, and habitat, and physical and mental health benefits but also for its ability to sequester carbon and cool the surrounding environment.

Climate change will affect utilities. California is already experiencing impacts from climate change such as an increased number of wildfires, sea level rise and severe drought. Utility efforts to deal with these impacts range from emergency and risk management protocols to new standards for infrastructure design and new resource management techniques. Utilities are just beginning to build additional resilience and redundancy into their infrastructure investments from a climate adaptation perspective, but have been doing so from an overall safety and reliability perspective for decades. Significant efforts are also being made in those areas that overlap with climate change mitigation such as diversification of resources, specifically the addition of more renewables to the portfolio mix, as well as implementation of demand response efforts to curb peak demand. Efforts are also under way to upgrade the distribution grid infrastructure, which should add significant resilience to the grid as well. New development will have to adapt and incorporate these new approaches as they evolve. Existing and new development will be affected from impacts that includes not only diminished capacity from all of the utility assets from generation to transmission and distribution, but also the cost consequences resulting from prevention, replacement, outage, and energy loss. These have the potential for greatly impacting not just residential development but commercial and industrial and all utility users.

Addressing Urban Heat Islands and Heat Events. New development will contribute to urban heat island (UHI) impacts and will need to incorporate urban greening methods into all aspects of development; interior and exterior of buildings, surrounding environment and beyond. New development will need to reduce its impacts to the overall UHI impacts affecting the county and surrounding region. On-going and expanding heat wave awareness and assistance will also affect new development. Continued funding for weatherization, reduced utility rates and similar programs that offers assistance to elderly, low-income residents to install roof insulation, solar, trees and cool surfaces to save energy and lower indoor temperatures.

4.3.4. Coastal Flooding and Sea Level Rise Vulnerability Assessment

Likelihood of Future Occurrence—Likely
Vulnerability—Medium

A report prepared for Main County in October of 2016 titled Marin Bay Shoreline Sea Level Rise Vulnerability Assessment included an analysis of San Rafael's risk to coastal flooding and sea level rise. A community profile for the City of San Rafael was included in that report. It serves as the basis for this vulnerability assessment. The Marin Bay vulnerability assessment for bayside shoreline presents asset profiles describing parcels and buildings, transportation networks, utilities, working lands, natural resources, recreational assets, emergency services, and cultural resources.

The Planning Team noted that coastal flooding and sea level rise are exacerbated during king tides. King tides are simply the very highest tides. They are naturally occurring, predictable events. Planning team members noted that king tides of today may give an idea of future normal conditions that may occur due to sea level rise.

Sea Level Rise and Coastal Flooding Scenarios

Table 4-31 shows the range of sea level rise projections for California adopted by the National Research Council in 2012. Given the uncertainty in the magnitude and timing of future sea level rise, this assessment uses a scenario-based approach to assess a range of potential sea level rise impacts for mean higher high water (MHHW). The 6 scenarios selected for the BayWAVE vulnerability assessment are derived from the USGS Coastal Storm Modeling System (CoSMoS) that combines global climate and wave models with projected sea level rise to identify areas that could be flooded across 10 different sea levels (ranging from 0 to 200 inches) and 4 storm severities (none, annual, 20-, 100-year storms) to total 40 possible combinations. These six scenarios are shown in Table 4-32. Both Figure 4-44 and Figure 4-45 show expected inundation for the eastern and western portions of the City, respectively.

Table 4-31 Sea Level Rise Projections for San Francisco, CA Region

Time Period	Projected Range
by 2030 (Near)	1.6 – 11.8 inches
by 2050 (Medium)	4.7 – 24 inches
by 2100 (Long)	16.6 – 65.8 inches

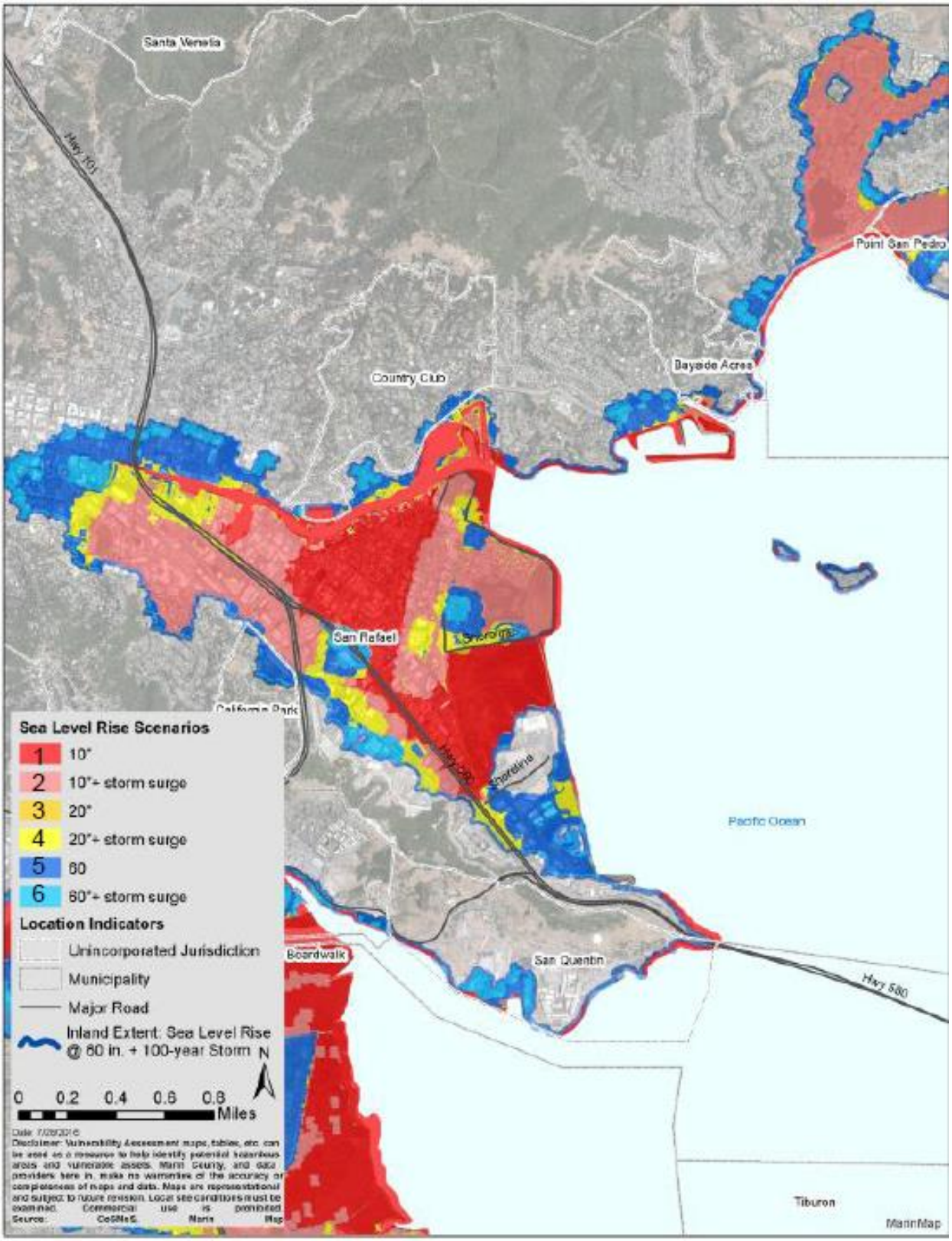
Source: Marin Bay Shoreline Sea Level Rise Vulnerability Assessment

Table 4-32 Marin Bay and San Rafael – BayWAVE Sea Level Rise Scenarios

Sea Level Rise Scenario		Term
1	10 inches	Near
2	10 inches+100-year storm surge	
3	20 inches	Medium
4	20 inches+100-year storm surge	
5	60 inches	Long
6	60 inches+100-year storm surge	

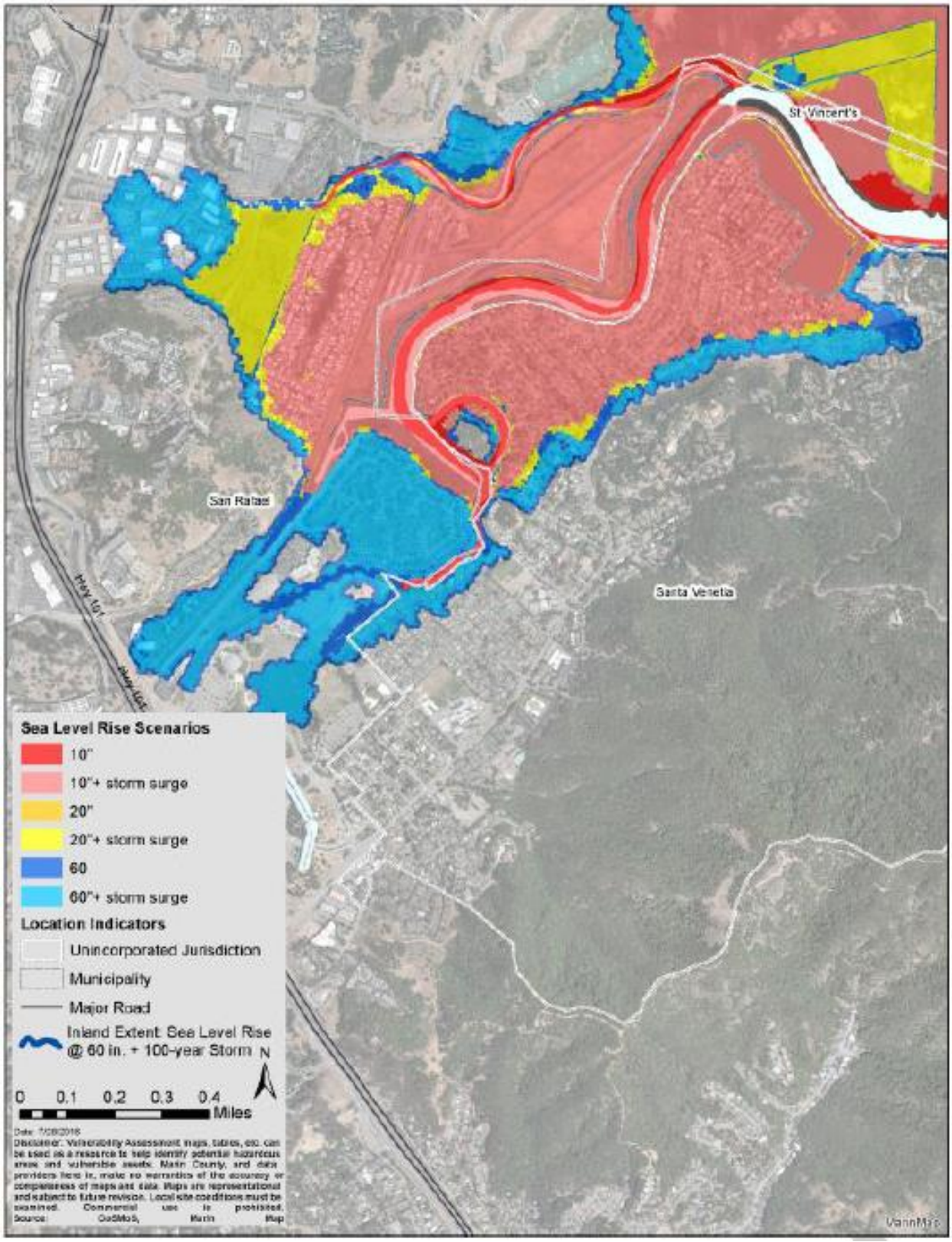
Source: Marin Bay Shoreline Sea Level Rise Vulnerability Assessment

Figure 4-43 West San Rafael – 6 Sea Level Rise Scenarios



Source: Marin Bay Shoreline Sea Level Rise Vulnerability Assessment

Figure 4-44 East San Rafael – 6 Sea Level Rise Scenarios



Source: Marin Bay Shoreline Sea Level Rise Vulnerability Assessment

Vulnerable Assets

San Rafael's vulnerable assets include the entire Canal and Kerner Business district areas, and shoreline development and boating facilities off Point San Pedro Road. In time, the impacts move into downtown San Rafael, Peacock Gap, and Marin Lagoon areas. These areas contain significant amounts of development and land area in the City. In addition to sea level rise, subsidence is already a significant issue south of State Routes 580 and 101, and in Marin Lagoon, where development is built largely on fill and bay mud. With sea level rise, subsidence rates could increase. Table 4-33 ranks select vulnerable assets by onset and maximum flood depth.

Table 4-33 San Rafael – Assets Vulnerable to Sea Level Rise and Tidal Flooding

Asset	Scenarios - Maximum Flood Depth		
	1	3	5
Canal shoreline trail open space	10'3"	11'1"	25'4"
John F. McInnis Park	7'6"	8'6"	10'6"
Jean and John Starkweather Shoreline Park	5'4"	6'	16'3"
Pickleweed Park	5'	5'8"	8'9"
E Hwy 580	0-4'	0-4'10"	4"-7'8"
Kerner Blvd	0-4'	0-4'7"	8"-7'5"
Francisco Blvd E	0-3'10"	0-4'7"	1'-7'5"
Bellam Blvd	0-3'5"	0-4'	0-7'3"
Canal Street	0-3'4"	1'2"-4'2"	2'-7'11"
Bahia Way	2'-3'3"	2'4"- 3'11"	5'2"-6'10"
Open Space Lands 008	3'2"	3'11"	6'10"
W Hwy 580	1"-2'10"	1"-3'7"	1"-6'5"
Bay Trail	0-2'3"	0-3'	0-10'3"
San Rafael Yacht Harbor	1'2"	4'	10'4"
San Rafael Municipal Harbor	1'	2'	6'
Lowrie Yacht Harbor	9"	3'7"	8'5"
Bahia Vista Elem. School/Trinity Preschool	8"	2'3"	4'8"
Hi-Tide Boat sales and services	6"	3'4"	8'5"
Marin Yacht Club	1"	1'6"	3'9"
Marin County Health Innovation Campus	1"	1'3"	3'
Open Space Lands 025	–	9'2"	12'2"
Beach Park	–	8'11"	11'10"
Peacock Gap Neighborhood Park	–	6'3"	9'
Grand Avenue	–	0-6'	7"-9'
Anderson Drive	–	0-5'	3"-8"
Francisco Blvd W	–	0-4'9"	1'8"-9'5"

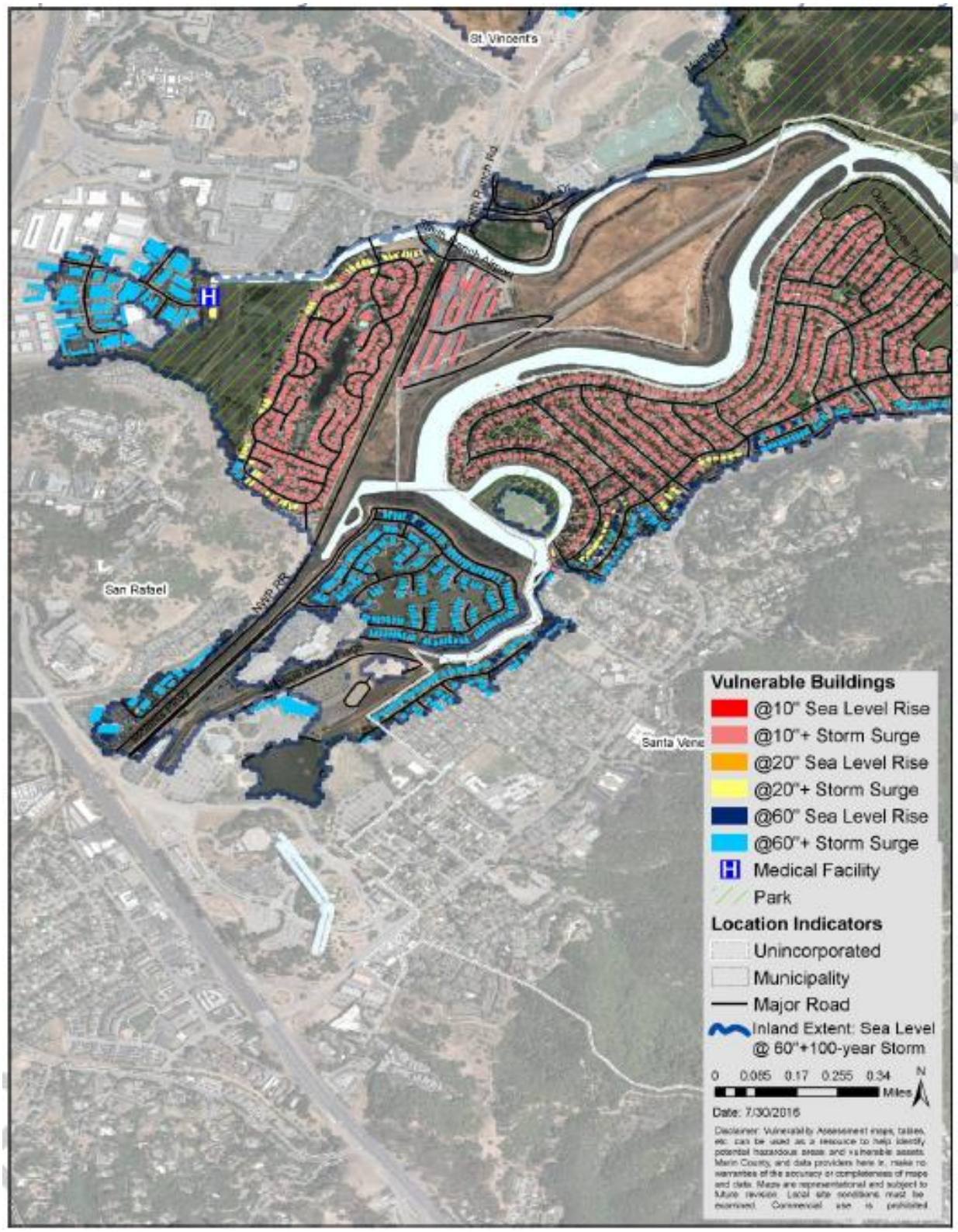
Asset	Scenarios - Maximum Flood Depth		
	1	3	5
Peacock Drive	–	0-4’	9”-6’8”
SMART Rail	–	1’8”- 3’9”	1’2”-6’8”
Loch Lomond Marina	–	3’7”	9’7”
Peacock Gap Lagoon and Golf Course homes	–	1”-3’6”	2”-8’9”
San Rafael Airport	–	3’5”	8’10”
Canal District	–	1”-3’	2”-7’8”
Marin Lagoon	–	5”-2’5”	1’-6’
N. Hwy 101	–	0-2’5”	6”-5’3”
Davidson Middle School	–	2’3”	5’9”
Pt. San Pedro Road	–	0-2’2”	4”-5’10”
San Rafael Yacht Club	–	2’2”	5’7”
S. Hwy 101 Off Ramp	–	0-2’	1’4”-5’
GGBD Headquarters and Bus Depot	–	1’8”-2’	4’2”-5’
Downtown	–	1”-1’3”	3”-3’3”
PG&E Office and Yard	–	1’2”	3’
Pickleweed Park facilities	–	1’2”	3’
Montecito Plaza	–	1’	2’3”
San Rafael Transit Center	–	11”	2’5”
San Rafael High School	–	10”	2’
SMART rail	–	–	1”-10’3”
Lincoln Avenue	–	–	10”-7’4”
Candy's Park	–	–	6’3
Open Space 051	–	–	5’1”
Schoen Park	–	–	4’2”
4th Street	–	–	1’-3’5”
2nd Street	–	–	1’-3’4”
Hetherton Street	–	–	1’4”-2’4”
Glenwood Elem. School	–	–	Storm Surge Only
Department of Public Works	–	–	Subsidence, Storm impacts only
US Post Office-Bellam Blvd.	–	–	Access issues Storm surge only
San Rafael Canal	Water resource		
PG&E Substation	–	–	Storm surge only
Marin Lagoon	Water resource		

Source: Marin Bay Shoreline Sea Level Rise Vulnerability Assessment – San Rafael Community Profile

Parcels and Buildings

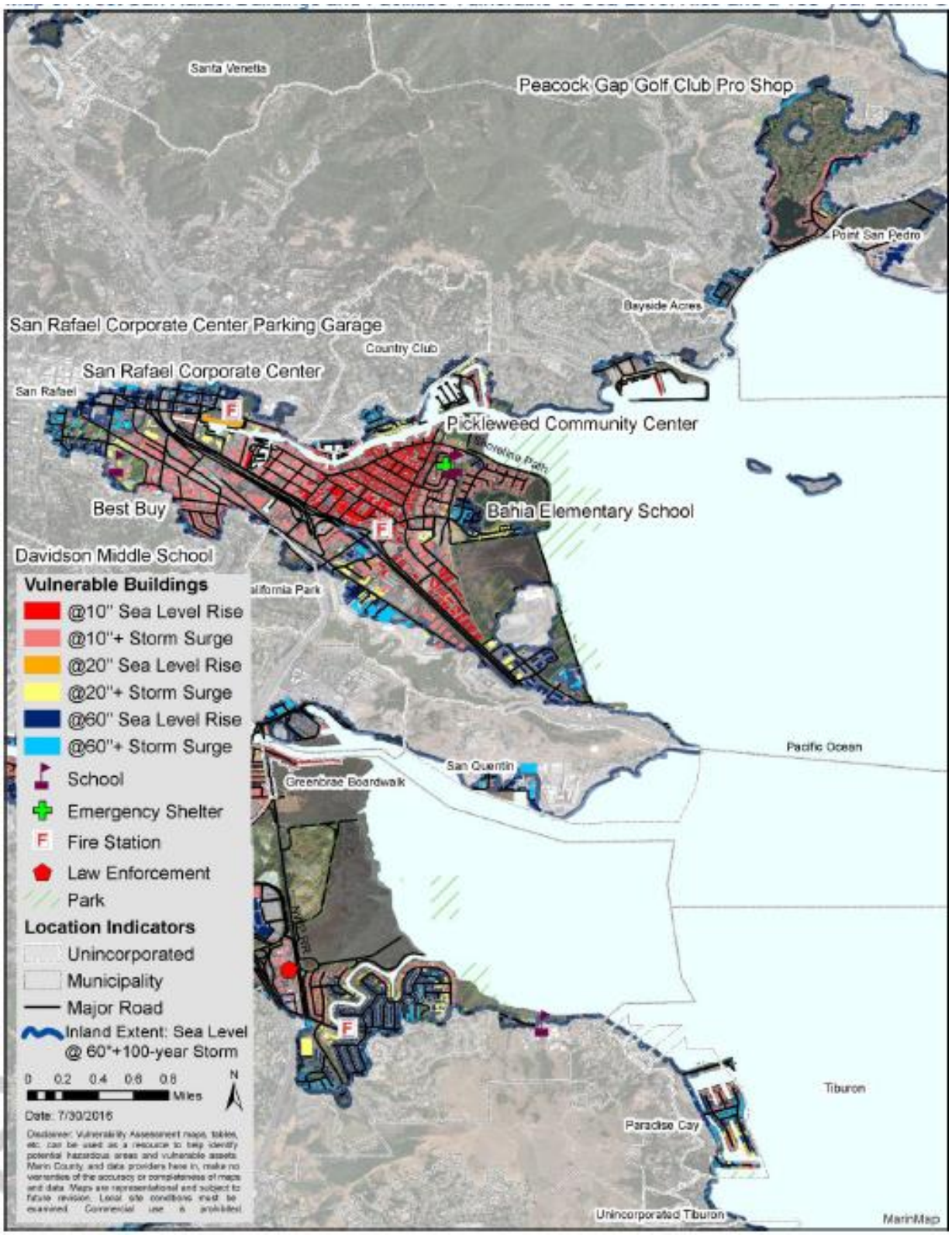
Coastal flooding and sea level rise pose a significant risk to buildings in the City of San Rafael. This can be seen in Figure 4-45 and Figure 4-47 which illustrates impacts for each of the six sea level rise scenarios

Figure 4-45 East San Rafael – Buildings and Facilities Vulnerable to Sea Level Rise and a 100-year Storm Surge



Source: Marin Bay Shoreline Sea Level Rise Vulnerability Assessment– San Rafael Community Profile

Figure 4-46 West San Rafael – Buildings and Facilities Vulnerable to Sea Level Rise and a 100-year Storm Surge



Source: Marin Bay Shoreline Sea Level Rise Vulnerability Assessment– San Rafael Community Profile

In the near-term, as seen in Table 4-34, two percent of parcels and buildings could be exposed to sea level rise with 90 parcels and 410 buildings. And as shown in Table 4-35, within the exposed parcels, three percent of all residential parcels and 11 percent of all commercial parcels could face tidal MHHW flooding. With a 100-year storm surge, an additional 136 parcels and 1,438 buildings could experience temporary flooding. These are mostly buildings lining the San Rafael canals and in the low-lying areas west of the canal. The area is characterized by a variety of apartment complexes, light industrial sites, and commercial strip areas that serve the predominantly Latino residents. One section, near Spinnaker Point, is a single family home subdivision that is not directly at risk until later in the century, however, year round vehicular access may prove challenging before then. Bahia Vista Elementary School, Pickleweed Community Center and Park, San Rafael Fire Station 54, and the Marin County Health Innovation campus are some of the impacted public facilities.

The Kerner business district is vulnerable in the near and medium-terms. Though some portions of the district are protected until after the medium –term because of shoreline armoring, after three feet of sea level rise this area could be saturated at high tides. Note that storm surges could cause temporary impacts as early as scenario 2.

Development is also compromised in the near-term on Irwin, 2nd, and 3rd Streets. This area, known as Montecito, includes gas stations, grocery stores, small offices, and several daily needs businesses. San Rafael High School is located here and could see long-term impacts. In the medium-term, 121 parcels and over 1,000 buildings could be exposed to tidal flooding and nearly twice that could be exposed under a 100-year storm surge. In scenario 3, nearly twice as many parcels are residential or commercial as in scenario 1. By the long-term, nearly 2,500 buildings, or 13 percent of all buildings in San Rafael, could face some level of tidal flooding. Due to sea level rise alone, 12 percent of residential parcels and a significant 40 percent of San Rafael's commercial parcels could flood regularly. Under storm surge conditions, up to 30 percent of parcels and 18 percent of buildings could experience storm damage. Between the medium- and long-terms, ocean waters move further into the valley, crossing the freeway interchanges, flooding out the on and off ramps, and eventually impacting the Anderson and Francisco W industrial and commercial areas, downtown, and eventually Gerstle Park where Davidson Middle School and Albert Park are located.

Table 4-34 San Rafael – Exposed Parcels and Buildings by Sea Level Rise Scenario

Scenario	Parcels		Buildings	
	#	%	#	%
1	90	2%	410	2%
2	246	5%	1,846	10%
3	121	3%	1,088	6%
4	445	10%	2,097	11%
5	687	15%	2,495	13%
6	1,216	27%	3,247	18%

Source: Marin Bay Shoreline Sea Level Rise Vulnerability Assessment– San Rafael Community Profile

Table 4-35 San Rafael – Vulnerable Residential and Commercial Parcels to Sea Level Rise

Property Type	Scenario					
	1		3		5	
	#	%	#	%	#	%
Residential	491	3	883	6	1,798	12
Commercial	132	1	234	19	475	40

Source: Marin Bay Shoreline Sea Level Rise Vulnerability Assessment– San Rafael Community Profile

The analysis presented in Table 4-36 breaks down the exposed buildings in to the flood depths they could experience at MHHW. Storm surges would have one to three feet of additional water and would impact significantly more buildings. In the near and medium-terms most buildings experience 6 feet or shallower waters, with the majority experiencing three feet or less. In the long-term, over 600 buildings could flood with up to three feet of salt water, over 1,000 buildings could flood with between three and six feet of tidewaters, and over 400 buildings could be flooded with up to nine feet of water.

Table 4-37 shows FEMA Hazus post-disaster estimates of up to $1.5 billion in assessed structural value exposed in scenario 6. This analysis assumes that every exposed building experiences the same level of damage.

Table 4-36 San Rafael – Tidal MHHW Flood Depth Estimates for Exposed Buildings

Flood Depth (feet)		Scenario		
		1	3	5
0.1-1	#	94	143	108
	%	1	1	1
1.1-2	#	143	212	228
	%	1	1	1
2.1-3	#	187	251	346
	%	1	1	2
3.1-4	#	26	206	548
	%	0	1	3
4.1-5	#	3	102	401
	%	0	1	2
5.1-6	#	1	9	360
	%	0	0	2
6.1-7	#	0	1	215
	%	0	0	1
7.1-8	#	0	0	190
	%	0	0	1
8.1-9	#	0	0	26
	%	0	0	0

Source: Marin Bay Shoreline Sea Level Rise Vulnerability Assessment– San Rafael Community Profile

Table 4-37 FEMA Damage Levels Applied to San Rafael Buildings Exposed in Scenario 6

Buildings	3,247
Yellow Tag-Minor ($5,000-17,000)	$16,235,000-55,199,000
Orange Tag ($17,001+)	$55,202,247
Red Tag-Destroyed Assessed structural value	$1,496,065,489

Source: Marin Bay Shoreline Sea Level Rise Vulnerability Assessment– San Rafael Community Profile

Buildings in San Rafael are older, and many, especially downtown are unreinforced (see Table 4-41 in Section 4.3.6) and could be weakened by flooding. These buildings are primarily mixed-use or commercial. Newer commercial buildings are typically concrete slab tilt-ups or smaller cinder block and stucco buildings. According to a BCDC profile for San Rafael for the Safer Housing Stronger Cities Initiative on seismic and flooding safety, most single-family homes in the low-lying areas of San Rafael are one- and two story homes, built in the Victorian era, the earlier part of the 20th century, post-WWII, and newer modern homes. There are also 2-4 unit dwellings, and medium- and larger-sized apartment complexes of typically wood construction.

According to San Rafael asset managers, several critical businesses are exposed to sea level rise. These include: 30 grocery stores from 7-11 to Whole Foods Market, 10 pharmacies, 16 medical clinics, 48 doctor offices, 35 childcare facilities, five residential care facilities of Aegis of San Rafael, Golden Home Extended Care, Miracle Hands Homecare, Saint Michael's Extended Care, Schon Hyme Rest Home, seven convalescent facilities at All Saints Extended Care, Inc., Country Villa San Rafael, Harmony House, Kindred Transitional Care And Rehabilitation, Pine Ridge Care Center, San Rafael Care Center, Inc., and San Rafael Healthcare & Wellness Center, LP, and finally 29 building supply stores. These businesses either contain critical goods like medications and access to medical and buildings supplies after a major storm or flooding event or house some of the most vulnerable populations in the region.

Transportation

Transportation is a major concern for San Rafael and for the entire region. San Rafael serves as a regional transit center, and nearly all routes stop here, including the newly unveiled SMART line. In the near-term, other major roads impacted are Bellam Blvd, Francisco Blvd., East, Kerner Blvd, Grand Ave. and Irwin Street.

Much like with buildings, many of the roads to be flooded first are in, or are major access ways to, the Canal District and south of State Route 580. Residents in this area tend to live with scarce financial resources and can be especially burdened by disruptions in the transportation system or damages to their vehicles. In addition, those with health or mobility constraints, who do not own a home or car, or are not proficient in the English language, may also be disproportionally burdened by sea level rise and storms. If these residents are displaced, the upheaval and loss would be significant to the community and the regional economy that depends on their contributions. Further, this area hosts the majority of light industrial and a major portion commercial uses that depend on the transportation network to reach clients, receive and

deliver materials, and receive customers. Moreover, already constrained street parking could be flooded with tidal waters. Repeated exposure to salt water would damage personal and commercial vehicles. Finally, emergency access for fire, ambulance, and police could be limited at a time residents are most vulnerable. In fact, Fire Station 54 could be directly flooded, damaging equipment and vehicles in the station.

In the medium-term, tidewaters extend under the freeways further into the street grid of downtown and the industrial and commercial Anderson Drive area. While State Route 101 is generally elevated, on and off ramps at grade could be flooded out along most of its course through the City. Unlike 101; however, State Route 580 could see surface flooding between the medium- and long-terms. By the long-term, streets in the residential neighborhoods west of downtown and north of 101 could flood as Mahon Creek overflows its banks in the Gerstle Park neighborhood. While previously impacted by storm surges. Pt. San Pedro Rd. could see impacts at tidal MHHW by the long-term as well. Roads bayside of Pt. San Pedro Road, such as Mooring Road, are vulnerable in the near-term.

Table 4-38 lists the exposed roads by scenario and annotates who the responsible party for the road is San Rafael has jurisdiction over the majority of the exposed portion of Pt. San Pedro Road, and the County has jurisdiction bordering the small unincorporated Country Club portions.

Table 4-38 San Rafael – Roads Exposed to Sea Level Rise and a 100-year Storm Surge Scenarios

Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
7.5 miles	21.5 miles	15 miles	27.1 miles	35 miles	41 miles
Hwy 101 [C]	Roads in scenario 1	Roads in scenario 1	Roads in scenarios 1-3	Roads in scenarios 1-4	Roads in scenarios 1-5
Hwy 580 [C]	Pt. San Pedro Rd [L, C]	Francisco Blvd[W L]	2nd St [L]	4th St [L]	C St [L]
Bellam Blvd [L]	Acadia Ln [L]		3rd St [L]	A St [L]	Bayview St [L]
Francisco Blvd E [L]	Bahia Ln [L]		Lindaro St [L]	B St [L]	Bridgewater Dr [L]
Kerner Blvd [L]	Baxters Ct [P]		Aqua Vista Dr [L]	Hetherton St [L]	Commercial Pl [L]
Grand Ave [L]	Bedford Cv [L]		Baypoint Dr [L]	Albert Park Ln [L]	Loma Linda Rd [L]
Irwin St [L]	Billou St [L]		Baypoint Village Dr [L]	Avocet Ct [P]	Main Dr [L]
Canal St [L]	Bret Ave [L]		Biscayne Dr [L]	Brooks St [L]	Mariners Cir [L]
Alto St [L]	Bryce Canyon Rd [L]		Dodie St [L]	Chapel Cove Dr L	Mark Dr [L]
Amalfi Pl [L]	Carlsbad Ct [L]		Egret View [L]	Cijos St [L]	McInnis Pkwy L
Bahia Pl [L]	Catalina Blvd [L]		Loch Lomond Dr [L]	Dowitcher Wy [P]	Milano Pl [L]
Bahia Wy [L]	Crater Lake Wy [L]		Novato St [L]	Embarcadero Wy [L]	Mitchell Blvd [L]
Bahia Cir [L]	De Luca Pl [L]		Pelican Wy [L]	Glacier Pt [L]	Newport Wy [L]
Bay Harbor Wy [P]	Dolores St [L]		Royal Ct [L]	Grange Ave L	Octavia St [L]
Belvedere St [L]	Du Bois St [L]		Simms St [L]	Jacoby St [L]	Paul Dr [L]
Capri Ct [L]	Duffy Pl [L]		Yacht Club Dr [P]	Knight Dr [L]	Pelican Wy [L]
Castro Ave [L]	Duxbury Cv [L]			Leith Ln [L]	Riviera Manor [L]
Charlotte Dr [L]	Falmouth Cv [L]			Lido Ln [L]	Rockport Cv [L]
Elaine Wy [L]	Gary Pl [L]			Lochinvar Rd [L]	San Pedro Cv [P]
Fairfax St [L]	Glacier Way [L]			Lootens Pl [L]	Sandpiper Ct [L]
Front St [L]	Gloucester Cv [L]			Mariposa Rd [L]	Shores Ct [L]
Golden Gate Dr [L]	Hingham Cv [L]			Mary St [L]	Smith Ranch Rd [L]
Irene St [L,P]	Hoag St [L]			Mission Ave [L]	Taylor St [L]
Larkspur St [L]	Hyannis Cv [L]			Morphew St [L]	Waterside Cir [L]
Lido Ln [L]	Isla Vista Ln [L]			Park St [L]	Willow St [L]
Lisbon St [L]	Isle Royale Ct [L]			Piombo Pl [L]	Woodland Pl [L]
Louise St [L]	Jordan St [L]			Portsmouth Cv [L]	
Madera St [P]	Lagoon Pl [L]			Ritter St [L]	
Marian Ct [L]	Lagoon Rd [L]			Riviera Pl [L]	
Market St [L]	Lincoln Ave [L]			Silk Oak Cir [L]	
Medway Rd [L]	Loma Vista Pl [L]			Summit Ave [L]	
Mill St [L]	Lovell Ave [L]			Surfwood Cir [L]	
Mooring Rd [L]	Marina Way [L]			Tern Ct [P]	
Novato St [L]	McNear Dr [L]			Turnstone Dr [P]	
Portofino Rd [L]	Mesa Verde Wy [L]			Union St [L]	
Sea Wy [L]	Nantucket Cv [L]			Warner Ct [L]	
Shoreline Path	Narragansett Cv [L]				
Smith Ranch Airport [L]	Newport Wy [L]				
	Olympic Wy [L]				
Sonoma St [L]	Peacock Dr [L]				
Sorrento Wy [L]	Playa Del Rey [L]				
Summit Ave [L]	Plymouth Cv [L]				
Tiburon St [L]	Porto Bello Dr [L]				
Verdi St [L]	Rice Dr [L]				
Vivian St [L]	Riviera Dr [L]				
Yosemite Rd [L]					

Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
7.5 miles	21.5 miles	15 miles	27.1 miles	35 miles	41 miles
	Rockport Cv [L] Salem Cv [L] San Marcos Pl [L] Shenandoah Pl [L] Shoreline Pkwy [L] Spinnaker Point Dr [L] Tahoe Pl [L] Teton Ct [L] Vista Del Mar [L] Windward Wy [L] Woodland Ave [L] Yellowstone Ct [L] Zion Ct [L]				

Source: Marin Bay Shoreline Sea Level Rise Vulnerability Assessment– San Rafael Community Profile
M = Marin County; C = State of California; L = Local Municipality; P = Private.

Compromises in the road network undoubtedly impacts transit services. Nearly every transit service provider passes through the exposed areas in San Rafael. Not only could service be interrupted, the GGBD and Marin Airporter facilities could be compromised as early as scenario 2. Moreover, the San Rafael Transit Center and SMART Station downtown are vulnerable to tidal flooding in the long term. Transit stops in the exposed are:

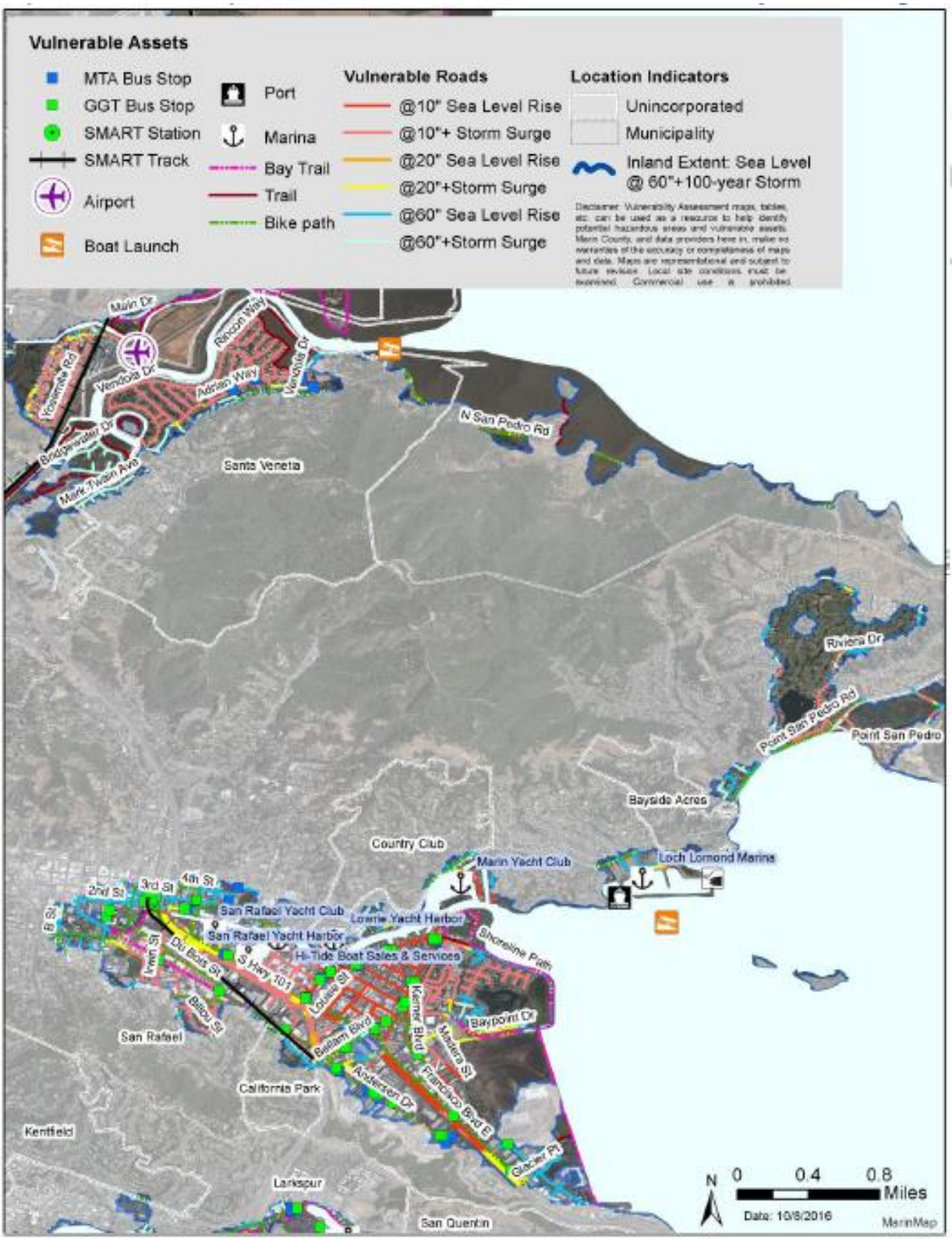
Golden Gate Transit	Mendocino Transit Authority
San Rafael Transit Center Platform A, B, C, D Kerner Blvd. and Fairfax St., Canal St. and Medway Rd., Canal St. and Novato St., Canal St. and Sonoma St., Kerner Blvd. and Larkspur St., Medway Rd. and Francisco Blvd., E Kerner Blvd. and Canal St., Medway Rd. and Mill St., Canal St. and Novato St., Kerner Blvd. and Bahia Way, Second St. and Grand Ave., Third St. and Grand Ave., 445 Francisco Blvd. E, Irene St. and Francisco Blvd. E-Kerner Blvd., -3140 Kerner Blvd., Bellam Blvd. and Lisbon St., 1525 Francisco Blvd. E, Andersen Dr. and Jacoby St., 1261 Andersen Dr., 1022 Andersen Dr., Andersen Dr. and PG&E, Bellam Blvd. and Francisco Blvd. E, Andersen Dr. and Simms St., Bellam Blvd. and I-580 EB On-Ramp 1011 Andersen Dr., Francisco Blvd. E and Pelican Way, Kerner Blvd. and Shoreline Pkwy., Lindaro St. and Andersen Dr., Andersen Dr. and Francisco Blvd. W, Andersen Dr. and Dubois St., Andersen Dr. and Irwin St., and Lindaro St. and Second St.	Riviera Dr. and Milano Pl., Point San Pedro Rd and Riviera Dr., Point San Pedro Rd and Peacock Dr., Point San Pedro and Lochinvar, Point San Pedro and Loch Lomond, Point San Pedro Rd. and Summit Ave., Third St. and Union St., Third St. and Embarcadero Way, Knight Dr. and Dellwood Ct., Point San Pedro Rd. and Riviera Dr. Second St and Irwin St., 2nd and Grand Ave., 887 Andersen Dr., Third St and Grand Ave., San Rafael Transit Center, Andersen Dr. P and R Lot, Andersen Dr. and W Francisco Blvd., Andersen Dr. and Du Bois St., Andersen Dr. and Irwin St., Lindaro St. and Second St., Lindaro St. and Andersen Dr., Kerner Blvd. and Canal St., Andersen Dr. At Office 1261, Medway Rd. and E Francisco Blvd., Andersen Dr. and PG&E Office, E Francisco Blvd. and Bay St., Canal St. and Medway Rd., Medway Rd. and Front St., Canal St. and Novato St., Medway Rd. and Mill St., Canal St. and Sonoma St., Canal St. and Novato St., Kerner Blvd. and Fairfax St., Canal St and Sonoma St., Kerner Blvd and Bahia Way, Andersen Dr. GGBD facility Kerner Blvd. and Larkspur St., Kerner Blvd Btw #3140 and #3160, Bellam Blvd. and Lisbon St., Bellam Blvd. and E Francisco Blvd., Andersen Dr. and Jacoby St., 1011 Andersen Dr., Andersen Dr. and Simms St., Bellam Blvd. and Fwy., Bellam Blvd. and I-580 On-Ramp, E. Francisco and Pelican, Francisco At 1525 Office Building Irene St. and Francisco Blvd., Second St. and Grand Ave., Union St. and Mission Ave., Union St. and Fourth St., and San Rafael Golden Gate Transit (Andersen Drive).

Source: Marin Bay Shoreline Sea Level Rise Vulnerability Assessment– San Rafael Community Profile

Water transportation is a major contributor to San Rafael's sense of place, commercial activity, and recreation. One of Marin's two ports is located here along with several private marinas that could experience damage from storms and their facilities flooded out if barriers walls not elevated or pier and dock supporting pylons are not high enough for the highest high tides. Finally, several trails are vulnerable to sea level rise including the Bay Trail and Shoreline Trail.

Transportation assets at risk to sea level rise and coastal flooding using the six scenarios are shown on Figure 4-47.

Figure 4-47 San Rafael – Transportation Assets Vulnerable to Sea Level Rise and a 100-year Storm Surge



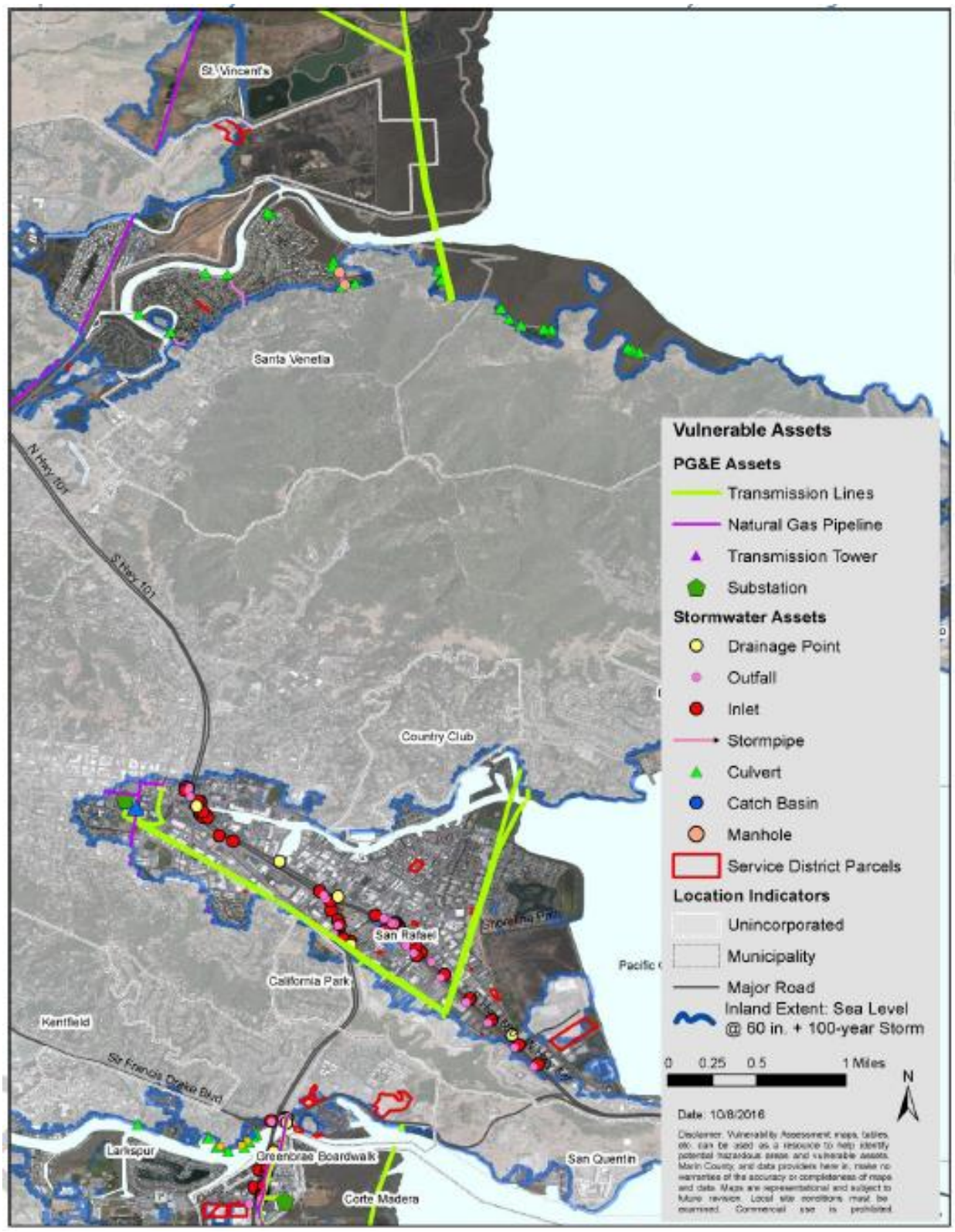
Source: Marin Bay Shoreline Sea Level Rise Vulnerability Assessment– San Rafael Community Profile

Utilities

PG&E has significant assets in San Rafael that could be exposed and vulnerable to sea level rise and storm surge impacts. This can be seen in Figure 4-48. Underground gas pipes could face buoyancy pressures as the water table beneath them rises and pushes them to the surface. The pressure can place bending forces on the pipes, especially where they are held down by roads. Moreover, if a road sheltering a natural gas pipe is damaged enough to rupture the pipes the consequences could be severe. The transmission lines are over ground and are vulnerable to falling trees and high winds. In addition, posts could become damaged over time, from floating debris, and subsidence. In addition, a natural gas station on Lindaro Street could see flooding from storms in the medium-term and tidal flooding by the long-term. With respect to other utilities, San Rafael is vulnerable to similar issues as other shoreline communities in the study area such as:

- Underground pipes face compounding pressure forces from water and the road,
- Road erosion and collapse with underlain pipes,
- Saltwater inflow and infiltration causing inefficiencies in wastewater treatment,
- Continuously subsiding soils or fill, and
- Escalating activity, capacity demands, energy consumption, and wear and tear on San Rafael's on pump stations 50-61 in stormwater systems, and others in wastewater systems,
- Aging individual site connections for water, sewer, and electrical, and
- Flood waters interrupting access for employees to reach work sites.

Figure 4-48 San Rafael – Utility Assets Vulnerable to Sea Level Rise and a 100-year Storm Surge



Source: Marin Bay Shoreline Sea Level Rise Vulnerability Assessment – San Rafael Community Profile

Natural Resources

The canal and its tributaries are highly urbanized with marginalized wildlife habitat. The shoreline stemming away from the canal hosts more significant riparian and tidal marsh habitats. Based on the National Inventory of Habitats, several endangered species are known to inhabit these tidal areas including the California Black Rail, Ridgway's Rail, the California Brown Pelican, and the tidewater goby. Other than Brick Yard Beach, San Rafael incorporated has a few beaches that are used for recreation and are not necessarily of habitat value. The Marin Rod and Gun Club beach is also narrow.

Recreation

The San Rafael shoreline and canal are highly active recreation areas. Boating, biking, and walking the pathways are the most common. The marinas are used for boating and could face challenges in the onset of sea level rise. Biking and walking on the streets and trails could be limited to low tides and inaccessible depending on the path's proximity to the existing shoreline.

In the near-term Beach, Gallinas Creek, Pickleweed, and Starkweather Shoreline parks could see impacts at the shoreline edges, and in the medium-term, see significant tidal flooding. In the long-term, Albert, Candy's, Peacock Gap, and Schoen parks could also see tidal flooding. A few hotels, including the Extended Stay America, North Bay Inn, and Motel 6 could also be exposed to tidal flood waters.

Emergency Services

The San Rafael Fire Department could be directly impacted at the Castro Street Station 54 in the near-term and face access issues at Station 52 and 55 in the medium- and long-terms. In addition, Bahia Vista Elementary and the Pickleweed Community center serve as emergency shelters that could each face up to two feet of flooding by scenario 3. Finally, access on flooded roads would be severely compromised during MHHW and storms.

Summary

For San Rafael, in the near-term, 449 acres could be exposed to sea level rise. By the long-term, 1,856 acres could be exposed to sea level rise, and 2,121 acres could be exposed during a 100-year storm surge. Within the study area, San Rafael could experience the most significant impacts, including:

- Flooding south of State Route 580 in the canal area and Kerner Business District could compromise extensive multi-family housing, commercial, industrial, and recreational uses.
- State Route 101 on and off-ramps could see storm surge flooding in near-term and tidal flooding in the medium-term.
- The San Rafael Transit Center could be vulnerable in the long-term. This could compromise local and regional bus lines, and the new SMART train.
- A significant portion of downtown could face storm surges in the near- and medium-terms and sea level rise in the long-term.
- GGBD facilities on Anderson Drive are vulnerable.
- Several schools including Bahia Vista and Glenwood Elementary, Davidson Middle, and San Rafael High schools could be vulnerable across the BayWAVE scenarios.

- A few historic landfills are on the shoreline.
- PG&E Lindaro Street natural gas station is in the flood area as are miles of electrical transmission and natural gas pipelines.
- Marinas and other boating facilities are vulnerable to sea level rise in the medium- to long-term.
- Peacock Gap homes and golf course are vulnerable to storms in the near-term and sea level rise in the long-term.
- Marin Lagoon and streets in the Las Gallinas area could begin to see peripheral tidal flooding and storm surge flooding in the near-term, and neighborhood scale flooding by the long-term.
- Fire Station 54 is exposed in scenario 1 and two others could have access issues.

Future Development/Redevelopment

CITY PLANNING TEAM – WHAT WILL BE DONE TO KEEP FUTURE DEVELOPMENT PROTECTED FROM SEA LEVEL RISE?

4.3.5. Drought and Water Shortage Vulnerability Assessment

Likelihood of Future Occurrence—Likely
Vulnerability—Medium

Drought is different than many of the other natural hazards in that it is not a distinct event and usually has a slow onset. Drought can severely impact a region both physically and economically. Drought affects different sectors in different ways and with varying intensities. Adequate water is the most critical issue for agricultural, manufacturing, tourism, recreation, and commercial and domestic use. As the population in the area continues to grow, so too will the demand for water.

Based on historical information, the occurrence of drought in California, including in San Rafael, is cyclical, driven by weather patterns. Drought has occurred in the past and will occur in the future. Periods of actual drought with adverse impacts can vary in duration, and the period between droughts is often extended. Although an area may be under an extended dry period, determining when it becomes a drought is based on impacts to individual water users. The vulnerability of the City to drought is citywide, but impacts may vary by area and include reduction in water supply, agricultural losses, and an increase in dry fuels.

Drought impacts are wide-reaching and may be economic, environmental, and/or societal. Tracking drought impacts can be difficult. The Drought Impact Reporter from the NDMC is a useful reference tool that compiles reported drought impacts nationwide by County. Table 4-39 show drought impacts for Marin County from 1850 to October 31, 2016. The data represented is skewed, with the majority of these impacts from records within the past ten years.

Table 4-39 Marin County – Drought Impacts (1850 to 2015)

Category	Number
Agriculture	38
Business and Industry	8
Energy	2

Category	Number
Fire	10
Plans & Wildlife	36
Relief, Response, and Restrictions	56
Society and Public Health	50
Tourism and recreation	6
Water Supply and Quality	64
Total	**270**

Source: National Drought Mitigation Center

The most significant qualitative impacts associated with drought in the City are those related to water intensive activities such as wildfire protection, municipal usage, commerce, tourism, recreation, agriculture, and wildlife preservation. Mandatory conservation measures are typically implemented during extended droughts. A reduction of electric power generation and water quality deterioration are also potential problems. Drought conditions can also cause soil to compact and not absorb water well, potentially making an area more susceptible to flooding.

It is difficult to quantitatively assess drought impacts to San Rafael and Marin County because not many county- or City-specific studies have been conducted. Some factors to consider include: habitat loss and associated effects on wildlife, and the drawdown of the groundwater table.

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

The North Marin Water District (NMWD),7 founded in 1948, is an independent special district in the northern portion of the county and operates under the authority of Division 12 of the California Water Code. NMWD provides water service to the greater Novato area and to areas of West Marin (Point Reyes Station, Olema, Bear Valley, Inverness Park and Paradise Ranch Estates). NMWD purchases approximately 80% of its Novato water supply from the Sonoma County Water Agency, with the remaining 20% derived from the District's Stafford Lake Reservoir (located in Marin County just west of Novato) and recycled water (Bentley and Landeros, 2015).

Drought can exacerbate tree mortality in the City, creating a greater wildfire risk. This is discussed in Section 4.3.15.

Future Development/Redevelopment

Population growth in the City will add additional pressure to water companies during periods of drought and water shortage. Water companies will need to continue to plan for and add infrastructure capacity for population growth.

WHAT IS THE CITY DOING TO PLAN FOR FUTURE WATER SUPPLY?

4.3.6. Earthquake

Likelihood of Future Occurrence—Occasional
Vulnerability—High

Earthquake vulnerability is primarily based on population and the built environment. Urban areas in high seismic hazard zones are the most vulnerable, while uninhabited areas are less vulnerable. Earthquake losses will vary across the City depending on the source and magnitude of the event. A map showing peak ground accelerations in San Rafael was shown in Figure 4-22. Based on this map, the City is located in a high seismic risk area. The earthquake scenario run for this LHMP provides a good estimate of loss to the City based on a realistic earthquake scenario. The methodology and results of this scenario are described below.

2017 Earthquake Scenarios

HAZUS-MH 2.2 was utilized to model earthquake losses for the City. Specifically, the probable magnitude used for San Rafael utilized a 7.9 magnitude earthquake, based on data from the San Rafael 2020 General Plan Background Report. Level 1 analyses were run, meaning that only the default data was used and not supplemented with local building inventory or hazard data. There are certain data limitations when using the default data, so the results should be interpreted accordingly; this is a planning level analysis.

The methodology for running the probabilistic earthquake scenario used probabilistic seismic hazard contour maps developed by the U.S. Geological Survey (USGS) for the 2002 update of the National Seismic Hazard Maps that are included with HAZUS-MH. The USGS maps provide estimates of potential ground acceleration and spectral acceleration at periods of 0.3 second and 1.0 second, respectively. The 2,500 year return period analyzes ground shaking estimates with a 2 percent probability of being exceeded in 50 years, from the various seismic sources in the area. The International Building Code uses this level of ground shaking for building design in seismic areas and is more of a worst case scenario.

The results of the probabilistic scenario are captured in Table 4-40. Key losses included the following:

- Total economic loss estimated for the earthquake was almost $3.6 billion, which includes building losses and lifeline losses based on the HAZUS-MH inventory.
- Building-related losses, including direct building losses and business interruption losses, totaled almost $3.5 billion.
- Over 48 percent of the buildings in the County were at least moderately damaged. 1,470 buildings were completely destroyed.

- Over 42 percent of the building- and income-related losses were residential structures. 16 percent of the estimated losses were related to business interruptions.
- The mid-day earthquake caused the most casualties: 123
- 89.3 percent of the households experienced a loss of potable water the first day after the earthquake.
- 88.2 percent of the households experienced a loss of potable water the first day after the earthquake.

Table 4-40 San Rafael – HAZUS-MH 2,500-year Earthquake Scenario Results

Impacts/Earthquake	7.9 Magnitude Earthquake	
Residential Buildings Damaged (Based upon 20,000 buildings)	Slight: 7,435 Moderate: 6,558 Extensive: 1,805 Complete: 1,470	
Building Related Loss	$3,452,890,000	
Total Economic Loss	$3,583,570,000	
Injuries (Based upon 2am time of occurrence)	Without requiring hospitalization: 395 Requiring hospitalization: 101 Life Threatening: 13 Fatalities: 26	
Injuries (Based upon 2pm time of occurrence)	Without requiring hospitalization: 1,215 Requiring hospitalization: 377 Life Threatening: 64 Fatalities: 123	
Injuries (Based upon 5pm time of occurrence)	Without requiring hospitalization: 825 Requiring hospitalization: 261 Life Threatening: 67 Fatalities: 83	
Essential Facility Damage (Based upon 33 buildings)	Before the earthquake, the region had 119 hospital beds available for use. On the day of the earthquake, the model estimates that only 39 hospital beds (33.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 84.00% of the beds will be back in service. By 30 days, 99.00% will be operational.	
Transportation and Utility Lifeline Damage	31 bridges with at least moderate damage, and 2 with complete damage. 1 railway bridge with at least moderate damage. 1 bus facility with at least moderate damage.	
Households w/out Power & Water Service (Based upon 25,252 households)	Water loss @ Day 1: 22,557 Water loss @ Day 3: 22,113 Water loss @ Day 7: 20,924 Water loss @ Day 30: 0 Water loss @ Day 90: 0	Power loss @ Day 1: 22,279 Power loss @ Day 3: 17,360 Power loss @ Day 7: 10,102 Power loss @ Day 30: 2,806 Power loss @ Day 90: 25
Displaced Households	2,458	
Shelter Requirements	1,507	
Debris Generation	720,000 tons	

Source: HAZUS-MH 2.2

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. HAZUS uses a Monte Carlo simulation model to estimate the number

of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be no ignitions.

In addition, the HMPC performed a search of unreinforced masonry buildings in the City. A report was put together for the City in 1994. This is shown on Table 4-41. There were 43 unreinforced masonry buildings in San Rafael concentrated mostly in downtown surrounding fourth street, that were retrofitted in the 1990's to comply with City Ordinance No. 1620.

Table 4-41 San Rafael – Unreinforced Masonry Buildings and Status

Address	Description	1994 Status
827 Fourth Street	Marin Fencing Academy	Phase II: Completed Construction
881 Fourth Street		Phase II: Completed Construction
1122 Fourth Street		Phase II: Completed Construction
1340 Fourth Street		Phase II: Completed Construction
1553 Fourth Street		Phase II: Completed Construction
1011 A Street		Phase II: Completed Construction
821 B Street		Phase II: Completed Construction
905 D Street		Phase II: Completed Construction
1012 Lincoln Ave		Phase II: Under Construction
716 Fourth Street		Phase II: Under Construction
1240 Fourth Street		Phase II: Under Construction
1318 Fourth Street		Phase II: Under Construction
1446 Fourth Street		Phase II: Under Construction
1219 Fourth Street		Phase II: Plans Being Reviewed
1321 Fourth Street		Phase II: Plans Being Reviewed
1617 Fourth Street		Phase II: Plans Being Reviewed
826 Second Street		Phase II: Still need to submit plans
1117 Third Street		Phase II: Still need to submit plans
704 Fourth Street		Phase II: Still need to submit plans
710 Fourth Street		Phase II: Still need to submit plans
718 Fourth Street		Phase II: Still need to submit plans
2138 Fourth Street		Phase II: Still need to submit plans
927 Tamalpias Ave		Phase I: Completed Construction
812 Fourth Street		Phase I: Completed Construction
815 Fourth Street		Phase I: Completed Construction
836 Fourth Street		Phase I: Completed Construction
931 Fourth Street		Phase I: Completed Construction
1238 Fourth Street		Phase I: Completed Construction
1327 Fourth Street		Phase I: Completed Construction

Address	Description	1994 Status
1330 Fourth Street		Phase I: Completed Construction
1615 Fourth Street		Phase I: Completed Construction
810 B Street		Phase I: Completed Construction
826 B Street		Phase I: Completed Construction
1 H Street		Phase I: Completed Construction
121 Knight Drive		Phase I: Completed Construction
842 Fourth Street		Phase I: Under Construction
1005 Fourth Street		Phase I: Under Construction
1200 Fourth Street		Phase I: Under Construction
1118 Fourth Street		Phase I: Vacant and require strengthening
522 B Street		Phase I: Vacant and require strengthening
1010 B Street	Rafael Theatre	Out of Compliance
1220 Fourth Street		Out of Compliance

Source: City of San Rafael

The Planning Team noted that earthquake shaking is the primary concern. Liquefaction impacts in the City would be limited. The aging infrastructure located throughout the City would be at greatest risk. The City has completed both a URM inventory and has mitigated all but a few listed properties. Many of the City's building inventory is wood frame which would experience fewer impacts during an earthquake event.

Community Impact

The overall impact to the community from earthquake includes:

- Commercial and residential structural and property damage;
- Damage to natural resource habitats and other resources, such as timber and rangeland;
- Disruption of and damage to public infrastructure and services;
- Loss of water, power, roads, phones, and transportation, which could impact, strand, and/or impair mobility for emergency responders and/or area residents;
- Economic losses (jobs, sales, tax revenue) associated with loss of commercial structures;
- Loss of churches, which could severely impact the social fabric of the community;
- Loss of schools, which could severely impact the entire school system and disrupt families and teachers, as temporary facilities and relocations would likely be needed;
- Impact on the overall mental health of the community;
- Injury and loss of life; and
- Negative impact on commercial and residential property values.

Future Development/Redevelopment

CAN THE CITY PROVIDE INPUT ON HOW THEY ARE ADDRESSING EARTHQUAKE ISSUES IN THE FUTURE DEVELOPMENT/REDEVELOPMENT AREAS?

4.3.7. Earthquake: Liquefaction Vulnerability Assessment

Likelihood of Future Occurrence—Occasional
Vulnerability—High

Earthquake is discussed in the Section 4.3.6, but is primarily focused on the vulnerability of buildings and people from earthquake shaking. This section deals with a secondary hazard associated with earthquake – the possible collapse of structural integrity of the ground underneath liquefaction prone areas.

Values at Risk

Marin County's 2016 parcel layer and Assessor's data, obtained from Marin Map were used as the basis for the City inventory of parcels and their associated values. GIS was used to create a centroid, or point representing the center of the parcel polygon. A liquefaction layer was obtained from Marin Map as well. That layer originated from the NEHRP Earthquake Program, with other limited support from the County of Napa, and recently also by the California Division of Mines and Geology. The current map consists of this new mapping and revisions of previous USGS mapping. The liquefaction layer was then overlaid on the parcel layer that was then joined to the County Assessor's data. For the purposes of this analysis, the liquefaction zone that intersected a parcel centroid was assigned the liquefaction risk zone for the entire parcel. The parcels were segregated and analyzed in this fashion for the City of San Rafael. Once completed, the parcel boundary layer was joined to the centroid layer and values were transferred based on the identification number in the Assessors database and the GIS parcel layer. Liquefaction zones for the City are shown in Figure 4-49. Details on risk to the City from liquefaction, by property use and liquefaction zone, is shown on Table 4-42.

Figure 4-49 San Rafael – Liquefaction Risk Zones

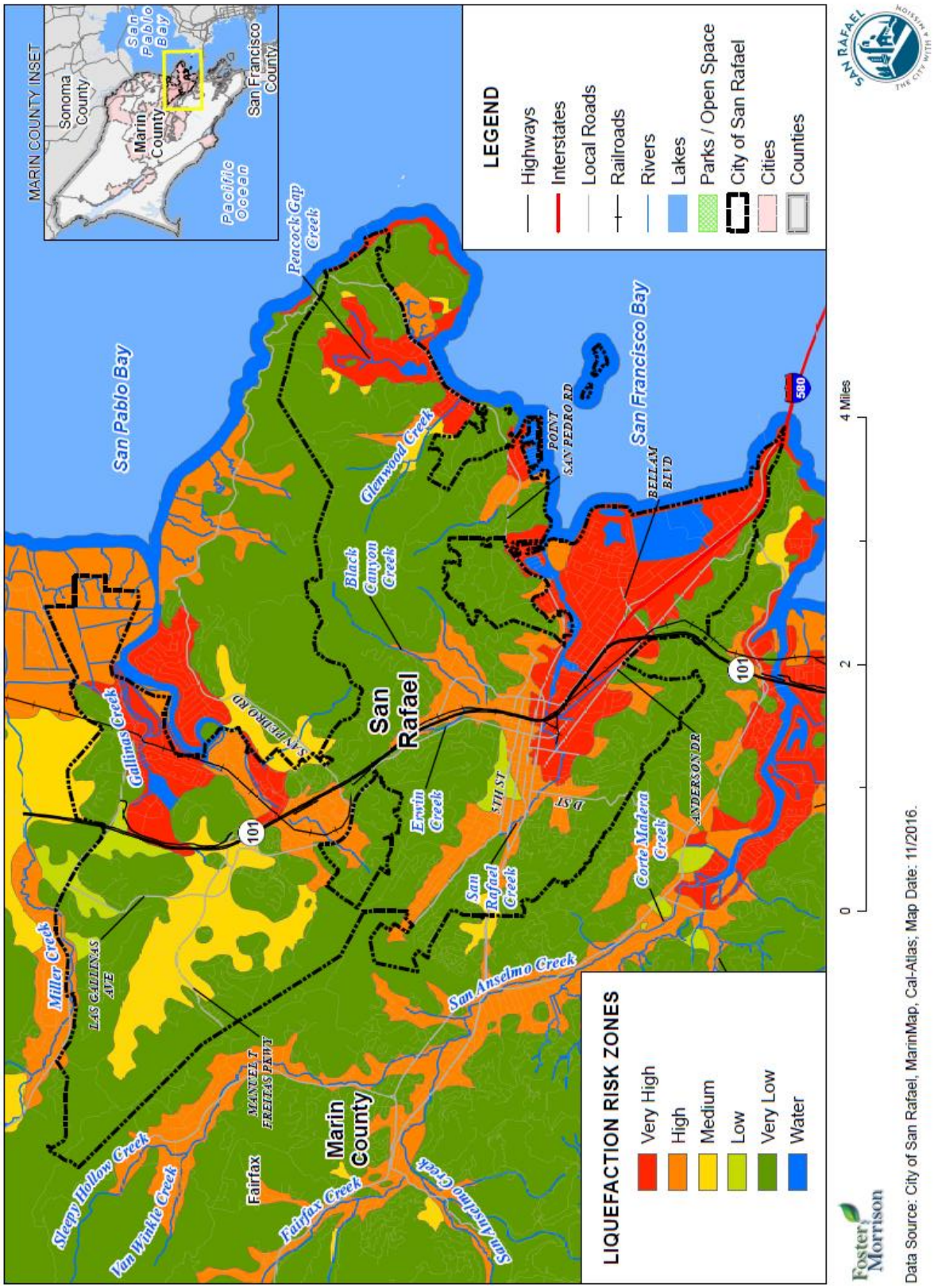


Table 4-42 San Rafael – Parcel Count and Values by Liquefaction Risk Zones and Property Use

Property Use	Total Parcel Count	Improved Parcel Count	Total Land Value	Improved Structure Value	Estimated Contents Value	Total Value*	% of Total Parcel Count
Very High							
Agricultural	0	0	$0	$0	$0	$0	0.0%
Commercial	554	492	$406,822,862	$661,129,445	$661,129,445	$1,729,081,752	15.6%
Exempt	207	29	$21,101,723	$34,564,741	$34,564,741	$90,231,205	0.9%
Industrial	257	234	$114,898,343	$137,014,938	$205,522,407	$457,435,688	7.4%
Residential	2,503	2,389	$539,005,345	$684,055,084	$342,027,542	$1,565,087,971	76.0%
Total – Very High	**3,521**	**3,144**	**$1,081,828,273**	**$1,516,764,208**	**$1,243,244,135**	**$3,841,836,616**	**100.0%**
High							
Agricultural	0	0	$0	$0	$0	$0	0.0%
Commercial	410	371	$198,779,840	$378,210,425	$378,210,425	$955,200,690	11.1%
Exempt	180	57	$35,404,699	$158,121,082	$158,121,082	$351,646,863	1.7%
Industrial	0	0	$0	$0	$0	$0	0.0%
Residential	2,976	2,923	$931,070,295	$903,395,454	$451,697,727	$2,286,163,476	87.2%
Total – High	**3,566**	**3,351**	**$1,165,254,834**	**$1,439,726,961**	**$988,029,234**	**$3,593,011,029**	**100.0%**
Medium							
Agricultural	1	0	$1	$0	$0	$1	0.0%
Commercial	77	73	$77,147,571	$146,654,961	$146,654,961	$370,457,493	3.0%
Exempt	63	26	$6,596,108	$23,383,449	$23,383,449	$53,363,006	1.1%
Industrial	0	0	$0	$0	$0	$0	0.0%
Residential	2,374	2,355	$591,333,214	$571,390,566	$285,695,283	$1,448,419,063	96.0%
Total – Medium	**2,515**	**2,454**	**$675,076,894**	**$741,428,976**	**$455,733,693**	**$1,872,239,563**	**100.0%**
Low							
Agricultura	0	0	$0	$0	$0	$0	0.0%
Commercial	37	35	$25,233,607	$45,695,511	$45,695,511	$116,624,629	9.3%
Exempt	21	7	$7,029,584	$18,184,023	$18,184,023	$43,397,630	1.9%
Industrial	2	1	$838,518	$1,454,897	$2,182,346	$4,475,761	0.3%
Residential	338	333	$88,025,682	$92,828,707	$46,414,354	$227,268,743	88.6%
Total – Low	**398**	**376**	**$121,127,391**	**$158,163,138**	**$112,476,233**	**$391,766,762**	**100.0%**

Source: Marin Map, Marin County 2016 Parcel/Assessor's Data

Population at Risk

The liquefaction zones were overlayed on the parcel layer. Those residential parcel centroids that intersect the differing liquefaction zones were counted and multiplied by the 2010 Census Bureau average household factors for the City of San Rafael (2.44). This is shown in Table 4-47.

Table 4-43 San Rafael – Count of Improved Residential Parcels and Population by Liquefaction Zone

Liquefaction Zone	Improved Residential Parcels	Population*
Very High	2,389	5,829
High	2,923	7,132
Medium	2,355	5,746
Low	333	813

Source: Marin County 2016 Assessor's Data; Marin Map Liquefaction Layer, US Census Bureau

Cultural and Natural Resources at Risk

ARE THERE ANY CULTURAL/NATURAL RESOURCES AT RISK TO THIS HAZARD?

Critical Facilities at Risk

An analysis was performed on the critical facility inventory in San Rafael in identified liquefaction zones. GIS was used to determine whether the facility locations intersects a NEHRP liquefaction area, and if so, which zone it intersects. Details of critical facilities by liquefaction zone for the City of San Rafael are shown in Figure 4-50 and Table 4-44. Details of critical facility definition, type, name and address and jurisdiction by flood zone are listed in Appendix E.

Figure 4-50 San Rafael – Critical Facilities in Liquefaction Risk Zones

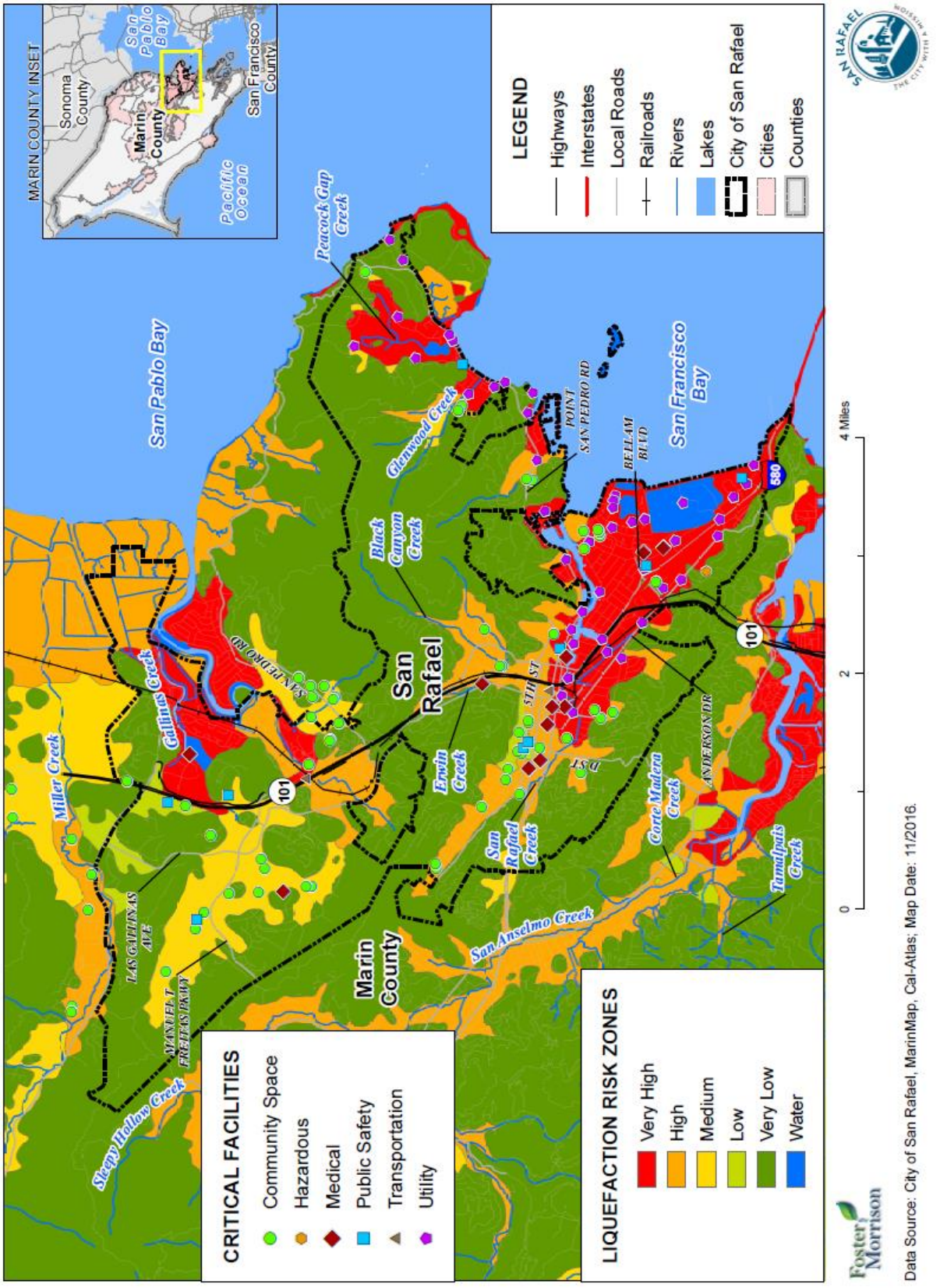


Table 4-44 San Rafael – Critical Facilities in Liquefaction Risk Zones

Location/Facility Type	Facility Count by Liquefaction Risk Zones						
	Very High	High	Medium	Low	Very Low	Water	Total
City of San Rafael							
Community Space	9	14	13	6	9	0	**51**
Hazardous	0	0	0	0	1	0	**1**
Medical	5	3	0	1	2	1	**12**
Public Safety	4	0	1	3	1	0	**9**
Transportation	1	1	0	0	0	0	**2**
Utility	45	2	0	0	2	4	**53**
Total	**64**	**20**	**14**	**10**	**15**	**5**	**128**
Adjacent to San Rafael							
Community Space	0	5	4	0	5	0	**14**
Hazardous	0	0	0	0	0	0	**0**
Medical	0	0	0	0	0	0	**0**
Public Safety	0	0	0	0	0	0	**0**
Transportation	0	0	0	0	0	0	**0**
Utility	1	0	0	0	2	0	**3**
Total	**1**	**5**	**4**	**0**	**7**	**0**	**17**
San Rafael Totals							
Community Space	9	19	17	6	14	-	**65**
Hazardous	0	0	0	0	1	0	**1**
Medical	5	3	0	1	2	1	**12**
Public Safety	4	0	1	3	1	0	**9**
Transportation	1	1	0	0	0	0	**2**
Utility	46	2	0	0	4	4	**56**
Grand Total	**65**	**25**	**18**	**10**	**22**	**5**	**145**

Source: City of San Rafael GIS; Marin Map Liquefaction Layer

Community Impact

The overall impact to the community from earthquake induced liquefaction includes:

- Commercial and residential structural and property damage;
- Damage to natural resource habitats and other resources, such as timber and rangeland;
- Disruption of and damage to public infrastructure and services;
- Loss of water, power, roads, phones, and transportation, which could impact, strand, and/or impair mobility for emergency responders and/or area residents;
- Economic losses (jobs, sales, tax revenue) associated with loss of commercial structures;
- Loss of churches, which could severely impact the social fabric of the community;

- Loss of schools, which could severely impact the entire school system and disrupt families and teachers, as temporary facilities and relocations would likely be needed;
- Impact on the overall mental health of the community;
- Injury and loss of life; and
- Negative impact on commercial and residential property values.

Future Development/Redevelopment

Future development/redevelopment areas for the City are broken out into three primary areas. GIS data is maintained by San Rafael, and was made available for this plan. An analysis was performed to quantify parcels within these redevelopment areas that are also in liquefaction hazard areas. Results can provide information on how and where to grow in the future.

Future development/redevelopment areas for the City are broken out into three primary areas: Downtown/Civic Center, Northgate, and Dutra McNair Quarry. GIS was used to create a centroid, or point representing the center of the parcel polygon. Those parcels centroids that fall inside the future development areas and that were within the liquefaction areas were selected and tabulated in Figure 4-51 and shown in Table 4-45 and Table 4-46. Note that because the Dutra McNair Quarry falls outside of the City limits, parcel and assessor data was unavailable for this analysis

Figure 4-51 City of San Rafael – Liquefaction Risk Zones and Future Development/Redevelopment Areas

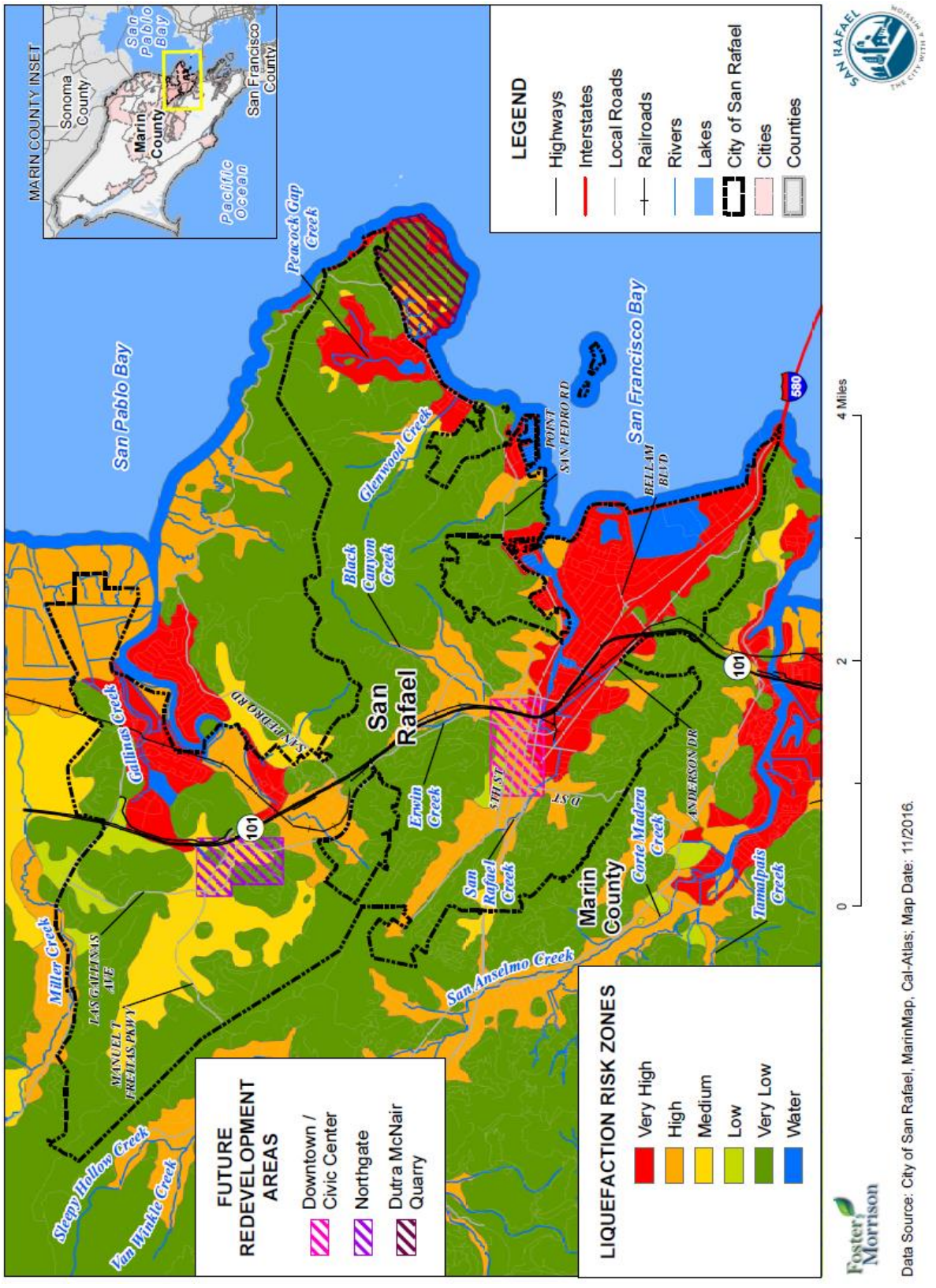


Table 4-45 City of San Rafael – Future Development/Redevelopment in Liquefaction Risk Zones by Location, Property Use, Parcels, and Acres

Downtown / Civic Center				Northgate				Dutra McNair Quarry			
Property Use	**Total Parcel Count**	**Improved Parcel Count**	**Total Acres**	**Property Use**	**Total Parcel Count**	**Improved Parcel Count**	**Total Acres**	**Property Use**	**Total Parcel Count**	**Improved Parcel Count**	**Total Acres**
Very High				**Very High**				**Very High**			
Commercial	50	44	20	Commercial	0	0	0	Commercial	0	0	0
Exempt	10	1	4	Exempt	0	0	0	Exempt	0	0	0
Residential	12	12	3	Residential	0	0	0	Residential	0	0	0
Total	**72**	**57**	**27**	**Total**	**0**	**0**	**0**	**Total**	**0**	**0**	**0**
High				**High**				**High**			
Commercial	242	222	46	Commercial	0	0	0	Commercial	0	0	0
Exempt	47	15	11	Exempt	0	0	0	Exempt	0	0	0
Residential	136	128	18	Residential	0	0	0	Residential	0	0	0
Total	**425**	**365**	**75**	**Total**	**0**	**0**	**0**	**Total**	**0**	**0**	**0**
Medium				**Medium**				**Medium**			
Commercial	0	0	0	Commercial	33	32	60	Commercial	0	0	0
Exempt	0	0	0	Exempt	4	1	4	Exempt	0	0	0
Residential	0	0	0	Residential	57	54	14	Residential	0	0	0
Total	**0**	**0**	**0**	**Total**	**94**	**87**	**78**	**Total**	**0**	**0**	**0**
Low				**Low**				**Low**			
Commercial	33	31	7	Commercial	0	0	0	Commercial	0	0	0
Exempt	12	4	9	Exempt	0	0	0	Exempt	0	0	0
Residential	90	87	7	Residential	0	0	0	Residential	0	0	0
Total	**135**	**122**	**22**	**Total**	**0**	**0**	**0**	**Total**	**0**	**0**	**0**
Very Low				**Very Low**				**Very Low**			
Commercial	1	1	0	Commercial	10	7	40	Commercial	-	-	-
Exempt	2	2	0	Exempt	2	1	2	Exempt	-	-	-
Residential	41	40	7	Residential	35	33	12	Residential	-	-	-
Total	**44**	**43**	**7**	**Total**	**47**	**41**	**53**	**Total**	**0**	**0**	**0**

Source: City of San Rafael GIS; Marin Map Liquefaction Layer

Table 4-46 City of San Rafael – Total Future Development/Redevelopment in Liquefaction Risk Zones by Property Use, Parcels, and Acres

Property Use	Total Parcel Count	Improved Parcel Count	Total Acres
Very High			
Commercial	50	44	20
Exempt	10	1	4
Residential	12	12	3
Total	**72**	**57**	**27**
High			
Commercial	242	222	46
Exempt	47	15	11
Residential	136	128	18
Total	**425**	**365**	**75**
Medium			
Commercial	33	32	60
Exempt	4	1	4
Residential	57	54	14
Grand Total	**94**	**87**	**78**
Low			
Commercial	33	31	7
Exempt	12	4	9
Residential	90	87	7
Grand Total	**135**	**122**	**22**
Very Low			
Commercial	11	8	40
Exempt	4	3	2
Residential	76	73	18
Grand Total	**91**	**84**	**61**

Source: City of San Rafael GIS; Marin Map Liquefaction Layer

4.3.8. Flood: 100/500-year Vulnerability Assessment

Likelihood of Future Occurrence—Occasional/Unlikely
Vulnerability—High

Flooding in the City can occur any time from fall to spring as a result of the occurrence of general rainstorms. General rain floods result from prolonged, heavy rainfall over tributary areas and are characterized by high peak flows and moderate duration and a large volume of runoff. Flooding is more severe when antecedent rainfall has resulted in saturated ground condition.

Flooding has historically occurred in the City, and the vulnerability to flood damages is high. This section quantifies the vulnerability of San Rafael to the 100- and 500-year floods.

Values at Risk

The City of San Rafael has mapped FEMA flood hazard areas. GIS was used to determine the possible impacts of flooding within the City and how the risk varies across the City. Maps and analysis tables detailing the FEMA flood hazard in the City are provided below. The following methodology was followed in determining parcels and values at risk to the 1% annual chance (i.e., 100-year) flood and 0.2% annual chance (i.e., 500-year) flood.

Methodology

Flood Parcel Inventory and Assessed Values

Marin County's 2016 parcel layer and Assessor's data, extracted from Marin Map were used as the basis for the city inventory of parcels, values, and acres. Marin County has a FEMA DFIRM dated March 16, 2016 which was utilized to perform the flood analysis.

In some cases there are parcels in multiple flood zones, such as Zone A, Zone X, or Shaded X. GIS was used to create a centroid, or point representing the center of the parcel polygon. DFIRM flood data was then overlaid on the parcel layer. For the purposes of this analysis, the flood zone that intersected a parcel centroid was assigned the flood zone for the entire parcel. The parcels were segregated and analyzed in this fashion for the City of San Rafael. Once completed, the parcel boundary layer was joined to the centroid layer and values were transferred based on the identification number in the Assessors database and the GIS parcel layer.

Flood Loss Estimate

The loss estimate for flood is based on the total of improved and contents value. Improved parcels include those with improved structure values identified in the Assessor's database. Only improved parcels and the value of their structure improvements were included in the flood loss analysis. The value of land is not included in the loss estimates as generally the land is not at loss to floods, just the value of improvements and structure contents. The land value is represented in the detailed flood tables, but are only present to show the value of the land associated with each flood zone.

The property use categories for the City (derived from the Assessor Use Code categories and Use Code Descriptions) were used to develop estimated content replacement values (CRV) that are potentially at loss from hazards, using FEMA Hazus methodologies as previously described in Section The CRVs were added to the improved parcel values.

Once the potential value of affected parcels was calculated, a damage factor was applied to obtain loss estimates by flood zone. When a flood occurs, seldom does the event cause total loss of an area or building. Potential losses from flooding are related to a variety of factors including flood depth, flood velocity, building type, and construction. The percent of damage is primarily related to the flood depth. FEMA's flood benefit/cost module uses a simplified approach to model flood damage based on building type and

flood depth. The values at risk in the flood analysis tables were refined by applying an average damage estimation of 20% of the total building value. The 20% damage estimate utilized FEMA's Flood Building Loss Table based on an assumed average flood depth of 2 feet.

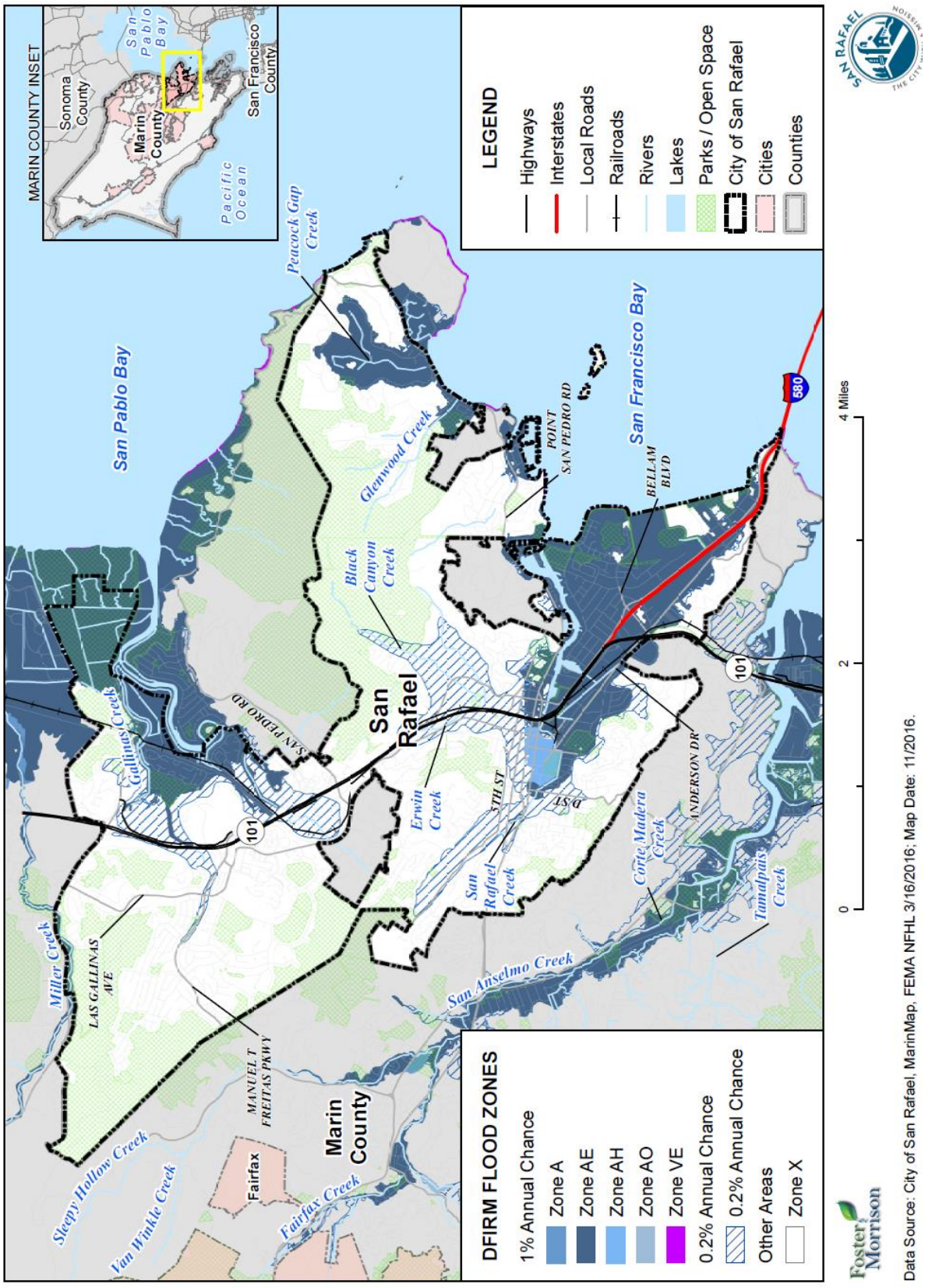
Each of the DFIRM flood zones that begins with the letter 'A' or 'V' depict the Special Flood Hazard Area, or the 1% annual chance flood event (commonly referred to as the 100-year flood). Table 4-47 explains the difference between DFIRM mapped flood zones within the 1% annual chance flood zone as well as other flood zones located within the City, and also includes flood zone information for Marin County which is also depicted in the City flood maps. The effective DFIRM maps for the City of San Rafael are shown on Figure 4-52.

Table 4-47 San Rafael – DFIRM Flood Hazard Zones

Flood Zone	Description	Flood Zone Present in San Rafael	Flood Zone Present in Marin County
A	100-year Flood: No base flood elevations provided		X
AE	100-year Flood: Base flood elevations provided	X	X
AH	Areas subject to inundation by 1-percent-annual-chance shallow flooding (usually areas of ponding) where average depths are between one and three feet. Base Flood Elevations (BFEs) derived from detailed hydraulic analyses are shown in this zone.	X	X
AO	Areas subject to inundation by 100-year shallow flooding (usually sheet flow on sloping terrain) where average depths are between one and three feet.		X
V	Areas along coasts subject to inundation by the 1-percent-annual-chance flood event with additional hazards associated with storm-induced waves. Because detailed hydraulic analyses have not been performed, no Base Flood Elevations (BFEs) or flood depths are shown.		X
VE	Areas subject to inundation by the 1-percent-annual-chance flood event with additional hazards due to storm-induced velocity wave action. Base Flood Elevations (BFEs) derived from detailed hydraulic analyses are shown.	X	X
Shaded X	500-year flood the areas between the limits of the 1% annual chance flood and the 0.2-percent-annual-chance (or 500-year) flood	X	X
X	No flood hazard	X	X
D	Unmapped Areas		X

Source: FEMA

Figure 4-52 San Rafael – DFIRM Flood Zones



Limitations

It also should be noted that the resulting flood loss estimates may actually be more or less than that presented in the below tables as the City may include structures located within the 1% or 0.2% annual chance floodplain that are elevated at or above the level of the base flood elevation, according to local floodplain development requirements. Also, it is important to keep in mind that these assessed values may be well below the actual market value of improved parcels located within the floodplain.

City of San Rafael Values at Risk: Flood Analysis Results

Table 4-48 and Table 4-49 contain flood analysis results for the City of San Rafael. Table 4-48 identifies parcels and associated values at risk by property use and detailed flood zone. This table shows the number of total parcels, improved parcels, and land and improved values at risk to each of the FEMA flood zones and also shows these potential losses summarized by 1% and 0.2% annual chance events.

Table 4-48 San Rafael – Parcel Counts and Values by Property Use in Flood Zones

Property Use	Total Parcel Count	Improved Parcel Count	Total Land Value	Improved Structure Value	Total Value
Zone AE					
Agricultural	0	0	$0	$0	$0
Commercial	485	429	$289,789,652	$353,221,813	$643,011,465
Exempt	208	30	$17,140,502	$27,874,933	$45,015,435
Industrial	182	162	$90,831,632	$85,995,632	$176,827,264
Residential	2,324	2,209	$476,875,281	$582,871,581	$1,059,746,862
Total Zone AE	**3,199**	**2,830**	**$874,637,067**	**$1,049,963,959**	**$1,924,601,026**
Zone AH					
Agricultural	0	0	$0	$0	$0
Commercial	59	54	$57,420,157	$154,553,614	$211,973,771
Exempt	17	2	$1,240,391	$2,702,459	$3,942,850
Industrial	0	0	$0	$0	$0
Residential	41	40	$18,680,890	$30,246,494	$48,927,384
Total Zone AH	**117**	**96**	**$77,341,438**	**$187,502,567**	**$264,844,005**
Zone VE					
Agricultural	0	0	$0	$0	$0
Commercial	0	0	$0	$0	$0
Exempt	2	0	$0	$0	$0
Industrial	0	0	$0	$0	$0
Residential	1	0	$1,015	$0	$1,015
Total Zone VE	**3**	**0**	**$1,015**	**$0**	**$1,015**

Property Use	Total Parcel Count	Improved Parcel Count	Total Land Value	Improved Structure Value	Total Value
Grand Total 1% Chance	**3,319**	**2,926**	**$951,979,520**	**$1,237,466,526**	**$2,189,446,046**
Zone X (shaded) – 0.2% Annual Chance					
Agricultural	0	0	$0	$0	$0
Commercial	400	364	$259,439,083	$493,529,017	$752,968,100
Exempt	153	50	$37,424,133	$140,667,507	$178,091,640
Industrial	86	83	$27,542,071	$53,356,245	$80,898,316
Residential	2,488	2,442	$768,601,079	$778,473,342	$1,547,074,421
Grand Total 0.2% Chance	**3,127**	**2,939**	**$1,093,006,366**	**$1,466,026,111**	**$2,559,032,477**
Zone X					
Agricultural	1	0	$1	$0	$1
Commercial	251	214	$233,471,220	$510,165,224	$743,636,444
Exempt	391	80	$43,071,427	$227,415,761	$270,487,188
Industrial	7	5	$4,186,788	$6,869,298	$11,056,086
Residential	10,700	10,287	$3,146,640,444	$3,258,291,685	$6,404,932,129
Total Zone X	**11,350**	**10,586**	**$3,427,369,880**	**$4,002,741,968**	**$7,430,111,848**

Source: FEMA DFIRM 3/16/2016, MarinMap, Marin County 2016 Parcel/Assessor's Data

Table 4-49 provides a flood loss estimate summarized by the 1% and 0.2% annual chance flood events and includes loss ratios for the City.

Table 4-49 gives details on flood loss estimates by flood zone and property use. The loss estimate for flood is based on the total of improved and CRVs and includes a 20% damage factor as previously described. The loss ratio is the loss estimate divided by the total potential exposure (i.e., total of improved and contents value for all parcels located in the City of San Rafael) and displayed as a percentage of loss. FEMA considers loss ratios greater than 10% to be significant and an indicator that a community may have more difficulties recovering from a flood. The City should keep in mind that the loss ratio could increase with additional development in the 1% and 0.2% annual chance floodplain, unless development is elevated in accordance with the local floodplain management ordinance.

Table 4-49 San Rafael – Flood Loss Estimates Summary

Property Use	Improved Parcel Count	Improved Structure Value	Estimated Contents Value	Total Value	Loss Estimate	Loss Ratio
1% Annual Chance Flood	2,926	$1,237,466,526	$973,905,305	$2,211,371,831	$442,274,366	2.66%
0.2% Annual Chance Flood	2,939	$1,466,026,111	$1,103,467,562	$2,569,493,674	$513,898,735	3.09%
Total	**5,865**	**$2,703,492,637**	**$2,077,372,867**	**$4,780,865,505**	**$956,173,101**	**5.75%**

Source: FEMA DFIRM 3/16/2016, MarinMap, Marin County 2016 Parcel/Assessor's Data

Table 4-50 San Rafael – Flood Loss Estimates Detail by Property Use and Flood Zone

Property Use	Improved Parcel Count	Improved Structure Value	Estimated Contents Value	Total Value	Loss Estimate	Loss Ratio
1% Annual Chance Flood						
AE						
Commercial	429	$353,221,813	$353,221,813	$706,443,626	$141,288,725	0.85%
Exempt	30	$27,874,933	$27,874,933	$55,749,866	$11,149,973	0.07%
Industrial	162	$85,995,632	$128,993,448	$214,989,080	$42,997,816	0.26%
Residential	2,209	$582,871,581	$291,435,791	$874,307,372	$174,861,474	1.05%
Total AE	**2,830**	**$1,049,963,959**	**$801,525,985**	**$1,851,489,944**	**$370,297,989**	**2.23%**
AH						
Commercial	54	$154,553,614	$154,553,614	$309,107,228	$61,821,446	0.37%
Exempt	2	$2,702,459	$2,702,459	$5,404,918	$1,080,984	0.01%
Residential	40	$30,246,494	$15,123,247	$45,369,741	$9,073,948	0.05%
Total AE	**54**	**$154,553,614**	**$154,553,614**	**$309,107,228**	**$61,821,446**	**0.37%**
Total 1%	**2,926**	**$1,237,466,526**	**$973,905,305**	**$2,211,371,831**	**$442,274,366**	**2.66%**
0.2% Annual Chance Flood						
Commercial	364	$493,529,017	$493,529,017	$987,058,034	$197,411,607	1.19%
Exempt	50	$140,667,507	$140,667,507	$281,335,014	$56,267,003	0.34%
Industrial	83	$53,356,245	$80,034,368	$133,390,613	$26,678,123	0.16%
Residential	2,442	$778,473,342	$389,236,671	$1,167,710,013	$233,542,003	1.40%
Total 0.2%	**2,939**	**$1,466,026,111**	**$1,103,467,563**	**$2,569,493,674**	**$513,898,735**	**3.09%**
Grand Total	**5,865**	**$2,703,492,637**	**$2,077,372,867**	**$4,780,865,505**	**$956,173,101**	**5.75%**

Source: FEMA DFIRM 3/16/2016, MarinMap, Marin County 2016 Parcel/Assessor's Data

According to the information in Table 4-48 through Table 4-49, the City of San Rafael has 2,926 improved parcels and roughly $2.2 billion of structure and contents value in the 1% annual chance floodplain. The City has 2,939 parcels and roughly $2.6 billion in structure and contents values in the 0.2% annual chance floodplain. The loss estimate refines these values a step further. Applying the 20 percent damage factor as previously described, there is a 1% chance in any given year of a flood event causing roughly $3442,274,366.20 in damage in the City of San Rafael. Applying the same factor, there is a 0.2% chance of a flood event causing $513,898,734.70 in damage to the City (since the 500-year floodplain also encompasses the 100-year floodplain). A loss ratio of 5.75% indicates that while the City has values at risk in the floodplain, flood losses would be limited compared to the total built environment and the community would likely be able to recover adequately.

Flooded Acres

Also of interest is the land area affected by the various flood zones. The following is an analysis of flooded acres in San Rafael.

Methodology

GIS was used to calculate acres flooded by FEMA flood zones and property use categories. The Marin County parcel layer and FEMA DFIRM were intersected, and each segment divided by the intersection of flood zone and parcels was calculated for acres. This process was conducted for 1% and 0.2% annual chance flood areas, with each segment being defined by zone type (A, AE, AH, AO, VE, 0.2% Annual Chance, and X) and acres. The resulting data tables with flooded acreages were then imported into a database and linked back to the original parcels, including total acres by parcel number. Once this was completed, each parcel contained acreage values for flooded acre by zone type within the parcel. In the tables below, the 1% and 0.2% annual chance flood zones are summarized and then split out by property use, their total flooded acres, total improved acres, and percent of improved acres that are flooded.

It is important to keep in mind that this methodology assumes that improvements are uniformly found throughout the parcel, while in reality only portions of the parcel are improved, and improvements may or may not fall within the flood zone portion of a parcel. Thus, areas of flooded improvements calculated through this method may be higher or lower than those presented.

Table 4-51 provides detailed flooded acres information by property use and detailed flood zone for the City.

Table 4-51 San Rafael – Flooded Acres by Property Use by Flood Zone

Flood Zone	Property Use	Total Flooded Acres	Improved Flooded Acres	% of Improved Flooded Acres
AE	Agricultural	0	0	0.0%
	Commercial	648.95	484.48	58.5%
	Exempt	624.14	12.61	1.5%
	Industrial	93.60	84.22	10.2%
	Residential	308.06	223.01	26.9%
	Total	**1,674.74**	**804.32**	**97.1%**
AH	Agricultural	0	0	0.0%
	Commercial	23.80	17.74	2.1%
	Exempt	16.19	0.38	0.0%
	Industrial	0	0	0.0%
	Residential	6.06	5.77	0.7%
	Total	**46.05**	**23.89**	**2.9%**
VE	Agricultural	0	0	0.0%
	Commercial	3.58	0	0.0%
	Exempt	9.58	0	0.0%

Flood Zone	Property Use	Total Flooded Acres	Improved Flooded Acres	% of Improved Flooded Acres
	Industrial	0	0	0.0%
	Residential	0.64	0	0.0%
	Total	**13.80**	**0**	**0.0%**
Total 1% Annual Chance		**1,734.59**	**828.21**	**100.0%**
Shaded X (0.2% Annual Chance)	Agricultural	0	0	0.0%
	Commercial	179.42	145.46	23.4%
	Exempt	240.05	75.29	12.1%
	Industrial	24.76	21.87	3.5%
	Residential	450.40	378.15	60.9%
	Total	**894.63**	**620.76**	**100.0%**
X	Agricultural	0.35	0	0.0%
	Commercial	364.65	243.82	8.3%
	Exempt	3,042.06	199.55	6.8%
	Industrial	5.91	3.64	0.1%
	Residential	3,084.16	2,485.25	84.8%
	Total	**6,497.14**	**2,932.26**	**100.0%**

Source: FEMA DFIRM 3/16/2016, Marin County Parcel Layer 2016

Population at Risk

The DFIRM flood zones were overlayed on the parcel layer. Those residential parcel centroids that intersect the flood zones were counted and multiplied by the 2010 Census Bureau average household factors for the City of San Rafael (2.44). According to this analysis, there is a total population of 5,488 and 5959 residents of San Rafael at risk to 1% and 0.2% annual chance flooding, respectively. This is shown in Table 4-52.

Table 4-52 San Rafael – Count of Improved Residential Parcels and Population by Flood Zone

Flood Zone	Improved Residential Parcels	Population*
AE	2,209	5,390
AH	40	98
Total 1% Annual Chance	**2,249**	**5,488**
0.2% Annual Chance (Shaded X)	2,442	5,959
Grand Total	**4,491**	**11,447**

Source: Marin County 2016 Assessor's Data; FEMA DFIRM 3/16/2016, US Census Bureau

NFIP Insurance Coverage Details

The City of San Rafael joined the NFIP on May 1, 1984. The City does not currently participate in the Community Rating System, but is considering joining in the future. NFIP insurance data provided by DWR indicates that as of February 19, 2016, there were 1,966 policies in force in the City, resulting in $561,195,100 of insurance in force. Total premiums paid total $2,804,671. Of these 1,966 policies, 960 are for single family homes, 162 are for multiple family homes, 603 are for other residential properties, and 241 are for non-residential properties. Of the 1,966 policies, 1,078 are in FEMA 100-Year flood zones (996 in A1-A30, 40 in A Zones, and 42 in AH Zones), 0 are in coastal flood zones, and 888 are in B, C, or X zones (639 are standard policies, and 249 are preferred policies). There have been 433 closed paid losses totaling $5,644,337.14. 11 of these claims were substantial damage claims. Of these 433 paid losses, 249 were for single family homes, 42 were for multiple family homes, 42 were for other residential properties, 102 were non-residential, and 1 was for an unknown property type. There have been 105 total repetitive loss claims in the City. These claims have resulted in $2,008,654.97 in total payouts. There are 2 buildings in the City that are severe repetitive loss structures (buildings with 4 or more loss payments).

CAN THE CITY PROVIDE INPUT ON HOW THEY HAVE ADDRESSED REPETITIVE LOSS PROPERTIES IN THE PAST OR WHAT THEY MIGHT BE DOING IN THE FUTURE? HAVE ANY OF THESE RL PROPERTIES BEEN MITIGATED?

Cultural and Natural Resources at Risk

ARE THERE ANY CULTURAL/NATURAL RESOURCES AT RISK TO THIS HAZARD?

Critical Facilities at Risk

An analysis was performed on the critical facility inventory in San Rafael in identified FEMA DFIRM flood zones. GIS was used to determine whether the facility locations intersects a DFRIM flood zone, and if so, which zone it intersects. Details of critical facilities by flood zone for the City of San Rafael are shown in Figure 4-53 and Table 4-53. Details of critical facility definition, type, name and address and jurisdiction by flood zone are listed in Appendix E.

Figure 4-53 San Rafael – Critical Facilities in DFIRM Flood Zones

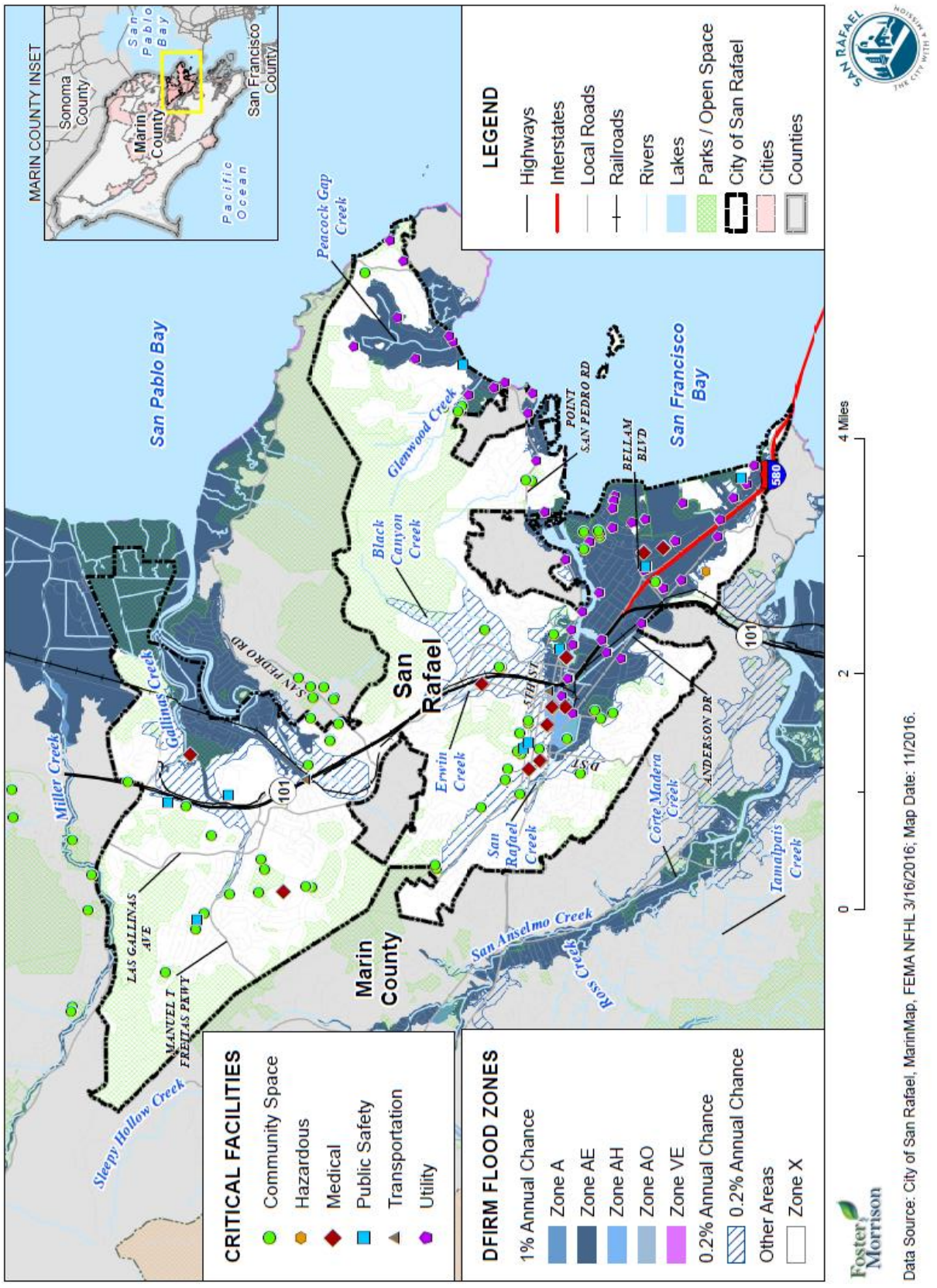


Table 4-53 San Rafael – Critical Facilities in DFIRM Flood Zones

San Rafael			Adjacent to San Rafael			San Rafael Totals		
Flood Zone	Facility Type	Facility Count	Flood Zone	Facility Type	Facility Count	Flood Zone	Facility Type	Facility Count
1% Annual Chance			1% Annual Chance			1% Annual Chance		
AE	Community Space	6	AE	Community Space	0	AE	Community Space	6
	Hazardous	0		Hazardous	0		Hazardous	0
	Medical	2		Medical	0		Medical	2
	Public Safety	2		Public Safety	0		Public Safety	2
	Transportation	0		Transportation	0		Transportation	0
	Utility	45		Utility	3		Utility	48
	AE Total	**55**		**AE Total**	**3**		**AE Total**	**58**
AH	Community Space	1	AH	Community Space	0	AH	Community Space	1
	Hazardous	0		Hazardous	0		Hazardous	0
	Medical	2		Medical	0		Medical	2
	Public Safety	0		Public Safety	0		Public Safety	0
	Transportation	0		Transportation	0		Transportation	0
	Utility	2		Utility	0		Utility	2
	AH Total	**5**		**AH Total**	**0**		**AH Total**	**5**
VE	Community Space	0	VE	Community Space	0	VE	Community Space	0
	Hazardous	0		Hazardous	0		Hazardous	0
	Medical	0		Medical	0		Medical	0
	Public Safety	0		Public Safety	0		Public Safety	0
	Transportation	0		Transportation	0		Transportation	0
	Utility	0		Utility	0		Utility	0
	VE Total	**0**		**VE Total**	**0**		**VE Total**	**0**
1% Annual Chance Total		**60**	**1% Annual Chance Total**		**3**	**1% Annual Chance Total**		**63**
0.2% Annual Chance			0.2% Annual Chance			0.2% Annual Chance		
Shaded X	Community Space	14	Shaded X	Community Space	0	Shaded X	Community Space	14
	Hazardous	0		Hazardous	0		Hazardous	0
	Medical	6		Medical	0		Medical	6
	Public Safety	1		Public Safety	0		Public Safety	1
	Transportation	2		Transportation	0		Transportation	2
	Utility	0		Utility	0		Utility	0
	0.2% Annual Chance Total	**23**		**0.2% Annual Chance Total**	**0**		**0.2% Annual Chance Total**	**23**

Other Areas				Other Areas				Other Areas		
X	Community Space	30		X	Community Space	14		X	Community Space	44
	Hazardous	1			Hazardous	0			Hazardous	1
	Medical	2			Medical	0			Medical	2
	Public Safety	6			Public Safety	0			Public Safety	6
	Transportation	0			Transportation	0			Transportation	0
	Utility	6			Utility	0			Utility	6
	X Total	**45**			**X Total**	**14**			**X Total**	**59**
Grand Total		**128**		**Grand Total**		**17**		**Grand Total**		**145**

Source: City of San Rafael GIS; FEMA DFIRM 3/16/2016

Overall Community Impact

Floods and their impacts vary by location and severity of any given event and will likely only affect certain areas of the City during specific times. Based on the risk assessment, it is evident that floods will continue to have potentially devastating economic impacts to certain areas of the San Rafael. However, many floods in the City are minor, localized events that cause nominal damage rather than a disaster. Impacts that are not quantified, but can be anticipated in large future events, include:

- Commercial and residential structural and property damage;
- Costs incurred due to post-flood clean up and repair of buildings and infrastructure;
- Damage to roads/bridges resulting in loss of mobility;
- Decreased revenue due to loss of income, sales, tourism, and property taxes;
- Deterioration of homes and neighborhoods as floods recur;
- Disruption of and damage to public infrastructure and services;
- Health hazards associated with mold and mildew, contamination of drinking water, etc.;
- Impact on the overall mental health of the community;
- Injury and loss of life, including first responders rescuing those who did not evacuate or are stranded;
- Loss of historical or unique artifacts;
- Loss of jobs due to businesses closing or cutting back on operating hours;
- Loss of programs or services that are cut to pay for flood recovery;
- Mental health and family impacts, including increased occurrence of suicides and divorce
- Negative impact on commercial and residential property values;
- Significant disruption to students and teachers as temporary facilities and relocations would likely be needed; and
- Significant economic impact (jobs, sales, tax revenue) to the community.

Future Development/Redevelopment

Future development/redevelopment areas for the City are broken out into three primary areas: Downtown/Civic Center, Northgate, and Dutra McNair Quarry. GIS data is maintained by San Rafael, and was made available for this plan. An analysis was performed to quantify parcels within these

redevelopment areas that are also in flood hazard areas. Results can provide information on how and where to grow in the future.

GIS was used to determine the number of parcels in the 1% and 0.2% annual chance flood events within the three future development/redevelopment areas. GIS was used to create a centroid, or point representing the center of the parcel polygon. Those parcels centroids that fall inside the future development areas and that were within the 1% annual chance flood event or the 0.2% annual chance flood events were selected and tabulated in Figure 4-54 and shown in Table 4-54 and Table 4-55. Note that because the Dutra McNair Quarry falls outside of the City limits, parcel and assessor data was unavailable for this analysis.

Figure 4-54 San Rafael – DFIRM and Future Development/Redevelopment Areas

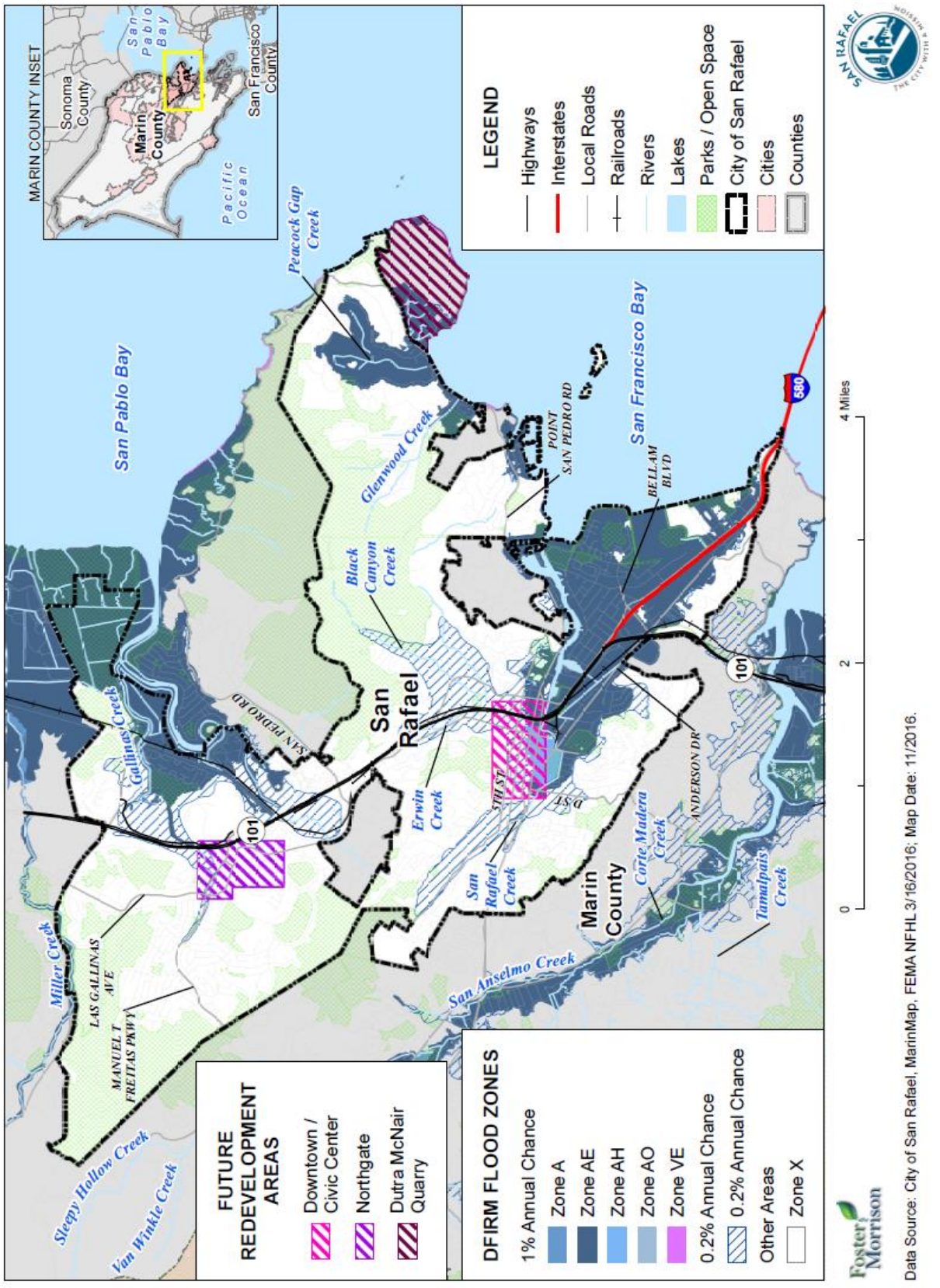


Table 4-54 City of San Rafael – Future Development/Redevelopment in FEMA DFIRM Flood Zones by Location, Property Use, Parcels, and Acres

Flood Zone	Property Use	Total Parcel Count	Imp. Parcel Count	Total Acres	Flood Zone	Property Use	Total Parcel Count	Imp. Parcel Count	Total Acres	Flood Zone	Property Use	Total Parcel Count	Imp. Parcel Count	Total Acres
Downtown / Civic Center					**Northgate**					**Dutra McNair Quarry**				
1% Annual Chance Flood					**1% Annual Chance Flood**					**1% Annual Chance Flood**				
Zone AE	Commercial	25	23	6	Zone AE	Commercial	0	0	0	Zone AE	Commercial	0	0	0
	Exempt	6	2	1		Exempt	0	0	0		Exempt	0	0	0
	Residential	27	25	3		Residential	0	0	0		Residential	0	0	0
	Total	**58**	**50**	**10**		**Total**	**0**	**0**	**0**		**Total**	**0**	**0**	**0**
Zone AH	Commercial	55	50	18	Zone AH	Commercial	0	0	0	Zone AH	Commercial	0	0	0
	Exempt	11	2	4		Exempt	0	0	0		Exempt	0	0	0
	Residential	28	28	4		Residential	0	0	0		Residential	0	0	0
	Total	**94**	**80**	**26**		**Total**	**0**	**0**	**0**		**Total**	**0**	**0**	**0**
1% Annual Chance Flood Grand Total		**152**	**130**	**36**	**1% Annual Chance Flood Grand Total**		**0**	**0**	**0**	**1% Annual Chance Flood Grand Total**		**0**	**0**	**0**
0.2% Annual Chance Flood					**0.2% Annual Chance Flood**					**0.2% Annual Chance Flood**				
Zone X (shaded)	Commercial	198	181	38	Zone X (shaded)	Commercial	2	2	7	Zone X (shaded)	Commercial	0	0	0
	Exempt	40	12	9		Exempt	1	0	0		Exempt	0	0	0
	Residential	93	87	14		Residential	3	3	0		Residential	0	0	0
	Total	**331**	**280**	**61**		**Total**	**6**	**5**	**8**		**Total**	**0**	**0**	**0**
Other Areas					**Other Areas**					**Other Areas**				
Zone X	Commercial	48	44	11	Zone X	Commercial	41	37	93	Zone X	Commercial	0	0	0
	Exempt	14	6	9		Exempt	5	2	5		Exempt	0	0	0
	Residential	131	127	13		Residential	89	84	25		Residential	0	0	0
	Total	**193**	**177**	**34**		**Total**	**135**	**123**	**123**		**Total**	**0**	**0**	**0**

Source: City of San Rafael GIS; FEMA DFIRM 3/16/2016

Table 4-55 San Rafael – Total Future Development/Redevelopment in DFIRM Flood Zones by Property Use, Parcels, and Acres

Flood Zone	Property Use	Total Parcel Count	Improved Parcel Count	Total Acres
1% Annual Chance Flood				
Zone AE	Commercial	25	23	6
	Exempt	6	2	1
	Residential	27	25	3
	Total AE	**58**	**50**	**10**
Zone AH	Commercial	55	50	18

Flood Zone	Property Use	Total Parcel Count	Improved Parcel Count	Total Acres
	Exempt	11	2	4
	Residential	28	28	4
	Total AH	**94**	**80**	**26**
1% Annual Chance Flood Grand Total		**152**	**130**	**36**
0.2% Annual Chance Flood				
Zone X (shaded)	Commercial	200	183	46
	Exempt	41	12	9
	Residential	96	90	14
0.2% Annual Chance Flood Grand Total		**337**	**285**	**69**
Other Areas				
Zone X	Commercial	89	81	104
	Exempt	19	8	15
	Residential	220	211	38
Other Areas Grand Total		**328**	**300**	**158**

Source: City of San Rafael GIS; FEMA DFIRM 3/16/2016

ARkStorm Scenario

Although much attention in California's focuses on the "Big One" as a high magnitude earthquake, there is the risk of another significant event in California – a massive, statewide winter storm. The last such storms occurred in the 19th century, outside the memory of current emergency managers, officials, and communities. However, massive storms are a recurring feature of the state, the source of rare but inevitable disasters. The USGS Multi Hazards Demonstration Project's (MHDP) developed a product called ARkStorm, which addressed massive U.S. West Coast storms analogous to those that devastated California in 1861-1862. Over the last decade, scientists have determined that the largest storms in California are the product of phenomena called Atmospheric Rivers, and so the MHDP storm scenario is called the ARkStorm, for Atmospheric River 1000 (a measure of the storm's size).

Scientific studies of offshore deposits in northern and southern California indicate that storms of this magnitude and larger have occurred about as often as large earthquakes on the southern San Andreas Fault. Such storms are projected to become more frequent and intense as a result of climate change. This scientific effort resulted in a plausible flood hazard scenario to be used as a planning and preparation tool by hazard mitigation and emergency response agencies.

For the ARkStorm Scenario, experts designed a large, scientifically realistic meteorological event followed by an examination of the secondary hazards (e.g., landslides and flooding), physical damages to the intense winter storms of 1861-62 that left California's Central Valley impassible. Storms far larger than the ARkStorm, dubbed megastorms, have also hit California at least six times in the last two millennia.

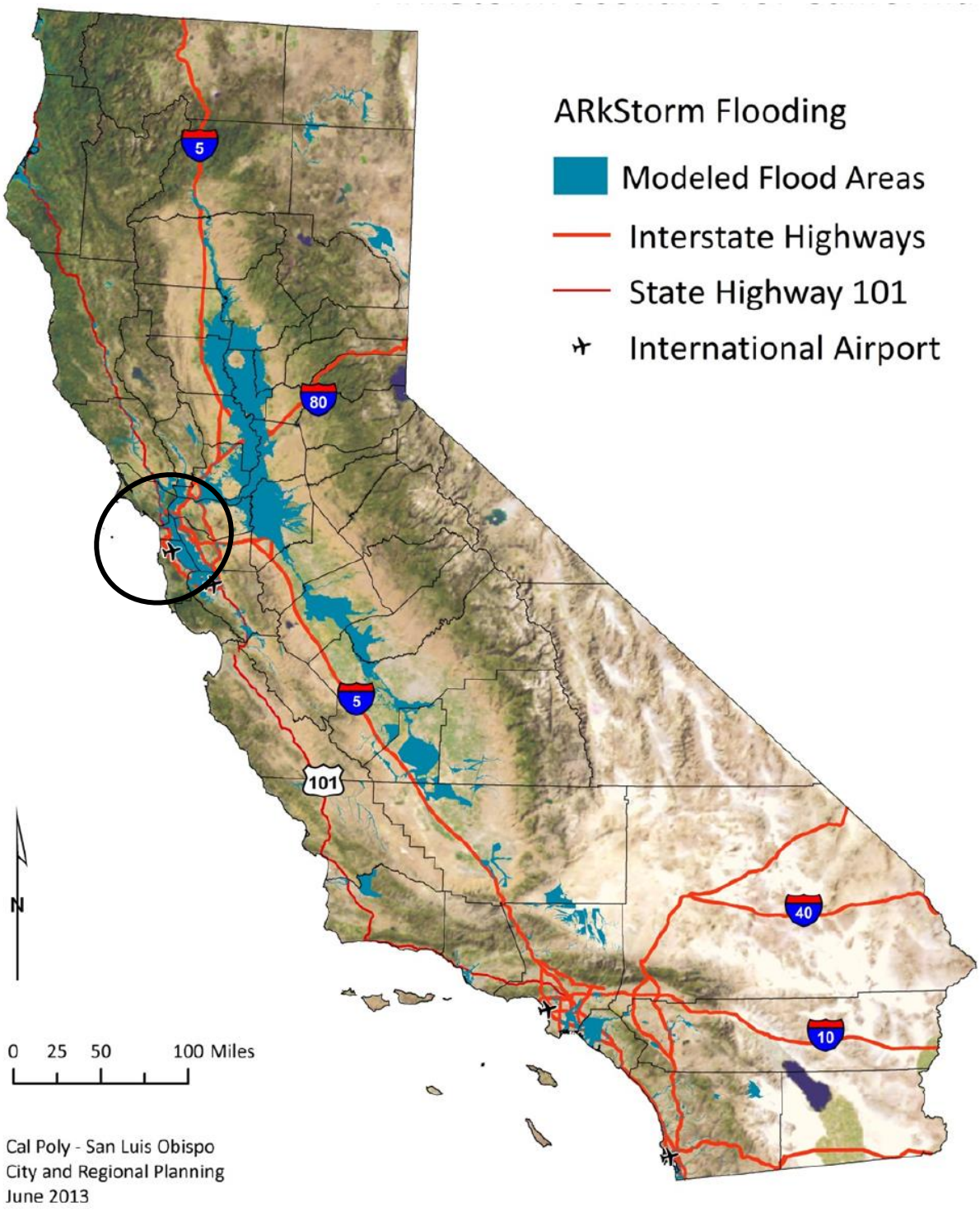
The ARkStorm produces precipitation in many places exceeding levels experienced on average every 500 to 1,000 years. Extensive flooding in many cases overwhelms the state's flood protection system, which is

at best designed to resist 100- to 200-year runoffs (many flood protection systems in the state were designed for much smaller runoff events). The Central Valley experiences widespread flooding. Serious flooding also occurs in Orange County, Los Angeles County, San Diego, the San Francisco Bay Area, and other coastal communities. In some places, winds reach hurricane speeds, as high as 125 miles per hour. Hundreds of landslides occur, damaging roads, highways, and homes. Property damage exceeds $300 billion, most of it from flooding. Agricultural losses and other costs to repair lifelines, dewater flooded islands, and repair damage from landslides brings the total direct property loss to nearly $400 billion, of which only $20 to $30 billion would be recoverable through public and commercial insurance. Power, water, sewer, and other lifelines experience damage that takes weeks or months to restore. Flooding evacuation could involve over one million residents in the inland region and Delta counties.

A storm of ARkStorm's magnitude has important implications: 1) it raises serious questions about the ability of existing national, state, and local disaster policy to handle an event of this magnitude; 2) it emphasizes the choice between paying now to mitigate, or paying a lot more later to recover; 3) innovative financing solutions are likely to be needed to avoid fiscal crisis and adequately fund response and recovery costs; 4) responders and government managers at all levels should be encouraged to conduct self-assessments and devise table-top exercises to exercise their ability to address a similar event; 5) the scenario can be a reference point for application of FEMA and Cal OES guidance connecting federal, state, and local natural hazards mapping and mitigation planning under the NFIP and Disaster Mitigation Act of 2000; and 6) common messages to educate the public about the risk of such an extreme event could be developed and consistently communicated to facilitate policy formulation and transformation.

Figure 4-55 depicts an ARkStorm modeled scenario showing the potential for flooding in the Central Valley as the result of a large storm. The modeled scenario suggests that San Rafael could face inundation.

Figure 4-55 Projected ARkStorm Flooding in California



Source: USGS ArkStorm

4.3.9. Flood: Localized Stormwater Flooding Vulnerability Assessment

Likelihood of Future Occurrence—Highly likely
Vulnerability—Medium

Historically, the City has been at risk to flooding primarily during the spring months when river systems in the City swell with heavy rainfall. Localized flooding also occurs throughout the City at various times throughout the year.

Stormwater has the potential to damage public infrastructure and private property in all areas of the City. The most severe damage typically occurs when warm heavy rain falls on previously saturated ground. These storm events bring a higher than normal flow of water that can exceed the capacity of ditches and channels. The flooding can be more intense and problematic in areas with steep slopes where the water is more likely to carry heavy silt and rocks, filling rains and plugging culverts.

Mean annual rainfall in the City ranges from 18 inches at Pt. San Pedro to 40 inches along the highest elevations on Southern Heights Ridge, towards the southwestern corner of the San Rafael Creek Watershed. Orographic influences associated with Mt. Tamalpais are responsible for the elevated rainfall totals in the southwestern portion of the City. Most of the rainfall occurs during the wet winter season, which typically extends from November to March. Significant runoff events occur in response to prolonged rainfall of two or three days' duration, punctuated by short periods of intense nested rainfall.

Figure 4-56 depicts areas of localized flooding concerns to the City of San Rafael. Table 4-56 lists roads that have experienced localized flooding and related events. The flooding events on these roads triggered debris removal (at a minimum) with most requiring more extensive maintenance. Typically, debris removal and associated issues routinely included downed trees, heavy mud, pavement deterioration and washouts.

Figure 4-56 San Rafael – Localized Flooding Areas of Concern

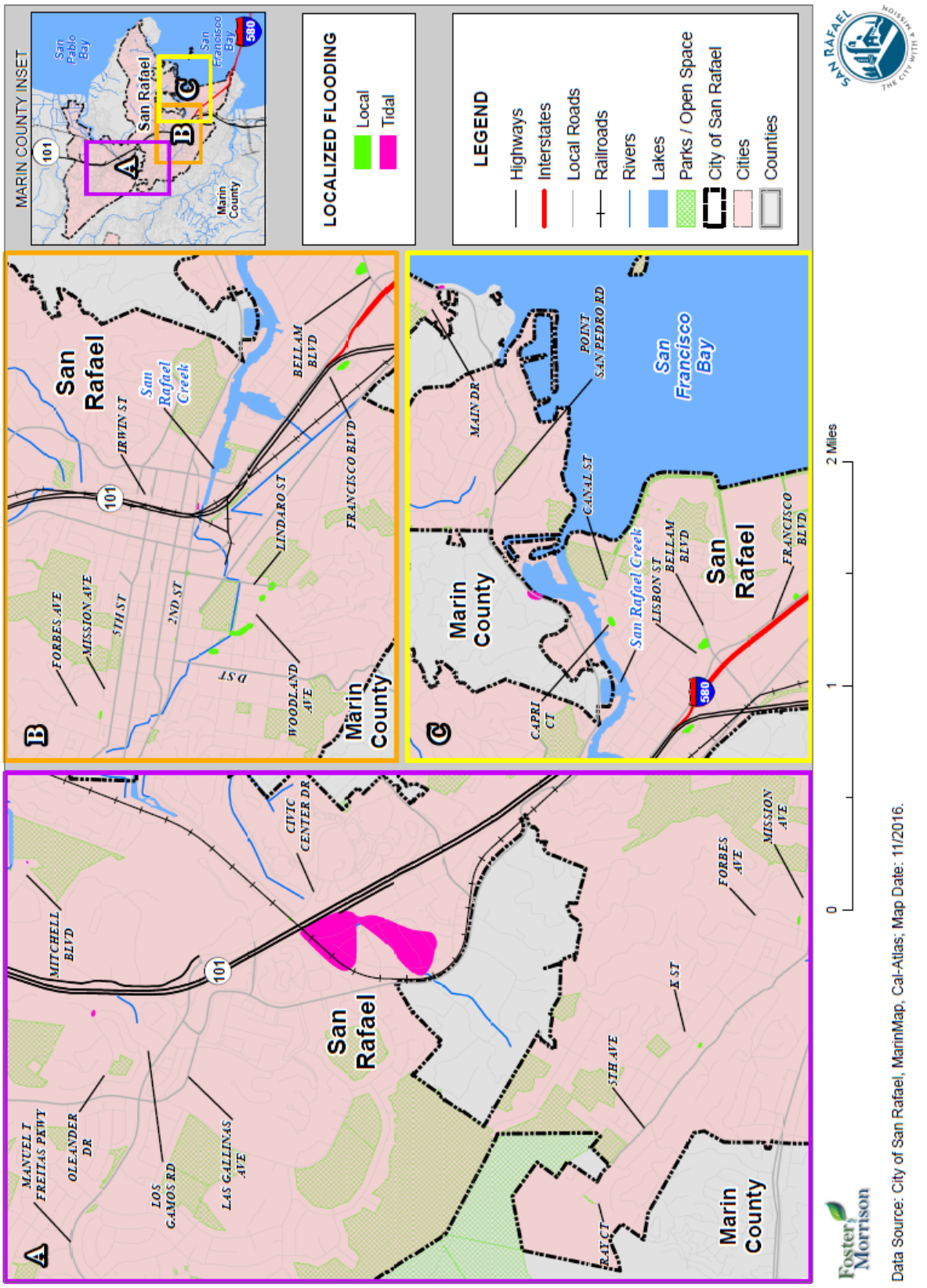


Table 4-56 San Rafael – Localized Flooding Areas

Location	Flooding Type	A	B	C
2nd near C St	Local			
2nd St and Lindaro St	Local			
B St and Woodland Ave	Local			
C St and Treanor St	Local			
Canal St and Capri Ct	Local			
Civic Center Dr and SMART Crossing	Local			
End of Mitchell Blvd	Tidal			
Francisco Blvd E between Castro Ave and Irene St	Local			
Francisco Blvd E between Irene St and Shoreline Pkwy	Local			
Francisco Blvd W near 101 Ramp	Local			
Irwin St and 2nd St	Tidal			
K St between Center St and 5th Ave	Local			
Lindaro St and Woodland Ave	Local			
Lisbon St and Bellam Blvd	Local			
Los Gamos Rd and Oleander Dr	Tidal			
Merrydale Rd and Las Gallinas Ave (center of large area)	Tidal			
Mission Ave and Forbes Ave	Local			
Point San Pedro Rd north of Main Dr	Tidal			
Point San Pedro Rd south of Main Dr	Tidal			
Point San Pedro Rd west of Summit Ave	Tidal			
Ray Ct near 5th Ave	Local			
Woodland Ave and Mariposa Rd	Local			

Source: City of San Rafael

Future Development/Redevlopment

The risk of stormwater/localized flooding to future development can be minimized by accurate recordkeeping of repetitive localized storm activity. Mitigating the root causes of the localized stormwater or choosing not to develop in areas that often are subject to localized flooding will reduce future risks of losses due to stormwater/localized flooding.

The potential for flooding may increase as storm water is channelized due to land development. Such changes can create localized flooding problems in and outside of natural floodplains by altering or confining natural drainage channels. Floodplain modeling and master planning should be based on the ultimate built-out land use in order to assure that all new development remains safe from future hydrologic conditions. While local floodplain management, stormwater management, and water quality regulations and policies address these changes on a site-by-site basis, their cumulative effects can result in floodplain impacts regardless. Additional growth and redevelopment in the City could contribute to increased localized flooding.

4.3.10. Landslide, Mudslides, Hillside Erosion, and Debris Flows Vulnerability Assessment

Likelihood of Future Occurrence—Likely
Vulnerability—Medium

Destructive landslides, mudslides, and debris flows usually occur very suddenly with little or no warning time and are short in duration. Slides have caused significant damage or destroyed homes, streets, and utilities from their heaving soils and slow downslope development.

Landslide risk is high in the coastal regions of California, which is home to much of the state's population industry, and infrastructure. Particularly hazardous terrain lies where weak rock layers are inclined in the same direction as the mountain slope which is found in many areas of California. The Franciscan Formation, which makes up much of the Northern California Coast Ranges, contains weak rock and that is both easily eroded and landslide prone. Because past decades of development have been continuing to spread into mountainous terrain where hazard exposure is high, most reported landslide losses occur in these regions, as illustrated in the cumulative landslide occurrences resulting from the 1995 El Nino winter storms.

CITY PLANNING TEAM – AREAS OF THE CITY THAT YOU HAVE CONCERNS ABOUT? AREAS OF SPECIFIC RISK/ PAST OCCURENCES, ETC?

The 2020 General Plan Background report noted issues with erosion in the City as well:

> *Sandy soils on moderate slopes or clayey soils on steep slopes are susceptible to erosion when exposed to concentrated surface water flow. The potential for erosion is increased when established vegetation is disturbed or removed. Within the valley areas, streams and river flow erodes the banks and causes the location of the stream or river to meander. The erosion undercuts the stream banks and leads o slope instability. The natural erosion and stream meander can undermine structures or roadways and cause damage or collapse. The potential for erosion damage is limited to localized areas.*

Values at Risk

Marin County's 2016 parcel layer and Assessor's data, extracted from Marin Map were used as the basis for the city inventory of parcels, values, and acres. Marin County has a landslide susceptibility areas dataset dated September 22, 1999 from the USGS which was utilized to perform the analysis. In some cases, there are parcels in multiple landslide susceptibility areas. GIS was used to create a centroid, or point representing the center of the parcel polygon. The landslide susceptibility areas GIS layer was then overlaid on the parcel layer. For the purposes of this analysis, the area that intersected a parcel centroid was assigned the susceptibility rating for the entire parcel. The parcels were segregated and analyzed in this fashion for the City of San Rafael. Once completed, the parcel boundary layer was joined to the centroid layer and values were transferred based on the identification number in the Assessors database and the GIS parcel layer. This is shown in Figure 4-57. Table 4-57 illustrates the estimated damages to the City that would be sustained from landslides, by property use and landslide risk.

Figure 4-57 San Rafael – Landslide Susceptibility Areas

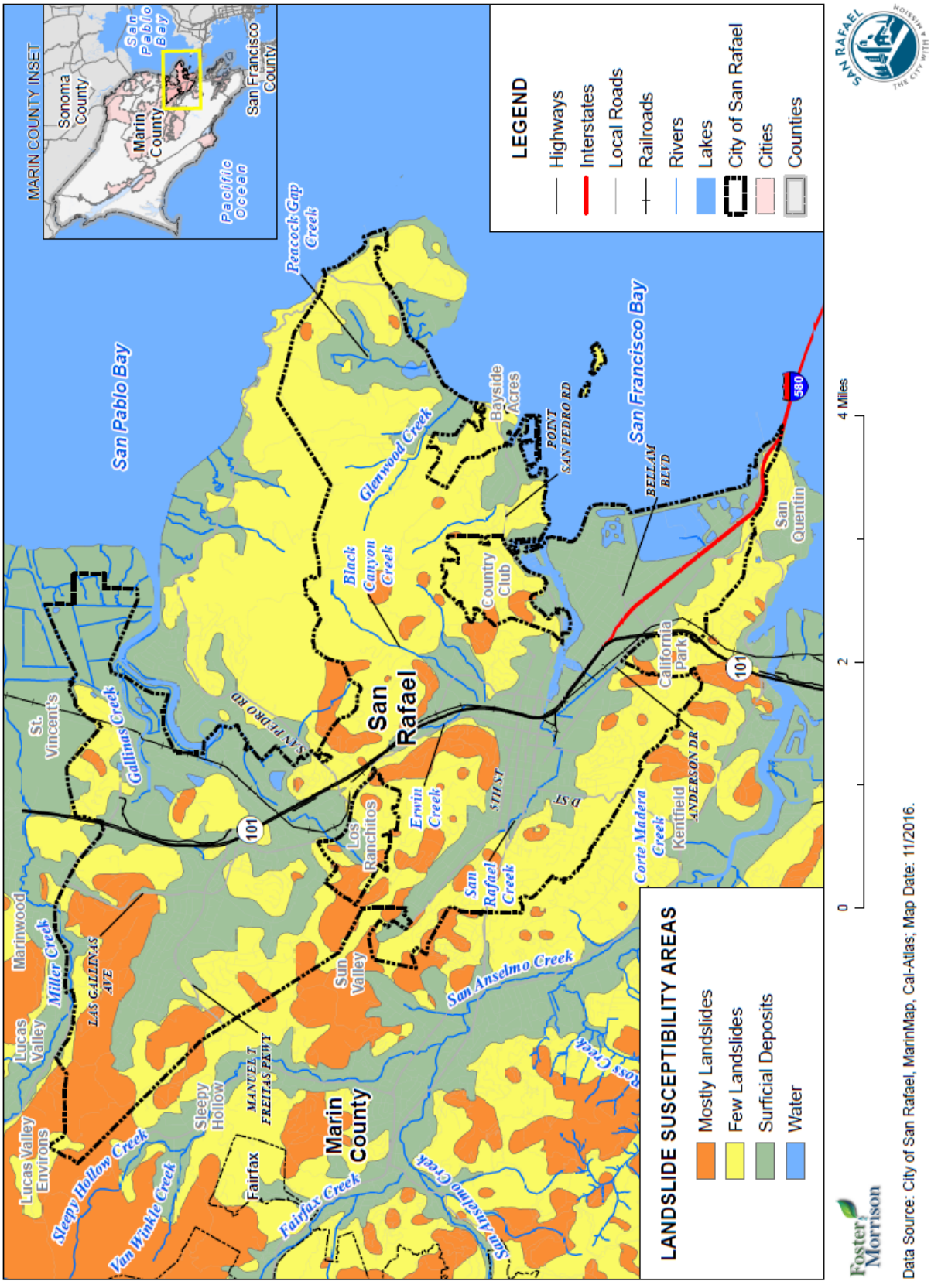


Table 4-57 San Rafael – Parcel Counts and Values at Risk to Landslide by Susceptibility Areas and Property Use

Property Use	Total Parcel Count	Improved Parcel Count	Total Land Value	Improved Structure Value	Estimated Contents Value	Total Value*	% of Total Parcel Count
Mostly Landslide							
Agricultural	0	0	$0	$0	$0	$0	0.0%
Commercial	11	9	$3,813,995	$3,649,299	$3,649,299	$11,112,593	0.6%
Exempt	53	7	$1,217,360	$2,232,503	$2,232,503	$5,682,366	0.4%
Industrial	0	0	$0	$0	$0	$0	0.0%
Residential	1,716	1,620	$471,103,539	$465,021,065	$232,510,533	$1,168,635,137	99.0%
Total	**1,780**	**1,636**	**$476,134,894**	**$470,902,867**	**$238,392,335**	**$1,185,430,096**	**100.0%**
Few Landslides							
Agricultural	0	0	$0	$0	$0	$0	0.0%
Commercial	108	91	$90,769,795	$199,818,924	$199,818,924	$490,407,643	1.5%
Exempt	205	34	$21,583,560	$132,577,290	$132,577,290	$286,738,140	0.5%
Industrial	1	1	$649,155	$908,817	$1,363,226	$2,921,198	0.0%
Residential	6,341	6,058	$1,947,375,725	$2,088,486,402	$1,044,243,201	$5,080,105,328	98.0%
Total	**6,655**	**6,184**	**$2,060,378,235**	**$2,421,791,433**	**$1,378,002,641**	**$5,860,172,309**	**100.0%**
Surficial Deposits							
Agricultural	1	0	$1	$0	$0	$1	0.0%
Commercial	1,019	913	$698,903,201	$1,227,034,470	$1,227,034,470	$3,152,972,141	10.8%
Exempt	487	120	$75,688,823	$263,192,882	$263,192,882	$602,074,587	1.4%
Industrial	273	248	$121,191,336	$144,432,358	$216,648,537	$482,272,231	2.9%
Residential	7,386	7,205	$1,967,450,505	$2,064,513,262	$1,032,256,631	$5,064,220,398	84.9%
Total	**9,166**	**8,486**	**$2,863,233,866**	**$3,699,172,972**	**$2,739,132,520**	**$9,301,539,358**	**100.0%**
Water							
Agricultural	0	0	$0	$0	$0	$0	0.0%
Commercial	57	48	$46,633,121	$80,966,975	$80,966,975	$208,567,071	33.1%
Exempt	26	1	$386,710	$657,985	$657,985	$1,702,680	0.7%
Industrial	1	1	$720,000	$880,000	$1,320,000	$2,920,000	0.7%
Residential	111	95	$24,868,940	$31,862,373	$15,931,187	$72,662,500	65.5%
Total	**195**	**145**	**$72,608,771**	**$114,367,333**	**$98,876,147**	**$285,852,251**	**100.0%**

Source: Marin Map, Marin County 2016 Parcel/Assessor's Data

It should be noted that maps represent best available data. There have been past occurrences of landslides in areas not shown to be at risk to landslide. Generally, landslide risk maps detail areas prone to slope failure; the maps rarely include the runout areas where the failed slope will go. By way of example, a landslide on March 22, 2014, killed 43 people when it wiped out a rural neighborhood in Oso, northeast of

Seattle. While the failed slope area was mapped as prone to landslides, the runout area was not. It was the runout area that resulted in devastating loss. Thus, mapping of landslide susceptible areas should be considered as one part of the equation. Damages to the area that could be inundated by such slope failure should also be considered by communities.

Populations at Risk

Those residential parcel centroids that intersect the landslide risk zones were counted and multiplied by the 2010 Census Bureau average household factors for San Rafael (2.44). This is shown in Table 4-58.

Table 4-58 San Rafael – Count of Improved Residential Parcels and Population by Landslide Susceptibility Areas

Landslide Susceptibility	Improved Residential Parcels	Population*
Mostly Landslide	1,620	3,953
Few Landslides	6,058	14,782
Surficial Deposits	7,205	17,580
Water	95	232

Source: Marin Map, Marin County 2016 Parcel/Assessor's Data

Cultural and Natural Resources at Risk

ARE THERE ANY CULTURAL/NATURAL RESOURCES AT RISK TO THIS HAZARD?

Critical Facilities at Risk

An analysis was performed on the critical facility inventory in San Rafael in identified landslide susceptibility areas. GIS was used to determine whether the facility locations intersects a landslide area, and if so, which area it intersects. Details of critical facilities by landslide zone for the City of San Rafael are shown in Figure 4-58 and Table 4-63. Details of critical facility definition, type, name and address and jurisdiction by landslide susceptibility area are listed in Appendix E.

Figure 4-58 San Rafael – Critical Facilities in Landslide Susceptibility Areas

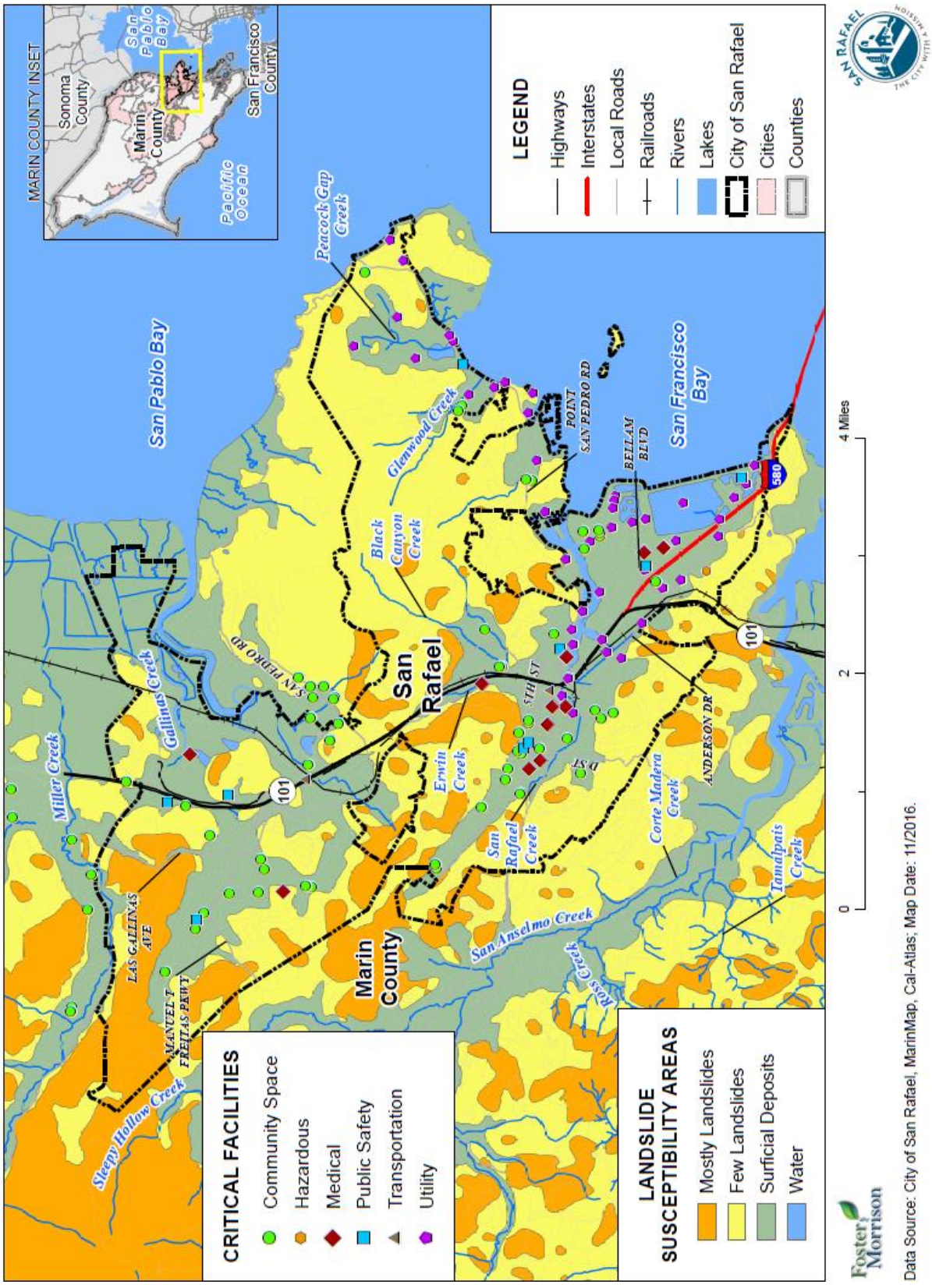


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Table 4-59 San Rafael – Critical Facilities in Landslide Susceptibility Areas

Location/ Facility Type	Facility Count by Landslide Susceptibility Areas				
	Mostly Landslides	Few Landslides	Surficial Deposits	Water	Total
San Rafael					
Community Space	1	6	44	0	**51**
Hazardous	0	0	1	0	**1**
Medical	0	1	11	0	**12**
Public Safety	0	1	8	0	**9**
Transportation	0	0	2	0	**2**
Utility	0	1	47	5	**53**
Total	**1**	**9**	**113**	**5**	**128**
Adjacent to San Rafael					
Community Space	0	3	11	0	14
Hazardous	0	0	0	0	0
Medical	0	0	0	0	0
Public Safety	0	0	0	0	0
Transportation	0	0	0	0	0
Utility	0	1	1	1	3
Total	**0**	**4**	**12**	**1**	**17**
San Rafael Totals					
Community Space	1	9	55	0	**65**
Hazardous	0	0	1	0	**1**
Medical	0	1	11	0	**12**
Public Safety	0	1	8	0	**9**
Transportation	0	0	2	0	**2**
Utility	0	2	48	6	**56**
Grand Total	**1**	**13**	**125**	**6**	**145**

Source: City of San Rafael GIS; Marin Map Landslide Layer

Overall Community Impact

The overall impact to the community from landslides, mudslides, hillside erosion, and debris flows include:

- Commercial and residential structural and property damage;
- Damage to roads/bridges resulting in loss of mobility;
- Damage to natural resource habitats and other resources, such as timber and rangeland;
- Disruption of and damage to public infrastructure and services;

- Loss of water, power, roads, phones, and transportation, which could impact, strand, and/or impair mobility for emergency responders and/or area residents;
- Economic losses (jobs, sales, tax revenue) associated with loss of commercial structures;
- Loss of churches, which could severely impact the social fabric of the community;
- Loss of schools, which could severely impact the entire school system and disrupt families and teachers, as temporary facilities and relocations would likely be needed;
- Impact on the overall mental health of the community; and
- Injury and loss of life;
- Negative impact on commercial and residential property values.

Future Development/Redevelopment

Future development/redevelopment areas for the City are broken out into three primary areas. GIS data is maintained by San Rafael, and was made available for this plan. An analysis was performed to quantify parcels within these redevelopment areas that are also in landslide susceptibility areas. Results can provide information on how and where to grow in the future.

GIS was used to determine the number of parcels in the landslide areas within the three future development/redevelopment areas. GIS was used to create a centroid, or point representing the center of the parcel polygon. Those parcels centroids that fall inside the future development areas and that were within the landslide areas were selected and tabulated in Figure 4-59 and shown in Table 4-60 and Table 4-61. Note that because the Dutra McNair Quarry falls outside of the City limits, parcel and assessor data was unavailable for this analysis.

Figure 4-59 San Rafael –Future Development/Redevelopment Areas and Landslide Susceptibility Areas

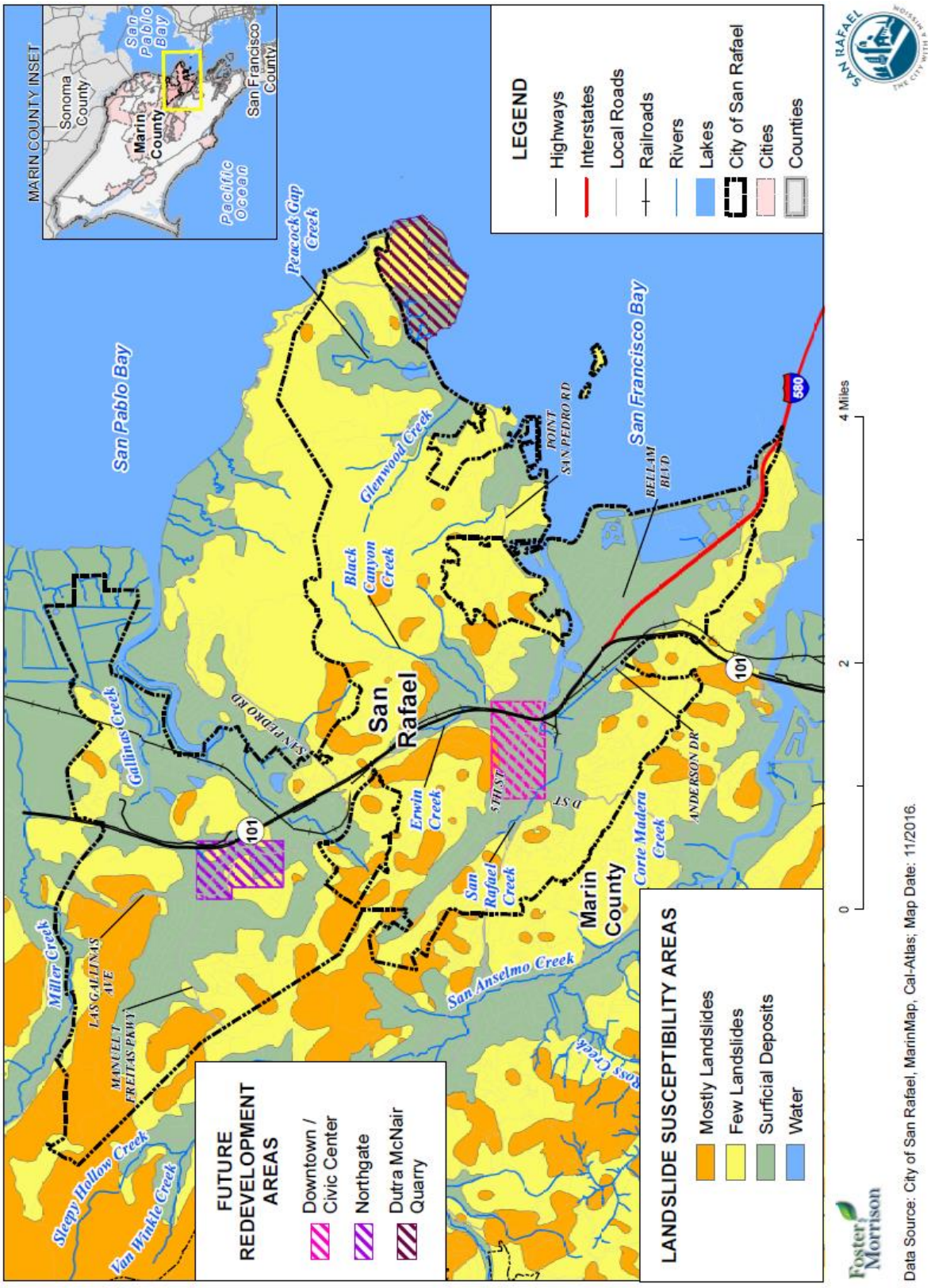


Table 4-60 San Rafael – Future Development/Redevelopment in Landslide Susceptibility Areas by Location, Property Use, Parcels, and Acres

Property Use	Total Parcel Count	Improved Parcel Count	Total Acres	Property Use	Total Parcel Count	Improved Parcel Count	Total Acres	Property Use	Total Parcel Count	Improved Parcel Count	Total Acres
Downtown / Civic Center				**Northgate**				**Dutra McNair Quarry**			
Mostly Landslide				**Mostly Landslide**				**Mostly Landslide**			
Commercial	0	0	0	Commercial	0	0	0	Commercial	0	0	0
Exempt	1	1	0	Exempt	0	0	0	Exempt	0	0	0
Residential	54	53	6	Residential	0	0	0	Residential	0	0	0
Total	**55**	**54**	**6**	**Total**	**0**	**0**	**0**	**Total**	**0**	**0**	**0**
Few Landslides				**Few Landslides**				**Few Landslides**			
Commercial	0	0	0	Commercial	9	7	29	Commercial	0	0	0
Exempt	0	0	0	Exempt	0	0	0	Exempt	0	0	0
Residential	4	4	1	Residential	32	30	11	Residential	0	0	0
Total	**4**	**4**	**1**	**Total**	**41**	**37**	**40**	**Total**	**0**	**0**	**0**
Surficial Deposits				**Surficial Deposits**				**Surficial Deposits**			
Commercial	326	298	74	Commercial	34	32	71	Commercial	0	0	0
Exempt	70	21	24	Exempt	6	2	6	Exempt	0	0	0
Residential	221	210	27	Residential	60	57	15	Residential	0	0	0
Total	**617**	**529**	**125**	**Total**	**100**	**91**	**92**	**Total**	**0**	**0**	**0**

Source: City of San Rafael GIS; Marin Map Landslide Layer

Table 4-61 San Rafael – Total Future Development/Redevelopment in Landslide Susceptibility Areas by Property Use, Parcels, and Acres

Property Use	Total Parcel Count	Improved Parcel Count	Total Acres
Mostly Landslide			
Commercial	0	0	0
Exempt	1	1	0
Residential	54	53	6
Total	**55**	**54**	**6**
Few Landslides			
Commercial	9	7	29
Exempt	0	0	0
Residential	36	34	12
Total	**45**	**41**	**41**
Surficial Deposits			
Commercial	360	330	145

Property Use	Total Parcel Count	Improved Parcel Count	Total Acres
Exempt	76	23	29
Residential	281	267	42
Total	**717**	**620**	**216**

Source: City of San Rafael GIS; Marin Map Landslide Layer

4.3.11. Levee Failure Vulnerability Assessment

Likelihood of Future Occurrence—Occasional
Vulnerability—Medium

Levee failure flooding can occur as the result of partial or complete collapse of an impoundment, and often results from prolonged rainfall and flooding. The primary danger associated with dam or levee failure is the high velocity flooding of those properties downstream of the breach.

A levee failure can range from a small, uncontrolled release to a catastrophic failure. Vulnerability to levee failures is generally confined to the areas subject to inundation downstream of the facility. Secondary losses would include loss of the multi-use functions of the facility and associated revenues that accompany those functions.

Levee failure flooding would vary in the City depending on which structure fails and the nature and extent of the failure and associated flooding. This flooding presents a threat to life and property, including buildings, their contents, and their use. Large flood events can affect lifeline utilities (e.g., water, sewerage, and power), transportation, jobs, tourism, the environment, agricultural industry, and the local and regional economies. In San Rafael, these can come as both riverine and tidal flooding.

There are numerous levee systems in San Rafael. These were shown on Figure 4-33. The 2016 Marin County FIS noted that approximately 6,500 feet of levee may be vulnerable to wave overtopping in the City of San Rafael. The FIS also noted that:

> *The levee has varying sections and side slopes. Outside levee slopes vary from approximately 3:1 to 5:1, and wave runup varies from elevation 17 feet NAVD 88 to elevation 14 feet NAVD 88, respectively. Wave runup would overtop the levee over the entire length. The estimated volume of water overtopping the levee would exceed the floodplain volume below an elevation of 9 feet NAVD 88 and the 1-percent annual chance floodplain would fill to an elevation of 9 feet NAVD 88. The low bank elevations along the San Rafael Canal would limit the water surface elevation to the 1-percent annual chance tide elevation.*
>
> *The tidal floodplain within the levee was not considered to be subject to significant wave action. There would be insufficient fetch to develop wind waves of 3 feet or more, and 1-percent annual chance flood depths would generally be insufficient to maintain a significant wave.*
>
> *Areas subject to tidal inundation include all areas lower than the 1-percent annual chance (USACE, 1975), which are not protected by an adequate, maintained levee system.*

However, none of them are accredited by FEMA as providing protection against the 100-year flood. Due to the lack of mapped levee data showing areas served by levees, no GIS analysis could be performed on

leveed areas in the Cinty. But it should be noted that these leveed areas are at risk to overtopping and failure during extreme weather events.

Future Development/Redevelopment

CITY/PLANNING TEAM – WHAT IS HAPPENING IN THESE AREAS IN TERMS OF DEVELOPMENT WITHIN THE AREAS PROTECTED BY LEVEES?

4.3.12. Severe Weather: Extreme Heat Vulnerability Assessment

Likelihood of Future Occurrence—Highly Likely
Vulnerability—Medium

Extreme heat happens in San Rafael each year. Limited data on temperature extreme impacts per County was available during the development of this hazard's profile. Extreme heat normally does not impact structures as there may be a limited number of days where the temperatures stay high which gives the structure periodic relief between hot and cool temperature cycles. Areas prone to excessively high temperatures are identified normally on a nation-wide assessment scale, which doesn't allow detailed results on specific structures.

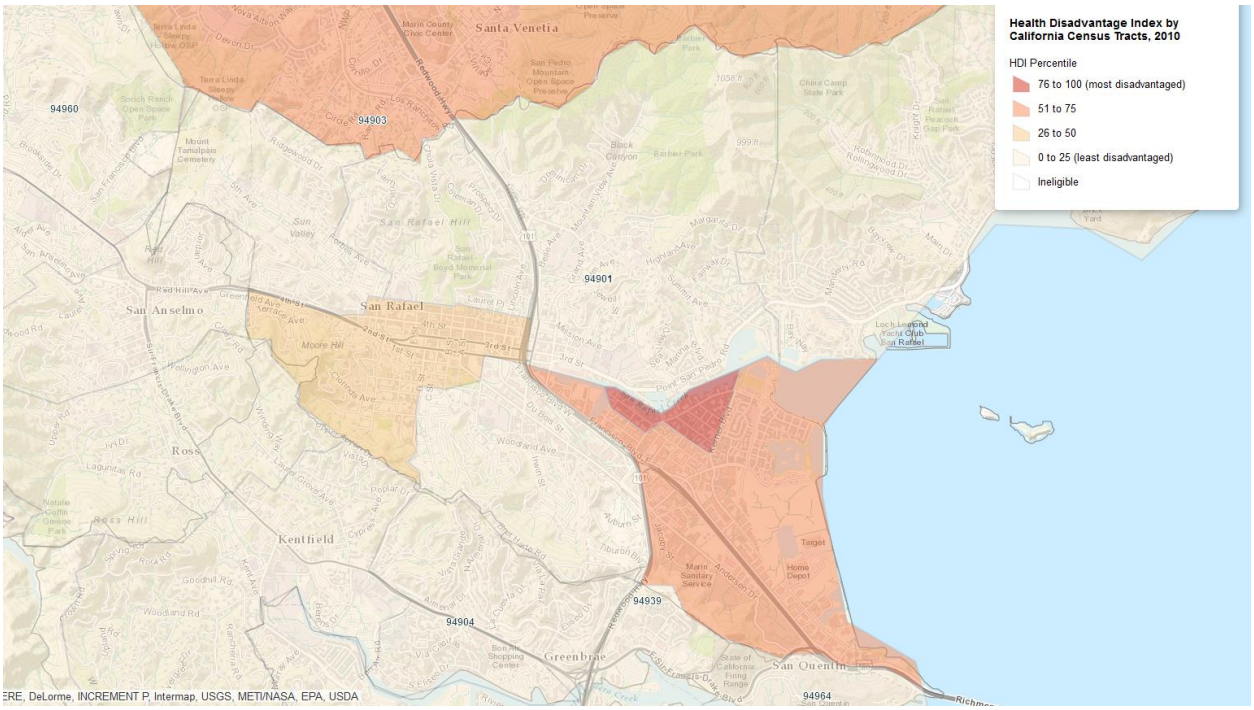
Recent research indicates that the impact of extreme temperatures, particularly on populations, has been historically under-represented. The risks of extreme temperatures are often profiled as part of larger hazards, such as severe winter storms or drought (see Section 4.3.5). However, as temperature variances may occur outside of larger hazards or outside of the expected seasons but still incur large costs, it is important to examine them as stand-alone hazards. Extreme heat may overload demands for electricity to run air conditioners in homes and businesses during prolonged periods of exposure and presents health concerns to individuals outside in the temperatures. Extreme heat may also be a secondary effect of droughts, or may cause drought-like conditions in a temporary setting. For example, several weeks of extreme heat increases evapotranspiration and reduces moisture content in vegetation, leading to higher wildfire vulnerability for that time period even if the rest of the season is relatively moist.

Vulnerable populations to extreme heat include:

- Homeless
- Infants and children under age five
- Elderly (65 and older)
- Individuals with disabilities
- Individuals dependent on medical equipment
- Individuals with impaired mobility

The Public Health Alliance has developed a composite index to identify cumulative health disadvantage in California. Factors such as those bulleted above were combined to show what areas are at greater risk to hazards like extreme heat. This is shown on Figure 4-60.

Figure 4-60 Health Disadvantage Index by California Census Tract



Source: Public Health Alliance of Southern California

In addition to vulnerable populations, pets and livestock are at risk to extreme heat.

CITY PLANNING TEAM – ANY SPECIFICS TO ADD AS TO THOSE CITY ASSETS MOST AT RISK TO EXTREME HEAT?

AND WHAT IS THE CITY DOING TO ADDRESS EXTREME HEAT EVENTS?

Future Development/Redevelopment

As the County shifts in demographics, more residents will become senior citizens. The residents of nursing homes and elder care facilities, as well as elderly individuals who live alone, are especially vulnerable to extreme temperature events. It is encouraged that such facilities generally have emergency plans or backup power to address power failure during times of extreme heat. Low income residents and homeless populations are also vulnerable. Cooling centers for these populations are opened when necessary.

4.3.13. Severe Weather: Heavy Rains and Storms Vulnerability Assessment

Likelihood of Future Occurrence—Highly Likely
Vulnerability—High

According to historical hazard data, severe weather is an annual occurrence in San Rafael. Damage and disaster declarations related to severe weather have occurred and will continue to occur in the future. Heavy rain and thunderstorms are the most frequent type of severe weather occurrences in the City. Wind, hail, and lightning sometimes accompany these storms and have caused damage in the past. However, actual

damage associated with the primary effects of severe weather has been limited in the City. It is the secondary hazards caused by weather, such as floods, mudslides, fire, and agricultural losses that have had the greatest impact. The risk and vulnerability associated with these secondary hazards are discussed in other sections of this plan.

Future Development/Redevelopment

New critical facilities should be built to withstand heavy rains and storms including, and thunderstorm winds. While no damages have occurred to critical facilities in the past due to heavy rains and storms, there still remains future risk. With development occurring in the region, future losses to new development may occur.

4.3.14. Tsunami Vulnerability Assessment

Likelihood of Future Occurrence—Unlikely
Vulnerability—Medium

The phenomenon called "tsunami" is a series of ocean waves of extremely long length generated by undersea earthquakes, volcanic eruptions, or massive undersea landslides. As a tsunami crosses the deep ocean its length from crest to crest may be a hundred miles and its height from trough to crest only a few feet. Tsunamis may reach speeds of 600 miles per hour in deep water. When the tsunami enters shallow coastal waters, its speed decreases and the wave height increases. This creates the large wave that becomes a threat to lives and property. Following the arrival of the first wave, subsequent waves may increase in height and arrive minutes to hours later. The 2004 Indonesian Tsunami caused over 300,000 deaths.

The County of Marin has produced Tsunami Evacuation Planning Maps for the Pacific Coast areas (see next section for the source of this data). The maps are intended to support evacuation planning purposes only and do not necessarily reflect how a tsunami wave may actually impact the mapped areas.

Values at Risk

Analysis was performed using a tsunami inundation layer from Marin Map. Marin Map tsunami data is derived from the University of South California Tsunami Research Center. Using GIS, the parcel layer was overlaid on the tsunami inundation layer. GIS was used to create a centroid, or point representing the center of the parcel polygon. For the purposes of this analysis, the hazard ranking that intersected a parcel centroid was assigned the hazard ranking for the entire parcel. Once completed the parcel centroid layer was joined to the Assessor's database to determine the values of parcels within the tsunami inundation area.

Results are presented by scenario for the City. Figure 4-61 show the areas of tsunami inundation areas in the City. Table 4-62 show total and improved parcel counts; land values, improved structure values and estimated content values (CRVs). CRVs were derived from the improved structure values using the methodology previously described in Section 4.3.1.

Figure 4-61 San Rafael – Tsunami Inundation Areas

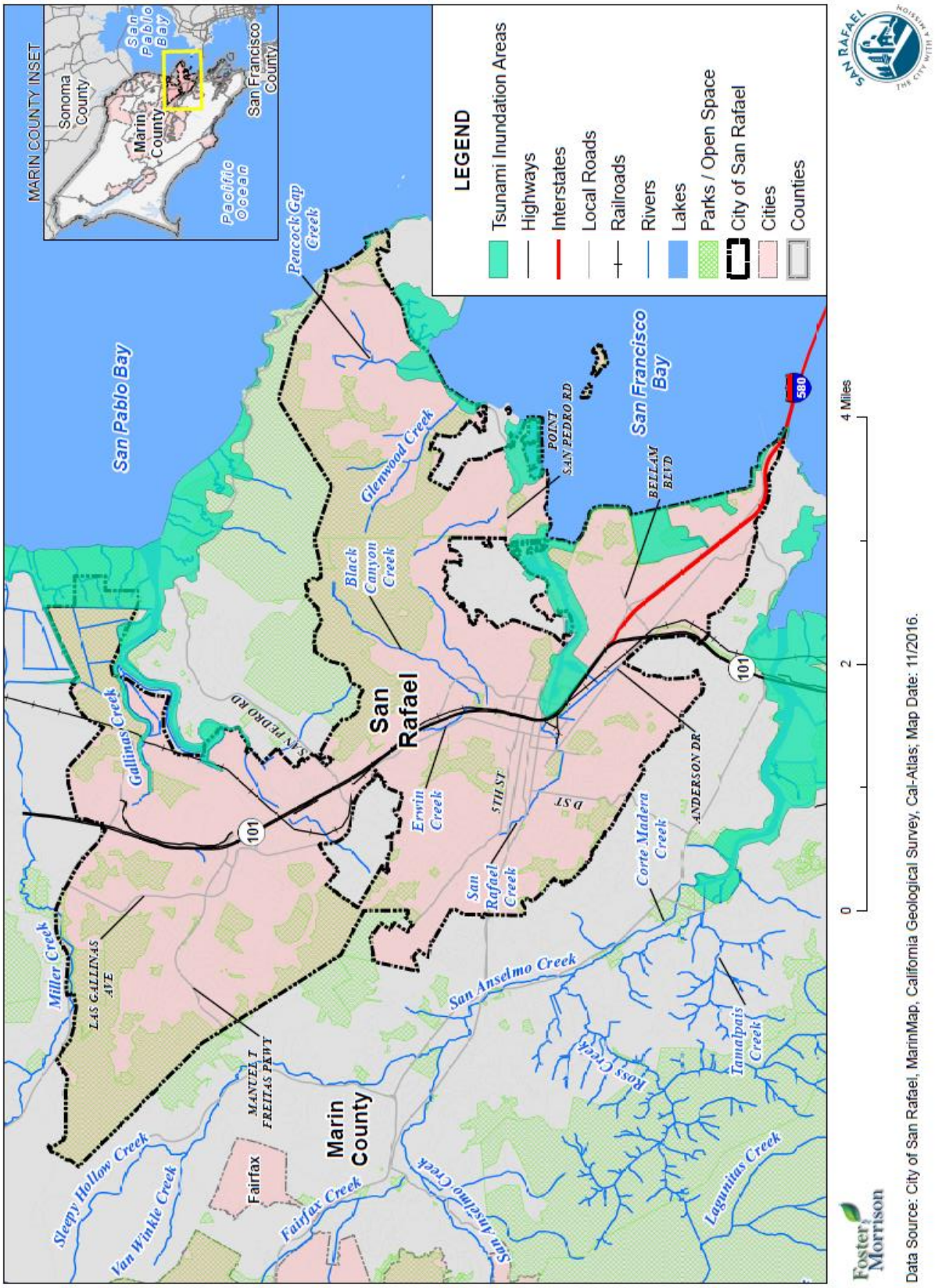


Table 4-62 San Rafael – Parcel Counts and Values by Property Use in Tsunami Inundation Areas

Property Use	Total Parcel Count	Improved Parcel Count	Total Land Value	Improved Structure Value	Estimated Contents Value	Total Value
Agricultural/Open Space	0	0	$0	$0	$0	$0
Commercial	72	59	$54,268,699	$57,861,658	$57,861,658	$169,992,015
Exempt	39	0	$0	$0	$0	$0
Industrial	4	4	$2,091,473	$1,721,456	$2,582,184	$6,395,113
Residential	420	353	$134,680,176	$142,452,163	$71,226,082	$348,358,421
Total	**535**	**416**	**$191,040,348**	**$202,035,277**	**$131,669,924**	**$524,745,549**

Source: Marin Map, California Geological Survey, Marin County 2016 Parcel/Assessor's Data

Population at Risk

The tsunami inundation dataset was overlayed on the parcel layer. Those residential parcel centroids that intersect the inundation area was counted and multiplied by the 2010 Census Bureau average household factors for San Rafael (2.44). This is shown in Table 4-63.

Table 4-63 San Rafael – Count of Improved Residential Parcels and Population by Tsunami Inundation Area

Tsunami Zone	Improved Residential Parcels	Population*
Inundation Area	353	861

Source: City of San Rafael; MarinMap; Marin County Parcel/Assessor's Data 2016

Cultural and Natural Resources at Risk

ARE THERE ANY CULTURAL/NATURAL RESOURCES AT RISK TO THIS HAZARD?

Critical Facilities at Risk

An analysis was performed on the critical facility inventory in San Rafael in the identified tsunami inundation areas. GIS was used to determine whether the facility location is within the tsunami inundation area. Details of critical facilities in the tsunami inundation area for the City of San Rafael are shown in Figure 4-62 and Table 4-64. Details of critical facility definition, type, name and address and jurisdiction by tsunami inundation zone are listed in Appendix E.

Figure 4-62 San Rafael – Critical Facilities in Tsunami Inundation Areas

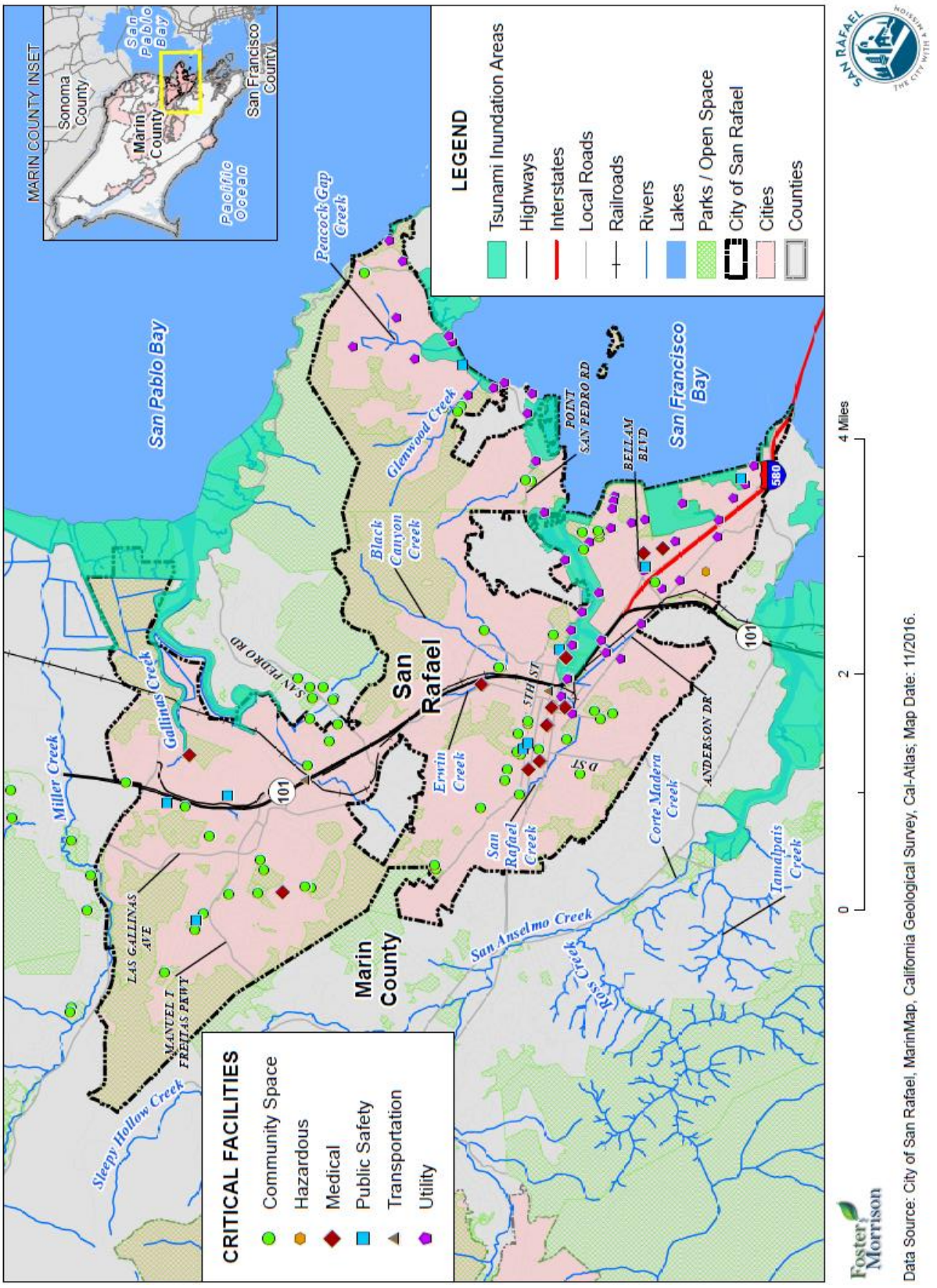


Table 4-64 San Rafael – Critical Facilities in Tsunami Inundation Areas

Location/Facility Type	Facility Count in Tsunami Inundation Area		
	Within	Outside	Total
San Rafael			
Community Space	1	50	**51**
Hazardous	0	1	**1**
Medical	1	11	**12**
Public Safety	0	9	**9**
Transportation	0	2	**2**
Utility	19	34	**53**
Total	**21**	**107**	**128**
Adjacent to San Rafael			
Community Space	0	14	**14**
Hazardous	0	0	**0**
Medical	0	0	**0**
Public Safety	0	0	**0**
Transportation	0	0	**0**
Utility	2	1	**3**
Total	**2**	**15**	**17**
San Rafael Totals			
Community Space	1	64	**65**
Hazardous	0	1	**1**
Medical	1	11	**12**
Public Safety	0	9	**9**
Transportation	0	2	**2**
Utility	21	35	**56**
Total	**23**	**122**	**145**

Source: City of San Rafael GIS; Marin Map Tsunami Inundation Layer

Overall Community Impact

The overall impact to the community from a tsunami includes:

- Injury and loss of life;
- Commercial and residential structural and property damage;
- Damage to natural resource habitats and other resources, such as timber and rangeland;
- Loss of water, power, roads, phones, and transportation, which could impact, strand, and/or impair mobility for emergency responders and/or area residents;
- Economic losses (jobs, sales, tax revenue) associated with loss of commercial structures;
- Negative impact on commercial and residential property values;

- Loss of churches, which could severely impact the social fabric of the community;
- Loss of schools, which could severely impact the entire school system and disrupt families and teachers, as temporary facilities and relocations would likely be needed; and
- Impact on the overall mental health of the community.

Future Development/Redevelopment

Future development/redevelopment areas for the City are broken out into three primary areas: Downtown/Civic Center, Northgate, and Dutra McNair Quarry. GIS data is maintained by San Rafael, and was made available for this plan. An analysis was performed to quantify parcels within these redevelopment areas that are also in tsunami inundation areas. Results can provide information on how and where to grow in the future.

GIS was used to determine the number of parcels in the tsunami areas within the three future development/redevelopment areas. GIS was used to create a centroid, or point representing the center of the parcel polygon. Those parcels centroids that fall inside the future development areas and that were within the tsunami inundation areas were selected and tabulated in Figure 4-63 and shown in Table 4-65. All off the parcels in this analysis that fall in the tsunami inundation zones are in the Downtown/Civic Center area. Note that because the Dutra McNair Quarry falls outside of the City limits, parcel and assessor data was unavailable for this analysis

Figure 4-63 San Rafael – Tsunami Inundation and Future Development/Redevelopment Areas

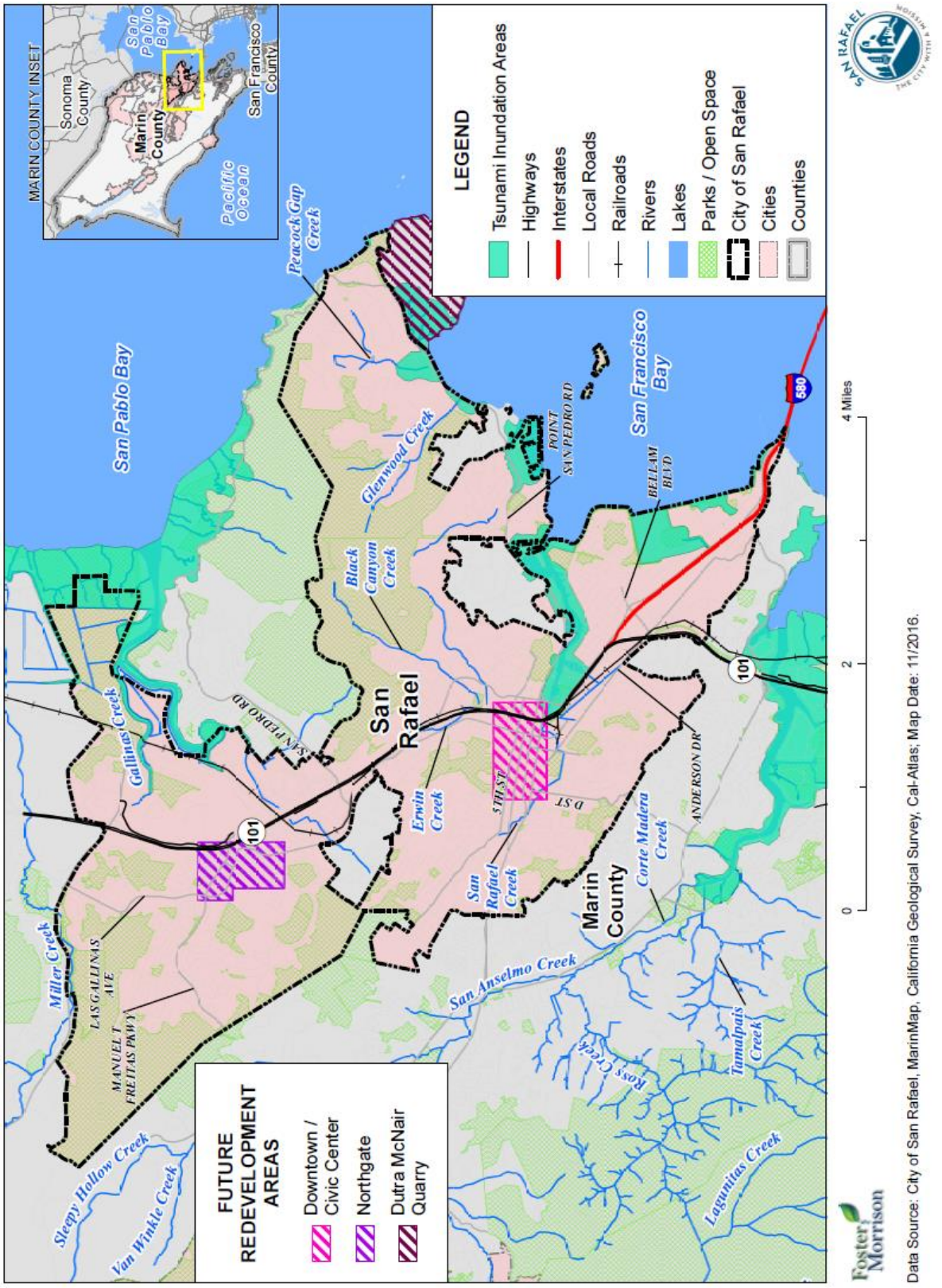


Table 4-65 San Rafael – Future Development/Redevelopment in Tsunami Inundation Areas by Parcels and Acres

Property Use	Total Parcel Count	Improved Parcel Count	Total Acres
Commercial	5	5	3
Exempt	0	0	0
Residential	0	0	0
Total	**5**	**5**	**3**

Source: City of San Rafael GIS; Marin Map Tsunami Inundation Layer

4.3.15. Wildfire Vulnerability Assessment

Likelihood of Future Occurrence—Likely
Vulnerability—High

During the April to October primary fire season, the dry vegetation and hot and sometimes windy weather, combined with continued growth in the WUI areas, can result in an increase in the number of ignitions. Any fire, once ignited, has the potential to quickly become a large, out-of-control fire. As development continues throughout the City, especially in these interface areas, the risk and vulnerability to wildfires will likely increase.

Wildfires can cause short-term and long-term disruption to the City. High intensity wildfires can have devastating effects on watersheds through loss of vegetation and soil erosion, which may impact the City by changing runoff patterns, increasing sedimentation, reducing natural and reservoir water storage capacity, and degrading water quality. Fires may result in casualties and can destroy buildings and infrastructure.

Although the physical damages and casualties arising from wildland-urban interface fires may be severe, it is important to recognize that they also cause significant economic impacts by resulting in a loss of function of buildings and infrastructure. In some cases, the economic impact of this loss of services may be comparable to the economic impact of physical damages or, in some cases, even greater. Economic impacts of loss of transportation and utility services may include traffic delays/detours from road and bridge closures and loss of electric power, potable water, and wastewater services. Fires can also cause major damage to power plants and power lines needed to distribute electricity to operate facilities.

An important consideration from a fire planning and emergency response perspective is the tourist population and temporal shifts in the transient population during the summer fire season. On warm days during the summer, the transient tourist population more than doubles as people come to the parks, beaches, and recreation areas in and around San Rafael and Marin County.

The National Fire Plan is a cooperative, long-term effort between various government agency partners with the intent of actively responding to severe wildland fires and their impacts to communities while ensuring sufficient firefighting capacity for the future. For purposes of the National Fire Plan, CAL FIRE generated a list of California communities at risk for wildfire. Three main factors were used to determine the wildfire threat in the wildland-urban interface areas of California: fuel hazards, probability of fire, and areas of

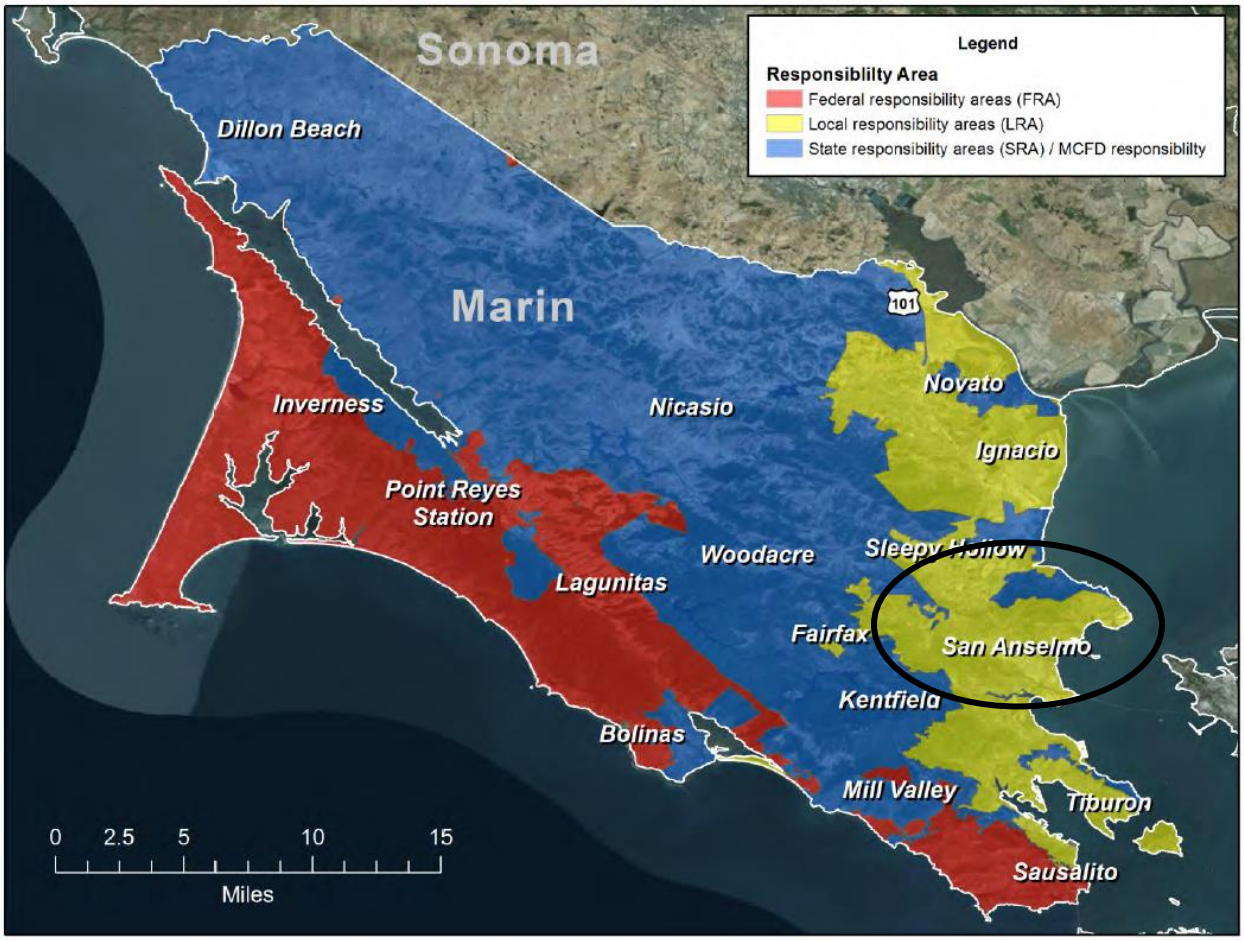
suitable housing density that could create wildland urban interface fire protection strategy situations. The preliminary criteria and methodology for evaluating wildfire risk to communities is published in the Federal Register, January 4, 2001. It should be noted that the City of San Rafael is considered a community at risk.

The City Planning Team noted that while wildfires occur frequently within the City and WUI areas and are a significant concern, with the ever present marine influence and its accompanying higher humidity, the potential for a catastrophic wildfire event is limited. While the area does experience some Diablo winds, they seem to have limited impact on wildfire conditions. Also, the City is comprised mostly of light flashy fuels which do not lend themselves to the catastrophic type wildfires.

Fire Responsibility Areas

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 in some cases in cooperation with state and local government agreements or contracts. 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. Figure 4-64 shows the FRA, SRA, and LRA in Marin County, with San Rafael circled in black.

Figure 4-64 Marin County – FRA, SRA, LRA Wildfire Areas



Source: Marin County 2016 CWPP

Tree Mortality and Wildfire

The Marin County CWPP noted that wildland fire hazard can be increased due to drought and tree mortality. Insect infestations and plant diseases, such as California sudden oak mortality syndrome (sudden oak death), are increasing and threaten to change the structure and overall health of native plant communities in Marin County and San Rafael. 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 and San Rafael 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, 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. 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 and San Rafael 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.

Values at Risk

Wildfire risk and vulnerability to the City of San Rafael was analyzed using two different data sources:

- The 2016 Marin County Community Wildfire Protection Plan (CWPP). This CWPP includes a hazard risk assessment using current, high resolution topography and fuels information combined with local fuel moisture and weather data. The assessment focused on identifying areas of concern throughout the county and beginning to prioritize areas where wildfire threat is greatest.
- City of San Rafael wildfire risk maps and data. City of San Rafael data further focuses on areas of concern to wildfire risk based on a variety of factors including WUI areas, fuels, and topography.

The following methodology was followed in determining parcel counts and values by property use and wildfire risk.

Methodology

Marin County's 2016 parcel layer and Assessor's data extracted from Marin Map were used as the basis for the City inventory of parcels and associated values for all wildfire analysis. For each of these analyses, maps and tables identifying areas of concern within the City and associated values at risk are provided.

2016 CWPP Wildfire Analysis

GIS maps and data from the 2016 Marin County CWPP was used for the wildfire analysis detailing areas of concern within San Rafael under both average fire season and extreme fire conditions.

As detailed in the 2016 CWPP, the wildfire risk assessment provides a framework for future collaboration that can be used to identify, prioritize, implement, and monitor hazard reduction activities throughout the county. The CWPP 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 and city stakeholders. This document was also developed to support the California Fire Plan and CAL

FIRE's Unit Strategic Fire Plan. While the CWPP broadly covers the entire county, this plan supports and encourages more focused plans for wildfire protection at the city, community, and neighborhood scales.

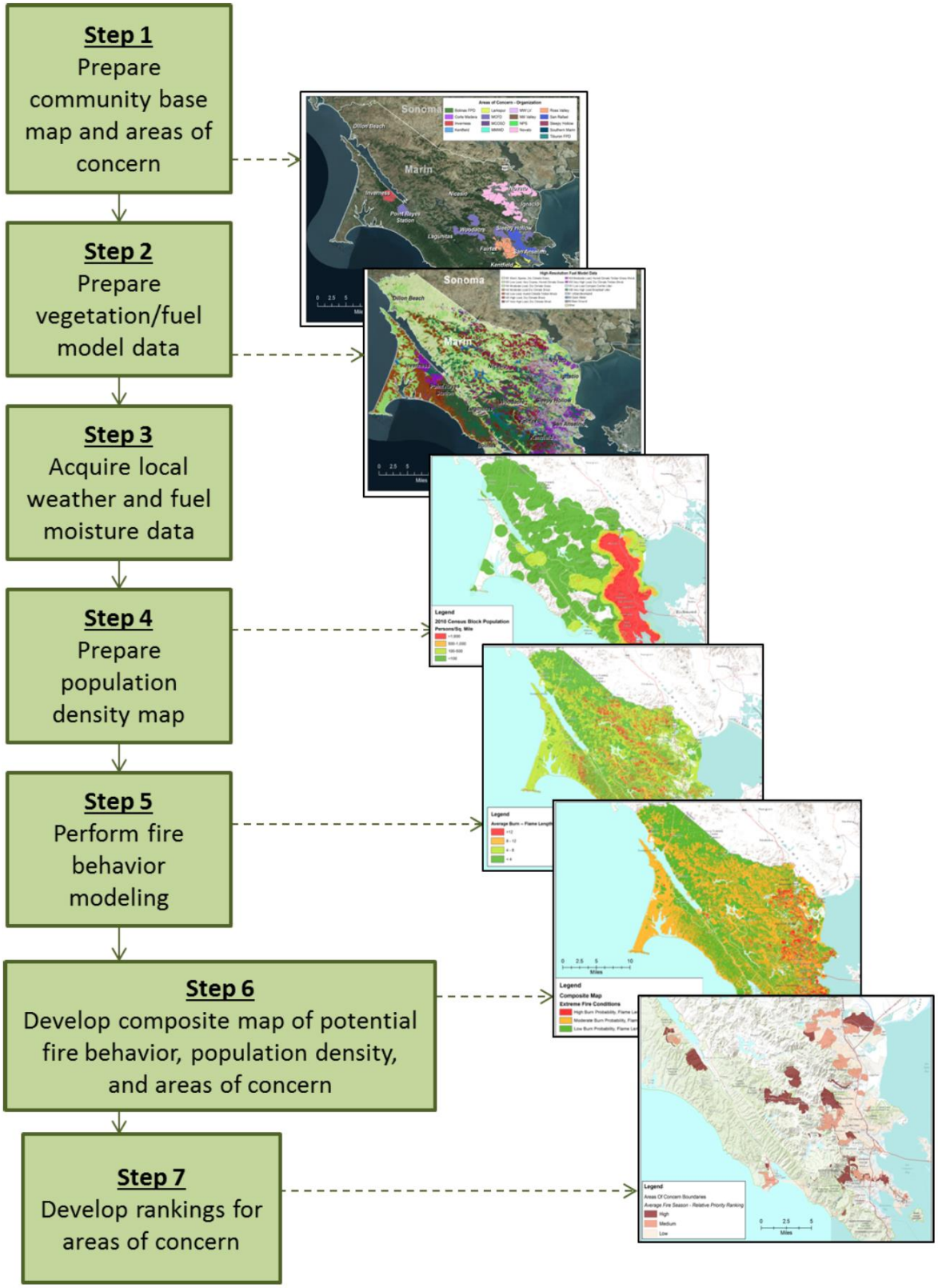
The CWPP risk assessment was undertaken, in part, to build upon CAL Fire's Fire Hazard Severity Zone (FHSZ) Maps, using local (and more recent) fuel characteristics and improved fire modeling methods that consider local perspectives and priorities regarding communities at risk and areas of concern. The CWPP risk assessment methodology is described further below.

2016 CWPP Risk Assessment Methodology

To build 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, using updated fuels data and representative weather scenarios, and the probability or likelihood that an area will burn given an ignition. The overall approach for identifying and beginning to prioritize areas of his hazard was based on: 1) using local and current data about the fuels on the ground (vegetation) available to burn, 2) the potential fire behavior (flame length and rate of spread) if the fuels were to burn, 3) areas that are populated and mixed with vegetation (the WUI), and 4) local knowledge of the areas of concern provided by each fire jurisdiction. These layers were combined and weighted to identify and prioritize the relative hazard. Based on this modeling effort, composite maps were generated indicating relative potential fire hazards throughout the county. This information can be used to prioritize areas of concern and potential fuel reduction strategies. Figure 4-65 shows the steps used to perform the hazard and asset, risk assessment. More detailed information on the methodology used can be found in the 2016 CWPP.

This LHMP utilized the CWPP Vulnerability Analysis models developed through implementation of CWPP Analysis Steps 1- 6 which resulted in the development of composite maps that were completed under two scenarios: Average Fire Season and Extreme Fire Conditions as detailed further below.

Figure 4-65 Marin County – CWPP Wildfire Vulnerability Analysis Steps



Source: Marin County 2016 CWPP

2016 CWPP Risk Assessment Results

Following this methodology, the 2016 CWPP developed composite maps based on flame length, rate of spread, and population density. for the County and City under two scenarios: Average Fire Season and Extreme Fire Conditions. These two scenarios used fuel moisture and weather data specific to each scenario. These composite maps provide rankings of Very High, High and Moderate for population density, flame length, and rate of spread noting the areas of high asset value where fire behavior is likely to be extreme.

Values at Risk

Analysis was performed using these two scenario datasets. Using GIS, the parcel layer were overlaid on the two scenarios. In some cases, there are parcels in multiple hazard rankings. GIS was used to create a centroid, or point representing the center of the parcel polygon. For the purposes of this analysis, the hazard ranking that intersected a parcel centroid was assigned the hazard ranking for the entire parcel. Once completed the parcel centroid layer was joined to the Assessor's database to determine the values of parcels within each hazard ranking by scenario.

Results are presented by scenario for the City. Figure 4-66 and Figure 4-67 show the composite maps and relative rankings by Average Fire Season and under Extreme Fire Conditions. Table 4-66 and Table 4-67 show total and improved parcel counts; land values, improved structure values and estimated content values (CRVs); and the percentage of parcels affected by each ranking for each of these scenarios. CRVs were derived from the improved structure values using the methodology previously described in Section 4.3.1.

Figure 4-66 San Rafael – Average Fire Season Composite Map

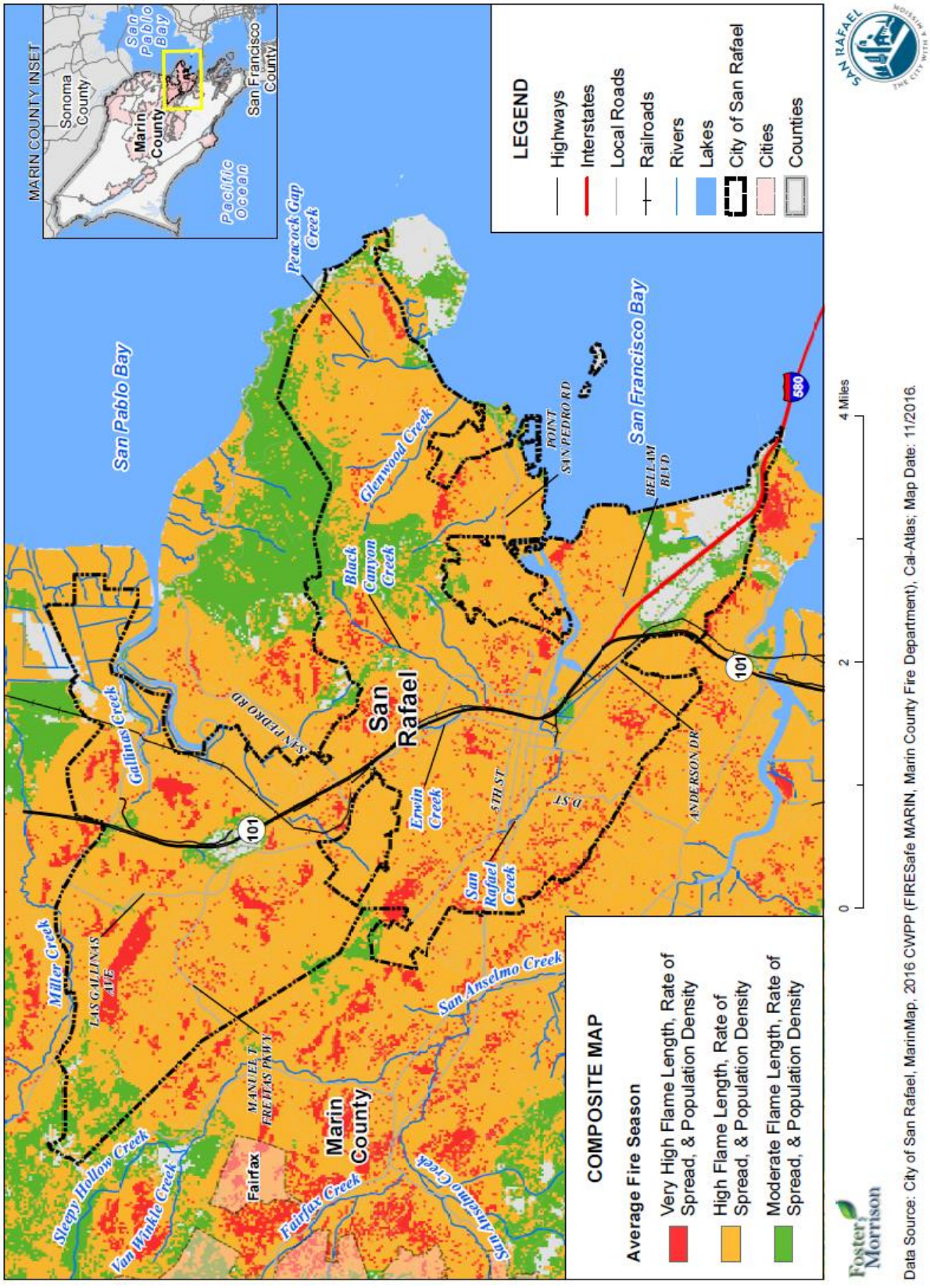


Table 4-66 San Rafael – Average Fire Season Composite Map: Count and Value of Parcels by Property Use and Hazard Ranking

Average Fire Season / Property Use	Total Parcel Count	Improved Parcel Count	Total Land Value	Improved Structure Value	Estimated Contents Value	Total Value*
Very High						
Agricultural/Open Space	0	0	$0	$0	$0	$0
Commercial	23	18	$14,504,998	$20,806,722	$20,806,722	$56,118,442
Exempt	50	4	$2,966,359	$5,099,463	$5,099,463	$13,165,285
Industrial	3	3	$415,149	$1,077,732	$1,616,598	$3,109,479
Residential	1,307	1,247	$360,730,169	$350,827,078	$175,413,539	$886,970,786
Very High Total	**1,383**	**1,272**	**$378,616,675**	**$377,810,995**	**$202,936,322**	**$959,363,992**
High						
Agricultural/Open Space	1	0	$1	$0	$0	$1
Commercial	899	795	$626,569,259	$1,105,112,897	$1,105,112,897	$2,836,795,053
Exempt	645	154	$92,503,937	$389,339,220	$389,339,220	$871,182,377
Industrial	241	220	$103,281,392	$119,579,245	$179,368,868	$402,229,505
Residential	13,961	13,456	$3,941,127,509	$4,163,282,555	$2,081,641,278	$10,186,051,342
High Total	**15,747**	**14,625**	**$4,763,482,098**	**$5,777,313,917**	**$3,755,462,262**	**$14,296,258,277**
Moderate						
Agricultural/Open Space	0	0	$0	$0	$0	$0
Commercial	88	75	$84,268,933	$150,149,737	$150,149,737	$384,568,407
Exempt	31	1	$1,332,625	$1,782,530	$1,782,530	$4,897,685
Industrial	6	5	$3,625,732	$5,052,423	$7,578,635	$16,256,790
Residential	227	218	$91,250,476	$114,059,482	$57,029,741	$262,339,699
Moderate Total	**352**	**299**	**$180,477,766**	**$271,044,172**	**$216,540,643**	**$668,062,581**
No Data / Out of Range						
Agricultural/Open Space	0	0	$0	$0	$0	$0
Commercial	185	173	$114,776,922	$235,400,312	$235,400,312	$585,577,546
Exempt	45	3	$2,073,532	$2,439,447	$2,439,447	$6,952,426
Industrial	25	22	$15,238,218	$20,511,775	$30,767,663	$66,517,656
Residential	59	57	$17,690,555	$21,713,987	$10,856,994	$50,261,536
No Data / Out of Range Total	**314**	**255**	**$149,779,227**	**$280,065,521**	**$279,464,415**	**$709,309,163**
Grand Total	**17,796**	**16,451**	**$5,472,355,766**	**$6,706,234,605**	**$4,454,403,642**	**$16,632,994,013**

Source: City of San Rafael; MarinMap; 2016 CWPP (FIRESafe MARIN, Marin County Fire Department); Marin County Parcel/Assessor's Data 2016

Figure 4-67 San Rafael – Extreme Fire Conditions Composite Map

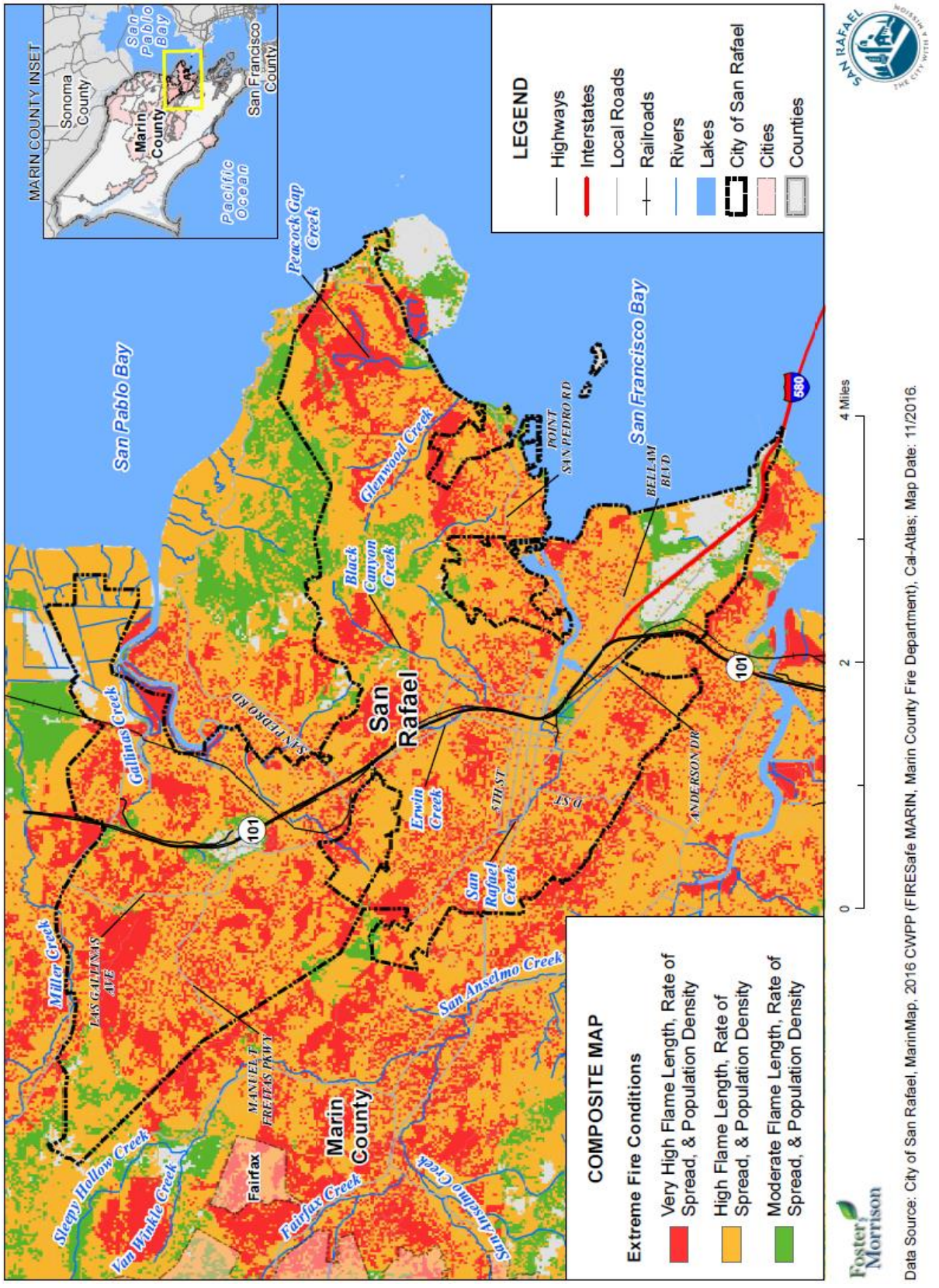


Table 4-67 San Rafael – Extreme Fire Conditions Composite Map: Count and Value of Parcels by Property Use and Hazard Rankings

Extreme Fire Conditions/ Property Use	Total Parcel Count	Improved Parcel Count	Total Land Value	Improved Structure Value	Estimated Contents Value	Total Value*
Very High						
Agricultural/Open Space	1	0	$1	$0	$0	$1
Commercial	114	96	$78,414,207	$142,304,363	$142,304,363	$363,022,933
Exempt	186	38	$23,767,757	$119,640,739	$119,640,739	$263,049,235
Industrial	14	13	$3,266,478	$6,041,745	$9,062,618	$18,370,841
Residential	4,780	4,590	$1,327,239,825	$1,345,070,794	$672,535,397	$3,344,846,016
Very High Total	**5,095**	**4,737**	**$1,432,688,268**	**$1,613,057,641**	**$943,543,117**	**$3,989,289,026**
High						
Agricultural/Open Space	0	0	$0	$0	$0	$0
Commercial	819	727	$566,697,897	$986,772,062	$986,772,062	$2,540,242,021
Exempt	514	120	$71,772,539	$274,797,944	$274,797,944	$621,368,427
Industrial	230	210	$100,430,063	$114,615,232	$171,922,848	$386,968,143
Residential	10,520	10,142	$2,985,600,748	$3,180,560,849	$1,590,280,425	$7,756,442,022
High Total	**12,083**	**11,199**	**$3,724,501,247**	**$4,556,746,087**	**$3,023,773,279**	**$11,305,020,613**
Moderate						
Agricultural/Open Space	0	0	$0	$0	$0	$0
Commercial	77	65	$80,231,086	$146,992,931	$146,992,931	$374,216,948
Exempt	26	1	$1,262,625	$1,782,530	$1,782,530	$4,827,685
Industrial	6	5	$3,625,732	$5,052,423	$7,578,635	$16,256,790
Residential	195	189	$80,267,581	$102,537,472	$51,268,736	$234,073,789
Moderate Total	**304**	**260**	**$165,387,024**	**$256,365,356**	**$207,622,832**	**$629,375,212**
No Data / Out of Range						
Agricultural/Open Space	0	0	$0	$0	$0	$0
Commercial	185	173	$114,776,922	$235,400,312	$235,400,312	$585,577,546
Exempt	45	3	$2,073,532	$2,439,447	$2,439,447	$6,952,426
Industrial	25	22	$15,238,218	$20,511,775	$30,767,663	$66,517,656
Residential	59	57	$17,690,555	$21,713,987	$10,856,994	$50,261,536
No Data / Out of Range Total	314	255	$149,779,227	$280,065,521	$279,464,415	$709,309,163
Grand Total	**17,796**	**16,451**	**$5,472,355,766**	**$6,706,234,605**	**$4,454,403,642**	**$16,632,994,013**

Source: City of San Rafael; MarinMap; 2016 CWPP (FIRESafe MARIN, Marin County Fire Department); Marin County Parcel/Assessor's Data 2016

City WUI Layer Analysis

Building upon the Countywide CWPP layer, San Rafael City Fire provided their WUI layer. The HMPC felt that the countywide data set provides good insight; however, the City felt that their local WUI layer better captures their areas of concern to wildfire.

Analysis was performed using the City provided WUI layer. Using GIS, the parcel layer was overlaid on the WUI layer to see what parcels are located within or outside the WUI area. GIS was used to create a centroid, or point representing the center of the parcel polygon. If the parcel centroid intersected the WUI layer, the entire parcel was considered to be within the WUI. Likewise, if the parcel centroid did not intersect the WUI layer, the parcel was determined to fall outside of the WUI. Once completed the parcel centroid layer was joined to the Assessor's database to determine the values of parcels within the City's WUI.

Figure 4-68 shows the WUI area for the City. Table 4-68 shows total and improved parcel counts, land values, improved structure values, and estimated content values (CRVs) falling within the City WUI. CRVs were derived from the improved structure values using the methodology previously described in Section 4.3.1.

Figure 4-68 San Rafael – WUI Areas

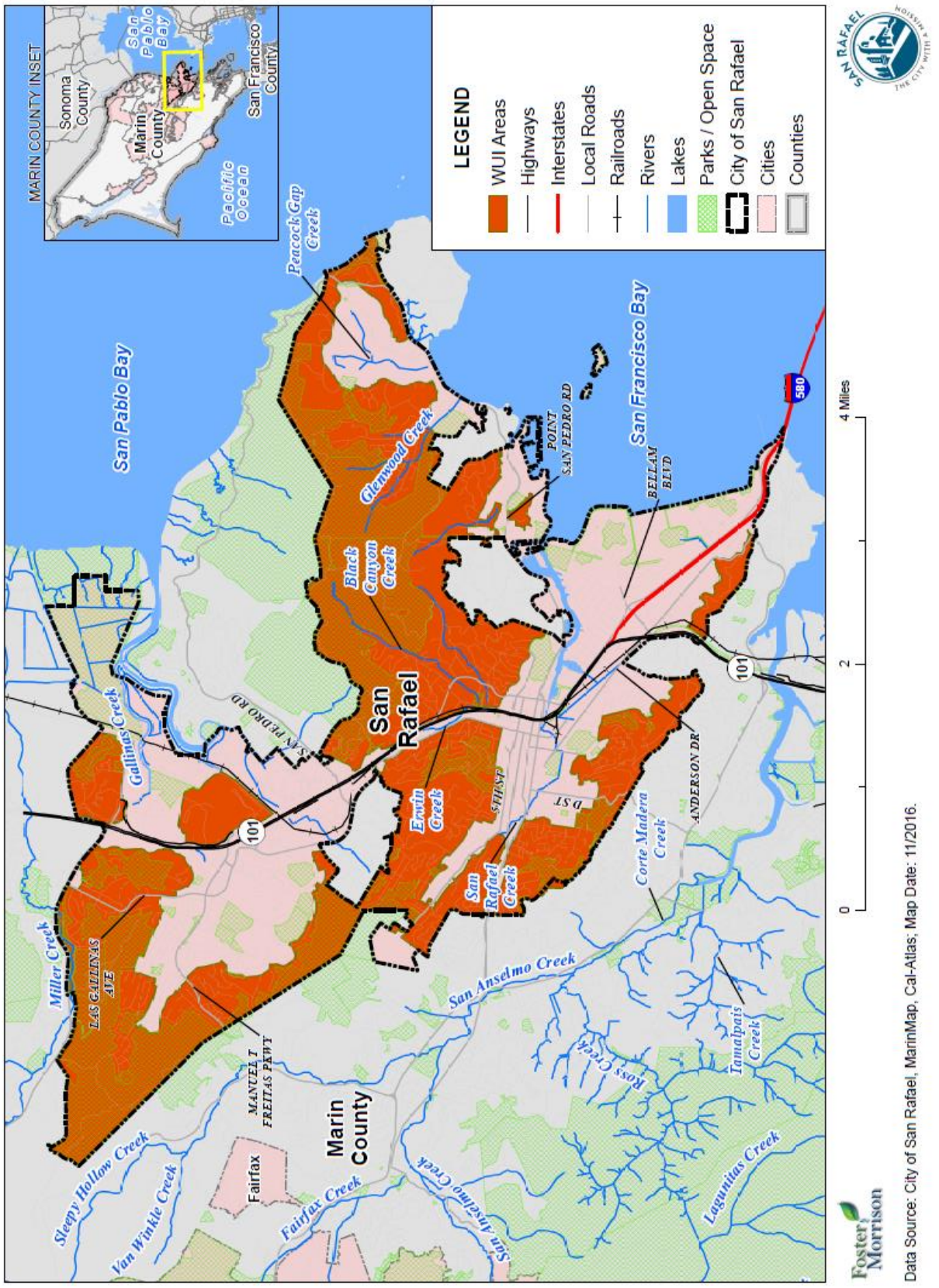


Table 4-68 San Rafael – Count and Value of Parcels by Property Use in the WUI

Property Use	Total Parcel Count	Improved Parcel Count	Total Land Value	Improved Structure Value	Estimated Contents Value	Total Value
Agricultural/Open Space	1	0	$1	$0	$0	$1
Commercial	84	24	$65,397,503	$130,550,371	$130,550,371	$326,498,245
Exempt	255	43	$23,863,586	$104,139,442	$104,139,442	$232,142,470
Industrial	1	0	$838,517	$1,454,897	$2,182,346	$4,475,760
Residential	8,218	6,115	$2,517,295,517	$2,582,753,758	$1,291,376,879	$6,391,426,154
Total	**8,559**	**6,182**	**$2,607,395,124**	**$2,818,898,468**	**$1,528,249,038**	**$6,954,542,630**

Source: City of San Rafael Fire; MarinMap; Marin County Parcel/Assessor's Data 2016

Population at Risk

The Average and Extreme Fire Season dataset was overlayed on the parcel layer. Those residential parcel centroids that intersect the areas of concern were counted and multiplied by the 2010 Census Bureau average household factors for San Rafael (2.44). Populations and residential parcels were tabulated for both the average and extreme fire season datasets. This is shown in Table 4-69.

Table 4-69 San Rafael – Count of Improved Residential Parcels and Population based on Composite Maps for Average Fire Season and Extreme Fire Conditions

Fire Zone	Average Fire Season			Extreme Fire Conditions	
	Improved Residential Parcels	Population		Improved Residential Parcels	Population
High	1,454	3,548		0	0
Moderate	7,311	17,839		8,763	21,382
Low	0	0		0	0

Source: City of San Rafael; MarinMap; 2016 CWPP (FIRESafe MARIN, Marin County Fire Department); Marin County Parcel/Assessor's Data 2016

In addition, the WUI layer provided by the City of San Rafael was was overlayed on the parcel layer. Those residential parcel centroids that intersect the WUI areas were counted and multiplied by the 2010 Census Bureau average household factors for San Rafael (2.44). Populations and residential parcels were tabulated for the City provided WUI, and shows 14,921 residents in the WUI zone.

Table 4-70 San Rafael – Count of Improved Residential Parcels and Population in the WUI

WUI Zone	Improved Residential Parcels	Population*
Inside WUI	6,115	14,921

Source: City of San Rafael Fire; MarinMap; Marin County Parcel/Assessor's Data 2016, US Census Bureau

Cultural and Natural Resources at Risk

ARE THERE ANY CULTURAL/NATURAL RESOURCES AT RISK TO THIS HAZARD?

Critical Facilities at Risk

An analysis was performed on the critical facility inventory in San Rafael for the two 2016 CWPP composite map scenarios (average fire season and extreme fire conditions) and City WUI zones. GIS was used to determine whether the facility locations intersects one of these areas, and if so, which zone it intersects. Details of critical facilities in the Composite Map, Average Fire Season scenario for the City of San Rafael are shown in Figure 4-69 and Table 4-66. Details of critical facilities in the Composite Map, Extreme Fire Conditions scenario for the City of San Rafael are shown in Figure 4-70 and Table 4-67. Details of critical facilities in the City defined WUI are shown in Figure 4-71 and Table 4-73. Details of critical facility definition, type, name and address and jurisdiction by both the 2016 CWPP and City WUI analyses are listed in Appendix E.

Figure 4-69 San Rafael – Critical Facilities in CWPP Composite Map, Average Fire Season Zones

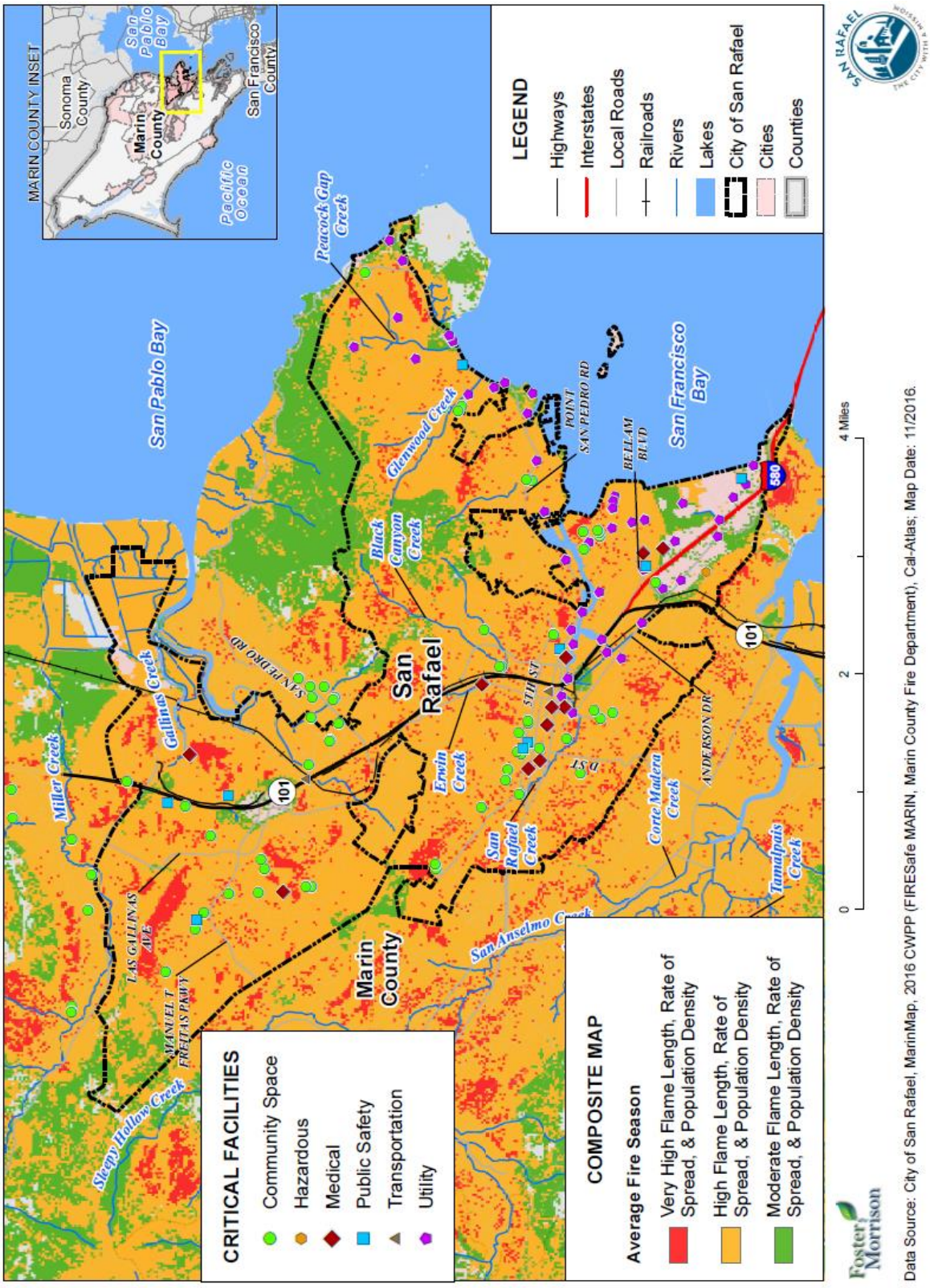


Table 4-71 San Rafael – Critical Facilities in CWPP Composite Map, Average Fire Season

Facility Type	Average Fire Season				
	Very High	High	Moderate	No Data / Out of Range	Total
San Rafael					
Community Space	3	46	2	0	51
Hazardous	0	0	1	0	1
Medical	0	12	0	0	12
Public Safety	0	9	0	0	9
Transportation	0	2	0	0	2
Utility	0	39	2	12	53
Total	**3**	**108**	**5**	**12**	**128**
Adjacent to San Rafael					
Community Space	0	14	0	0	14
Hazardous	0	0	0	0	0
Medical	0	0	0	0	0
Public Safety	0	0	0	0	0
Transportation	0	0	0	0	0
Utility	0	0	3	0	3
Total	**0**	**14**	**3**	**0**	**17**
San Rafael Totals					
Community Space	3	60	2	0	65
Hazardous	0	0	1	0	1
Medical	0	12	0	0	12
Public Safety	0	9	0	0	9
Transportation	0	2	0	0	2
Utility	0	39	5	12	56
Grand Total	**3**	**122**	**8**	**12**	**145**

Source: City of San Rafael GIS; 2016 CWPP (FIRESafe MARIN, Marin County Fire Department)

Figure 4-70 San Rafael – Critical Facilities – CWPP Composite Map, Extreme Fire Condition Zones

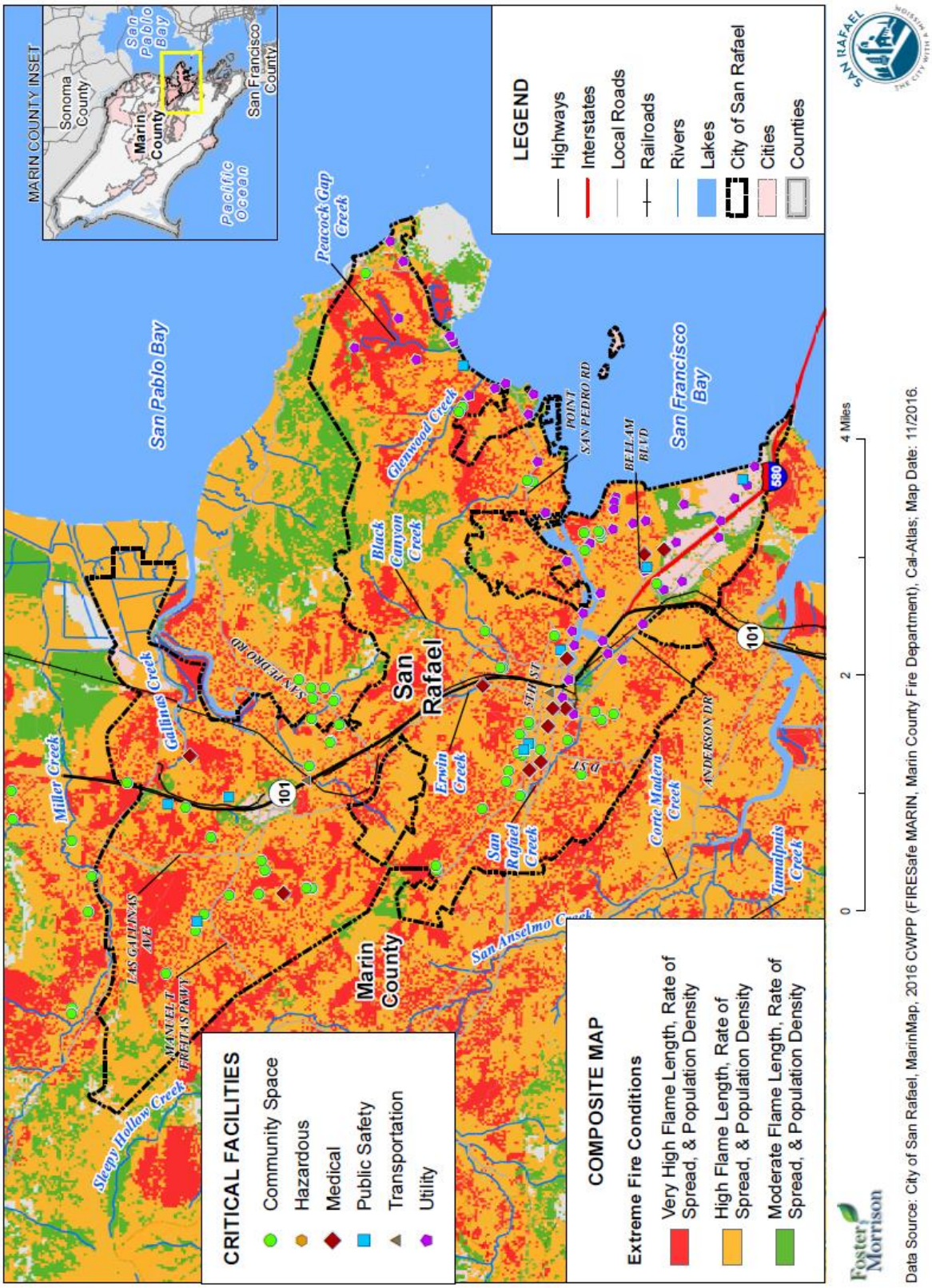


Table 4-72 San Rafael – Critical Facilities in CWPP Composite Map, Extreme Fire Condition Zones

Facility Type	Extreme Fire Conditions				
	Very High	High	Moderate	No Data / Out of Range	Total
San Rafael					
Community Space	11	38	2	0	51
Hazardous	0	0	1	0	1
Medical	0	12	0	0	12
Public Safety	0	9	0	0	9
Transportation	1	1	0	0	2
Utility	10	30	2	11	53
Total	**22**	**90**	**5**	**11**	**128**
Adjacent to San Rafael					
Community Space	1	13	0	0	14
Hazardous	0	0	0	0	0
Medical	0	0	0	0	0
Public Safety	0	0	0	0	0
Transportation	0	0	0	0	0
Utility	0	0	3	0	3
Total	**1**	**13**	**3**	**0**	**17**
San Rafael Totals					
Community Space	12	51	2	0	65
Hazardous	0	0	1	0	1
Medical	0	12	0	0	12
Public Safety	0	9	0	0	9
Transportation	1	1	0	0	2
Utility	10	30	5	11	56
Grand Total	**23**	**103**	**8**	**11**	**145**

Source: City of San Rafael GIS; 2016 CWPP (FIRESafe MARIN, Marin County Fire Department)

Figure 4-71 San Rafael – Critical Facilities in City WUI Areas

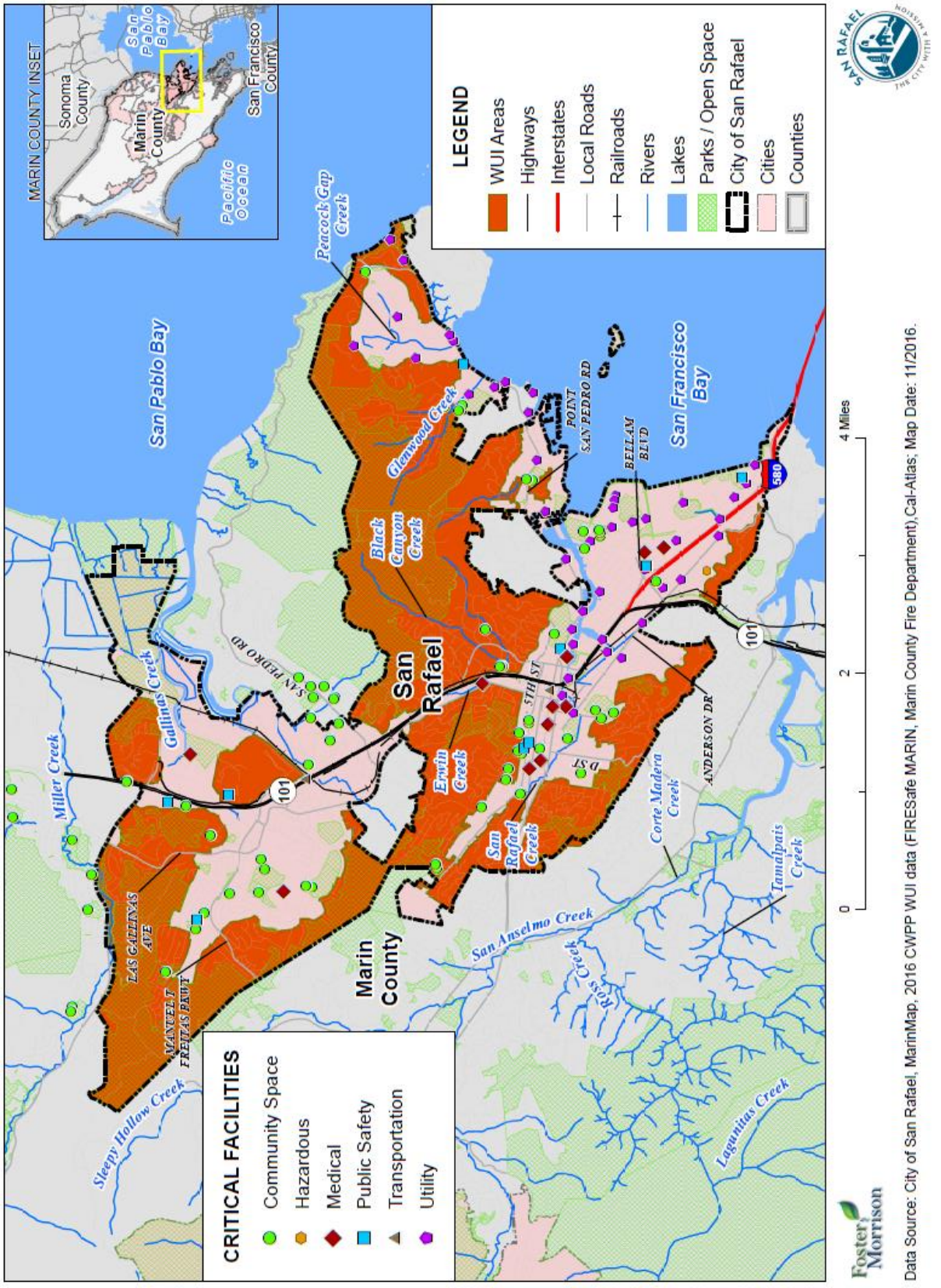


Table 4-73 San Rafael – Critical Facilities in City WUI Zones

Facility Type/Property Use	Facility Count by WUI Area		
	Within	Outside	Total
Community Space	12	39	51
Hazardous	0	1	1
Medical	0	12	12
Public Safety	1	8	9
Transportation	0	2	2
Utility	3	50	53
Total	**16**	**112**	**128**
Adjacent to San Rafael			
Community Space	0	14	14
Hazardous	0	0	0
Medical	0	0	0
Public Safety	0	0	0
Transportation	0	0	0
Utility	0	3	3
Total	**0**	**17**	**17**
San Rafael Totals			
Community Space	12	53	65
Hazardous	0	1	1
Medical	0	12	12
Public Safety	1	8	9
Transportation	0	2	2
Utility	3	53	56
Total	**16**	**129**	**145**

Source: City of San Rafael GIS; San Rafael Fire

Overall Community Impact

The overall impact to the community from a severe wildfire includes:

- Injury and loss of life;
- Commercial and residential structural and property damage;
- Decreased water quality in area watersheds;
- Increase in post-fire hazards such as flooding, sedimentation, and mudslides;
- Damage to natural resource habitats and other resources, such as timber and rangeland;
- Loss of water, power, roads, phones, and transportation, which could impact, strand, and/or impair mobility for emergency responders and/or area residents;
- Economic losses (jobs, sales, tax revenue) associated with loss of commercial structures;
- Negative impact on commercial and residential property values;

- Loss of churches, which could severely impact the social fabric of the community;
- Loss of schools, which could severely impact the entire school system and disrupt families and teachers, as temporary facilities and relocations would likely be needed; and
- Impact on the overall mental health of the community.

Future Development/Redevelopment

Future development/redevelopment was also analyzed for the City WUI areas, which best depict the City's areas of concern for wildfire. Future development/redevelopment areas for the City are broken out into three primary areas:

- Downtown/Civic Center,
- Northgate
- Dutra McNair Quarry

GIS data is maintained by San Rafael, and was made available for this plan. An analysis was performed to quantify parcels within these redevelopment areas that are also in WUI areas. Results can provide information on how and where to grow in the future.

GIS was used to determine the number of parcels in the WUI areas within the threefuture development/redevelopment areas. GIS was used to create a centroid, or point representing the center of the parcel polygon. Those parcels centroids that fall inside the future development areas and that were within the WUI areas were selected and tabulated in Figure 4-72 and shown in Table 4-74. Note that because the Dutra McNair Quarry falls outside of the City limits, parcel and assessor data was unavailable for this analysis

Figure 4-72 San Rafael – WUI Areas and Future Development/Redevelopment Areas

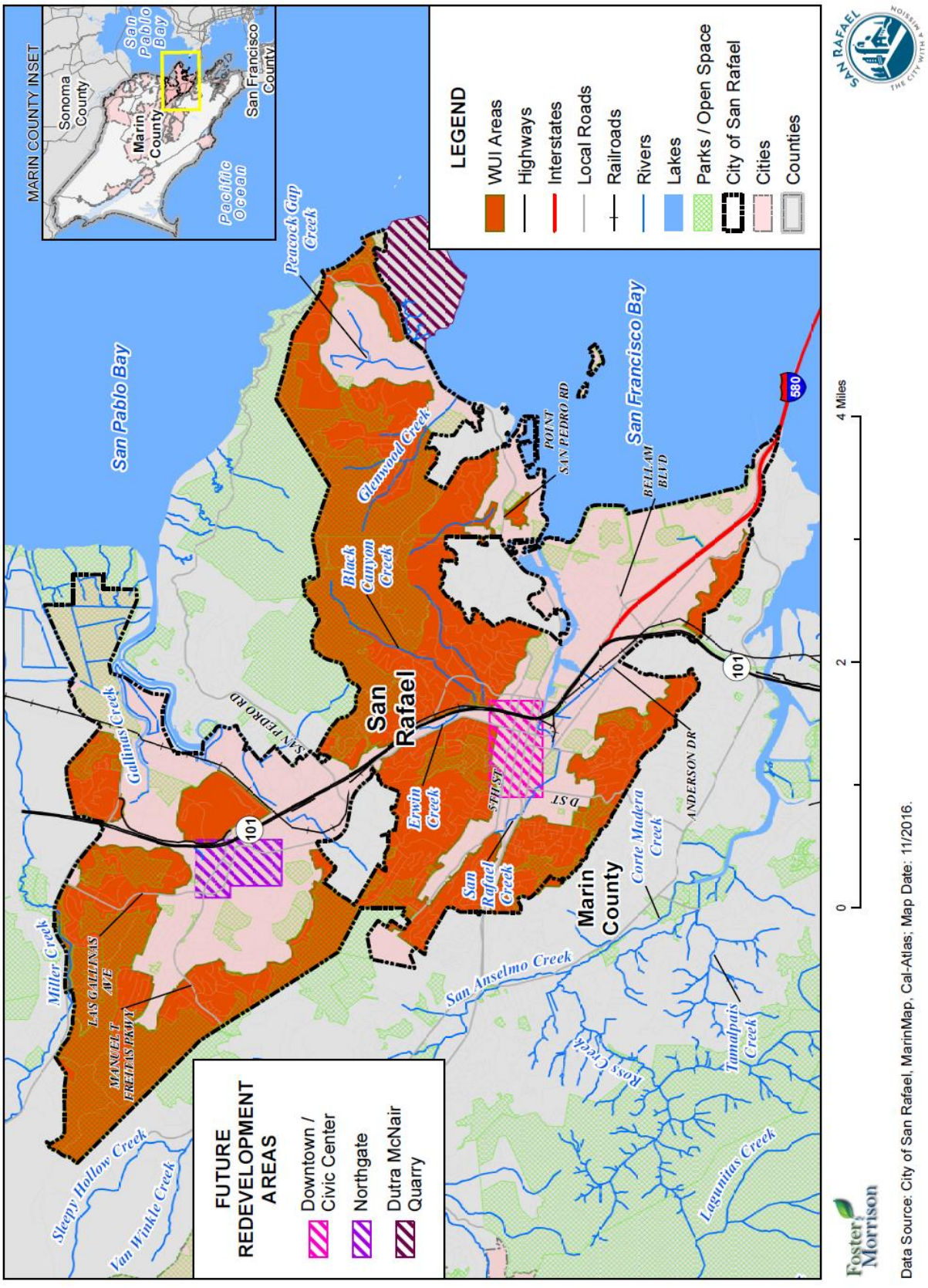


Table 4-74 San Rafael – Future Development/Redevelopment in WUI Areas by Property Use, Parcels, and Acres

Property Use	Total Parcel Count	Improved Parcel Count	Total Acres
Commercial	6	6	3
Exempt	3	2	1
Residential	49	48	8
Total	**58**	**56**	**12**

Source: City of San Rafael GIS; Marin Map Tsunami Inundation Layer

4.4 Capability Assessment

Thus far, the planning process has identified the natural hazards posing a threat to the City and described, in general, the vulnerability of the City to these risks. The next step is to assess what loss prevention mechanisms are already in place. This part of the planning process is the mitigation capability assessment. Combining the risk assessment with the mitigation capability assessment results in the City's net vulnerability to disasters, and more accurately focuses the goals, objectives, and proposed actions of this plan.

The HMPC used a two-step approach to conduct this assessment for the City. First, an inventory of common mitigation activities was made through the use of matrices. The purpose of this effort was to identify policies and programs that were either in place, needed improvement, or could be undertaken if deemed appropriate. Second, the HMPC conducted an inventory and review of existing policies, regulations, plans, and programs to determine if they contributed to reducing hazard-related losses or if they inadvertently contributed to increasing such losses.

Similar to the HMPC's effort to describe hazards, risks, and vulnerability of the City, this mitigation capability assessment describes the existing capabilities, programs, and policies currently in use to reduce hazard impacts or that could be used to implement hazard mitigation activities. This assessment is divided into four sections: regulatory mitigation capabilities are discussed in Section 4.4.1; administrative and technical mitigation capabilities are discussed in Section 4.4.2; fiscal mitigation capabilities are discussed in Section 4.4.3; and mitigation education, outreach, and partnerships are discussed in Section 4.4.4. A discussion of other mitigation efforts follows in Section 4.4.5.

4.4.1. City of San Rafael's Regulatory Mitigation Capabilities

Table 4-75 lists planning and land management tools typically used by local jurisdictions to implement hazard mitigation activities, and indicates those that are in place in the City. Excerpts from applicable policies, regulations, and plans and program descriptions follow to provide more detail on existing mitigation capabilities.

CITY – CAN YOU PLEASE MAKE SURE THE TABLES IN THIS SECTION ARE COMPLETE – IT SEEMS LIKE THEY MAY NOT BE.

Table 4-75 San Rafael – Regulatory Mitigation Capabilities

Plans	Y/N Year	Does the plan/program address hazards? Does the plan identify projects to include in the mitigation strategy? Can the plan be used to implement mitigation actions?
General Plan	Y	Safety Element/Sustainability Element
Capital Improvements Plan		
Economic Development Plan		
Local Emergency Operations Plan		
Continuity of Operations Plan		
Transportation Plan	Y	Circulation Element General Plan
Stormwater Management Plan/Program		
Engineering Studies for Streams	Y	Gallinas Creek Watershed Study
Community Wildfire Protection Plan		
Other special plans (e.g., brownfields redevelopment, disaster recovery, coastal zone management, climate change adaptation)	Y	Climate Change Action Plan (2009) Currently being updated
Building Code, Permitting, and Inspections	**Y/N**	**Are codes adequately enforced?**
Building Code	Y	Version/Year: CBC 2013
Building Code Effectiveness Grading Schedule (BCEGS) Score	N	Score:
Fire department ISO rating:	Y	The Fire Department has a Class 1 ISO Rating
Site plan review requirements	Y	Yes
Land Use Planning and Ordinances	**Y/N**	**Is the ordinance an effective measure for reducing hazard impacts? Is the ordinance adequately administered and enforced?**
Zoning ordinance	Y	Yes (hillside, conservation district, open space district, creeks/waterways and wetland overlay.
Subdivision ordinance	Y	Yes geotechnical and flooding provisions
Floodplain ordinance	Y	
Natural hazard specific ordinance (stormwater, steep slope, wildfire)	Y	Hillside overlay district, WUI overlay
Flood insurance rate maps	Y	
Elevation Certificates	Y	Certifications confirmed by City Engineer/Flood Administrator
Acquisition of land for open space and public recreation uses	Y	Open Space Element of the General Plan
Erosion or sediment control program	Y	Marin County Stormwater Pollution Prevention
Other		

As indicated in the table above, the City of San Rafael has several plans and programs that guide the City's mitigation of development of hazard-prone areas. Starting with the City of San Rafael General Plan, some of these are described in more detail below.

City of San Rafael Plans

2020 City of San Rafael General Plan

General Plan 2020 is the official policy framework for guiding decisions affecting the future of San Rafael. The City Council, City Boards and Commissions, City staff and San Rafael residents and business owners will implement the General Plan. Plan policies will be carried out through the adoption and revision of ordinances and City programs, through annual budgeting and capital improvement programming, through the participation of residents and community groups, and through decisions on development proposals. The plan is broken into the following sections:

- Our Use of Land
  - ✓ Land Use
  - ✓ Housing
  - ✓ Neighborhoods
  - ✓ Community Design

- Our Foundation Economic Vitality
  - ✓ Circulation
  - ✓ Infrastructure
  - ✓ Governance
  - ✓ Sustainability

- Our Quality of Life Culture and Arts
  - ✓ Parks and Recreation
  - ✓ Safety

- Noise
  - ✓ Our Natural Resources Open Space
  - ✓ Conservation
  - ✓ Air and Water Quality

The Safety Element of the General Plan is aimed at reducing potential risk of death, injuries, damage to property, and the economic and social dislocation resulting from fire, flood, and geologic hazards, and other public health and safety hazards. The General Plan provides policies and standards for the type, location, intensity and design of development in areas of potential hazards. The intent is not to remove all risks associated with each specific type of hazard, but to reduce risks to life and property and to make informed decisions about land use and development near these hazards. Significant geologic and seismic hazards that exist within the San Rafael include earthquakes, liquefaction, flow failures, lateral spreading, lurching, differential settlement, landslides, mudslides, subsidence and expansive soil. These hazards have the potential to damage or destroy residences, streets and utilities. Certain geologic hazards, such as liquefaction, expansive soils or small landslides, may be reduced or eliminated through engineering

solutions such as special foundations or slide repair. In some instances, an engineering solution may not be economically feasible, and avoidance of the hazard may be the best way to assure public health and safety. High occupancy and emergency response facilities may not be appropriate in areas of high seismic or geologic hazard. Geologic and seismic hazards should be considered in planning the location, design, intensity, density and type of land uses in a given area. Long term costs to the City, such as maintenance, liability exposure and emergency services, are potentially greater where high hazards exist. The City will only approve new development in areas of identified hazard if such hazard can be appropriately mitigated.

Specific mitigation related goals and objectives from the San Rafael General Plan Safety Element are:

It is the goal of San Rafael, as the first priority for city government, to provide excellent fire, public safety and paramedic services and to be prepared in the case of disaster or emergency. San Rafael residents deserve to feel safe and secure wherever they live, work and play.

- Objective S-1. Location of Future Development.
- Objective S-2. Location of Public Improvements.
- Objective S-3. Use of Hazard Maps in Development Review.
- Objective S-4. Geotechnical Review.
- Objective S-5. Minimize Potential Effects of Geological Hazards.
- Objective S-6. Seismic Safety of New Buildings.
- Objective S-7. Minimize Potential Effects of Landslides.
- Objective S-8. Seismic Safety of Existing Buildings.
- Objective S-9. Post Earthquake Inspections.
- Objective S-17. Flood Protection of New Development.
- Objective S-18 Storm Drainage Improvements.
- Objective S-19. Flood Control Improvements Funding.
- Objective S-20. Levee Upgrading.
- Objective S-21. Rise in Sea Level.
- Objective S-22. Erosion.
- Objective S-24. Creeks and Drainageways.
- Objective S-30. Maintenance and Landscaping for Fire Safety.
- Objective S-31. New Development in Fire Hazard Areas.
- Objective S-33. Disaster Preparedness Planning.
- Objective S-34. Emergency Operation Center.
- Objective S-38. Building Code and Fire Code Update.
- Objective S-39. Public Safety Facilities.
- Objective S-40. Outreach.

Capital Improvements Program

The City's Capital Improvements Program (CIP) manages the construction of new facilities and maintenance of existing facilities. The CIP is a major element of the City's budget, and includes projects that have been evaluated and prioritized through the City's interdepartmental review process. The CIP lists expected new facilities as well as facility improvements and repairs: the list includes fully funded projects as well as projects where funding is not yet available. As part of the City's budget, the CIP is updated on a bi-annual basis. The list of CIP projects identifies funding priorities. These priorities change in response to

the amount of funds available. Sources of funding include the City's General Fund, Gas Tax Fund, Storm Water Fund, Redevelopment Agency, State and regional grants, and private donations. San Rafael City Council approved the first 5-Year Capital Improvement Program formulated by the Department of Public Works in FY 2009/2010. This is the fourth update of that document, encompassing the period from FY 2012/2013 through FY 2016/2017. Capital improvement priorities can inform priority mitigation actions and identified mitigation actions can in turn inform capital improvement priorities.

City of San Rafael Community Emergency Preparedness Plan (2009)

Emergency preparedness involves activities that are done before a disaster; such as training, planning, community education, and exercises. Depending on an individual's interest in preparedness, there is a level of preparedness education to suit their need. From individual study and research to fully-developed Community Emergency Response Teams, there is no reason why anyone should find themselves unprepared when a disaster strikes. The Emergency Preparedness Plan's goal is to prepare both the City and its residents for possible emergency situations, in order to reduce risk to hazards. This is done in order that citizens may take efforts to be self-sufficient and be less of a burden on the emergency response system.

Climate Change Action Plan (2009)

San Rafael is stepping up to the climate change challenge. Mayor Al Boro was one of the initial signers of the US Conference of Mayors Climate Projection Agreement in 2005, pledging the City to reducing greenhouse gas (GHG) emissions in accord with the Kyoto Protocols. To meet these goals, the City Council appointed a 16-member Green Ribbon Committee to lead a community process to prepare a plan to guide both the City organization and the entire community in responding to climate change. This Plan is the result of that community effort. The City of San Rafael will have to comply with recent and anticipated state and federal regulations on reducing greenhouse gas (GHG) emissions, such as California's landmark AB32 and SB375 legislation. The Plan is organized by how its recommendations affect the various facets of our community: our lifestyles, our buildings, our environment, and our communities. Each community facet has recommended programs.

Greenhouse Gas Reduction Report (2014)

The GHG Reduction Strategy meets both the California Environmental Quality Act (CEQA) and Bay Area Air Quality Management District (BAAQMD) guidance and expectations for a qualified Greenhouse Gas Reduction Strategy. It commits the City to track implementation measures and emissions reductions while providing a valuable streamlining tool for reviewing new development and building projects. It allows applicants to demonstrate that they comply with Greenhouse Gas Reduction Strategy measures through utilization of a compliance checklist, saving time and cost for contractors and staff, while ensuring that GHG emissions reduction activities are included in projects. During this time frame, two projects were able to utilize this compliance checklist. San Rafael is currently the only local jurisdiction in Marin County with a Qualified Greenhouse Gas Reduction Strategy.

Climate Adaptation – Sea Level Rise in San Rafael, CA (2014)

This document presents a "white paper" on the topic of sea level rise. This topic has been a growing concern in the last decade as studies continue to report and confirm its direct connection to climate change associated with global warning. This paper was prepared as a 'first step' in responding to the San Rafael Climate Change Action Plan (CCAP), which was adopted in 2009. The CCAP includes several programs related to long-term planning for sea level rise, which recommend, among others, completing an inventory of the public and private levees throughout San Rafael and preparing a vulnerability assessment that would include recommended strategies for adaptation. The white paper is not a technical study nor is it a detailed quantitative analysis of sea level rise or its potential impacts on the community. Further, this paper does not present answers or solutions to sea level rise in San Rafael. Rather, the white paper has been prepared to provide information that can be used in understanding this issue and moving forward to the next steps for long-range planning.

Marin Bay Shoreline Sea Level Rise Assessment (2016)

The County of Marin Department of Public Works and Community Development Agency are the project leads for the Bay Waterfront Adaptation & Vulnerability Evaluation (BayWAVE) program. The program began in September 2015 with funding from County of Marin and additional financial support from the California Coastal Conservancy. An important outcome of the BayWAVE process is an adaptation toolkit and recommendations local municipalities, service districts, and County of Marin can use to update general plans, master plans, capital improvement plans, hazard mitigation plans, and other relevant plans and procedures.

Marin County Stormwater Pollution Prevention Program (MCSPPP)

The City of San Rafael does not have its own Stormwater management plan but it does participate in the MCSPPP. The municipalities in Marin County have been addressing stormwater pollution prevention since the early to mid-1990's. Marin municipalities pursued a countywide program to comply with the Water Board's December 1991 amended Water Quality Control Plan (Basin Plan) requirements for a baseline stormwater program. This Stormwater Management Plan – Action Plan 2010, builds on past successes by continuing to sharpen their focus on protecting and enhancing Marin's watersheds while meeting the permit requirements.

Marin County Community Wildfire Protection Plan (2016)

The City of San Rafael does not have its own CWPP. The City was included in the Marin County CWPP. This Marin County CWPP provides a scientifically based assessment of wildfire threat in the wildland urban interface (WUI) of Marin County, California. The CWPP was developed through a collaborative process involving Marin County fire agencies, county officials, county, state, and federal land management agencies, and community members. 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.

OTHER MITIGATION RELATED PLANS?

City of San Rafael Ordinances

The City General Plan provides policy direction for land use, development, open space protection, and environmental quality; however, this policy direction must be carried out through numerous ordinances, programs, and agreements. The following ordinances are among the most important tools for implementing the General Plan and/or are critical to the mitigation of hazards identified in this plan.

Chapter 4.12 – Wildland Urban Interface

This chapter establishes a Wildland-Urban Interface (WUI) in the city, as described in the city of San Rafael Wildland-Urban Interface (WUI) map, dated July 2, 2007, on file with the city clerk, as it may be amended hereafter from time to time by city council resolution, which is a designation of a very high severity zone as provided in Government Code Section 51179, and within which specific combustible vegetation management standards will be required in order to create defensible space around structures that will minimize the spread of fires from wildlands to structures, from structures to wildlands, and from structures to structures. Vegetation standards are included in this chapter's regulations:

- Any person owning, leasing, controlling, operating or maintaining a property containing a structure in or upon the city wildland-urban interface, and any person owning, leasing controlling, operating or maintaining a property that is adjacent to another property containing such a structure, shall at all times maintain a defensible space within one hundred feet (100′) of such a structure as follows:
  - ✓ Raise the crown of all trees, by removing growth less than three inches (3″) in diameter, from the ground up to a maximum height of ten feet (10′), provided that no crown shall be raised to a point so as to remove branches from more than the lower one-third of the tree's total height;
  - ✓ Cut and remove all dry grasses (by means other than discing, tilling or other soil manipulation) so that their height does not exceed three inches (3″);
  - ✓ Remove all combustible vegetation, provided that single specimens of combustible vegetation are permitted if separated by a distance equal to two (2) times the height of the next adjacent combustible or noncombustible bush on slopes 0 to twenty percent (20%), four (4) times the height of the next adjacent combustible or noncombustible bush on slopes twenty-one (21) to forty percent (40%), and six (6) times the height of the next adjacent combustible or noncombustible bush on slopes exceeding forty percent (40%) as measured from the most outer edge of both bushes.
  - ✓ Exception: Remove all Junipers (genus Juniperus) and Bamboo (genus Bambusa) within fifteen feet (15′) of any structure. Remove all Junipers (genus Juniperus) and Bamboo (genus Bambusa) from fifteen feet (15′) to one hundred feet (100′) of a structure before January 1, 2011. After January 1, 2011, single specimens of Junipers or Bamboo are permitted beyond fifteen feet (15′) of a structure if separated by two (2) times the height of the taller of the nearest bush as measured from the most outer edge of the bush;
  - ✓ Remove or chip the wood of all dead trees and other dead vegetation from the ground that is less than three inches (3″) in diameter, provided that the stump of a dead tree does not need to be removed. Chipping materials left upon the surface of the ground shall not exceed a depth of three inches (3″).

- Any person owning, leasing, controlling, operating or maintaining a property containing a structure in or upon the city wildland-urban interface shall at all times:
  - ✓ Remove combustible vegetation on the ground of the property within ten feet (10′) of any highways, city streets, or private streets used for vehicle traffic;
  - ✓ Remove all vegetation within ten feet (10′) of a chimney outlet;
  - ✓ Remove any portion of trees or brush on the property that overhang any roadway and reach within thirteen feet six inches (13′6″) vertically above the roadway surface;
  - ✓ Remove any combustible vegetation under the eaves, decks or other components of the structure on the property;
  - ✓ Maintain the roof of any structure on the property free of leaves, needles, or dead vegetative growth;
  - ✓ Maintain woodpiles a minimum of two (2) times the height of the woodpile away from any component of the structure on the property.
- To the extent there is any conflict, the vegetation management standards in this section shall supersede the property development standards for protecting the natural state of property

Title 7 – Emergency Services

This chapter establishes the city emergency services organization and provides for the preparation and carrying out of the plans for the protection of persons and property within this city in the event of an emergency; the direction of the emergency organization; and the coordination of the emergency functions of this city with all other public agencies, incorporated areas, corporations, organizations, and affected private persons.

Title 12 – Building Regulations

This Title concerns the regulation of buildings within the City. Relevant chapters of this title include:

- Chapter 12.23.010 - Adoption of California Green Building Standards Code, 2016 Edition- The City council hereby adopts, for the purpose of improving public health, safety and general welfare by enhancing the design and construction of buildings through the use of building practices that reduce negative environmental impact and encourage sustainable construction practices, that certain code known as the 2013 California Green Building Standards Code.
- Chapter 12.40 - UNREINFORCED MASONRY BUILDING MITIGATION PROGRAM- The purpose of this program is to promote public safety and welfare by reducing the risk of death or injury that may result from the effects of earthquakes on unreinforced masonry buildings. Such buildings have been widely recognized for sustaining life-hazardous damage, including partial or complete collapse during moderate to strong earthquakes.

The Planning Division of the Community Development Department provides information on land use, zoning and site development standards and processes applications for land use permits and land divisions.

Title 14 – Building Code and Zoning

This title, Title 14 of the San Rafael Municipal Code, shall be known and cited as "the San Rafael Zoning Ordinance," or, "the zoning ordinance." The zoning ordinance shall consist of the following components:

- A map, or set of maps, known as the zoning map, delineating the boundaries of zoning districts within the city of San Rafael;
- Regulations, known as zoning regulations, governing the use of land, and placement of buildings and improvements within the various classes of districts. Such regulations shall include, but not be limited to, property development standards for each district, parking standards, performance standards, and procedural rules for administering the ordinance.

A copy of the zoning regulations and the zoning map, together with a record of all amendments, shall be kept on file with the city clerk and shall constitute the original record. A copy of the zoning regulations and zoning map currently in effect shall also be kept on file in the planning department. The Code Enforcement Division enforces provisions of the Zoning Ordinance, Housing Code and other City ordinances. The Building Division is responsible for enforcing the various construction codes to insure public safety.

Title 15 – Subdivisions

This title shall be known and cited as the Subdivision Ordinance of the city of San Rafael. The purpose of this title is to provide subdivision regulations for the city of San Rafael and to supplement the provisions of the state of California Government Code Sections 66410 et seq., referred to in this title as the Subdivision Map Act. The regulations of this title are necessary to preserve the public health, safety and general welfare, to promote orderly growth, to provide protection of environmental resources and to ensure provision for adequate utilities, services and traffic circulation when considering matters and actions subject to this title.

All actions and activities subject to the provisions of this title shall conform to all pertinent city-adopted plans, ordinances and environmental guidelines, as follows:

- Conformance with the San Rafael general plan and applicable specific plan or neighborhood plan, the city zoning ordinance (SRMC Title 14), historic resources (SRMC Title 2, Chapter 2.18), archaeological resource protection (SRMC Title 2, Chapter 2.19) and any other pertinent city ordinances or municipal code sections (including but not limited to fire code and building code). Conformance shall be based on those plans and ordinances that are adopted and in effect at time applications are deemed complete for processing, unless, prior to the determination of completeness, the city has initiated by adoption of resolution, ordinance or by motion, an amendment to such plan or ordinance, and has published notice thereof as required by the Subdivision Map Act Section 66474.2.
- Conformance with all guidelines set forth in the most currently adopted city of San Rafael environmental assessment procedures manual and the guidelines of the California Environmental Quality Act (CEQA).

Title 17 – Waters and Waterways

San Rafael tidelands, shorelines, waterways, canals, beaches, or salt marshes are vital natural resources which can provide great benefits to present and future human generations. They offer scenic views, open space, recreational activities such as fishing, swimming, boating, walking, wildlife habitats, opportunities for water transportation and sites for homes and for water-oriented resorts and industries. They fulfill an indispensable role in preserving the climate and air purity of the city.

These benefits could be destroyed or seriously diminished by uncontrolled filling, excavation or construction. Therefore, it is the purpose of this title to encourage the fullest development of these potential

benefits with a minimum of physical disturbance and to set forth the standards and procedures by which filling, excavation and construction in tideland areas will be controlled.

Regulations in this title are provided for:

- Dumping, dredging, and construction within the tidal waterway
- Anchoring and Mooring in the San Rafael Canal and San Rafael Bay
- Watercraft traffic regulations
- Vessel sanitation and dock safety

Title 18 – Protection of Flood Hazard Areas

Floodplain Programs: NFIP survey was designed to help gather information from each jurisdiction to describe the current status of their participation in the NFIP, including existing floodplain management programs and continued compliance with federal requirements and standards. The NFIP contains specific regulatory measures that enable government officials to determine where and how growth occurs relative to identified flood hazards. In return for the meeting minimum regulatory standards, communities make the purchase of flood insurance through NFIP available to its property owners. Participation in the NFIP is voluntary, but is promoted by FEMA as a critical meant to not only make flood insurance available to community residents, but also to implement and sustain an effective, long term hazard mitigation program aimed at reducing future flood losses.

Title 19 – Open Space

The purpose of this title is to set forth basic policy statements which can be utilized in the maintenance, operation and management of open space areas under the jurisdiction of the city. An open space area is any parcel or area of land or water which is essentially unimproved natural landscape area, such as rivers, streams, watershed and shoreline lands, forest and agricultural lands, ridges, hilltops, canyons and other scenic areas, acquired and/or leased by the city for open space purposes.

OTHER MITIGATION RELATED ORDINANCES?

State and Federal Programs

A number of state and federal programs exist to provide technical and financial assistance to local communities for hazard mitigation. Some of the primary agencies/departments that are closely involved with local governments in the administration of these programs include:

- California Office of Emergency Services
- State of California Multi-Hazard Mitigation Plan;
- California Department of Water Resources;
- California Department of Forestry and Fire Protection (CAL FIRE);
- California Environmental Protection Agency;
- California Department of Fish and Game;
- California State Parks and Recreation Department
- California State Lands Commission;
- Federal Emergency Management Agency (Region IX);

- U.S. Army Corps of Engineers;
- Bureau of Reclamation;
- USDA Forest Service;
- National Parks Service;
- USDA Natural Resources Conservation Service;
- U.S. Environmental Protection Agency (Region IX); and
- American Red Cross.

4.4.2. City of San Rafael's Administrative/Technical Mitigation Capabilities

Table 4-76 identifies the City personnel responsible for activities related to mitigation and loss prevention in the City.

Table 4-76 San Rafael – Administrative/Technical Mitigation Capabilities

Administration	Y/N	Describe capability Is coordination effective?
Planning Commission	N	
Mitigation Planning Committee	N	
Maintenance programs to reduce risk (e.g., tree trimming, clearing drainage systems)	Y	Vegetation Management Program
Mutual aid agreements	Y	Marin County Mutual Aid Agreement, State of California Mutual Aid Plan
Other		
Staff	**Y/N FT/PT**	**Is staffing adequate to enforce regulations? Is staff trained on hazards and mitigation? Is coordination between agencies and staff effective?**
Chief Building Official	T/FT/Y	Community Development Department
Floodplain Administrator	Y/FT/Y	Department of Public Works or Community Development Building Official
Emergency Manager	Y/FT/Y	Fire
Community Planner	Y/FT/Y	Community Development Department
Civil Engineer	Y/FT/Y	DPW
GIS Coordinator	Y/FT/Y	DPW
Other		
Technical	**Y/N**	**Describe capability Has capability been used to assess/mitigate risk in the past?**
Warning systems/services (Reverse 911, outdoor warning signals)	Y	
Hazard data and information	Y	Previous Emergency Manager Started a Hazard Mitigation Planning Process
Grant writing	N	
Hazards analysis	Y	Previous Emergency Manager Started a Hazard Mitigation Planning Process
Other		

4.4.3. City of San Rafael's Fiscal Mitigation Capabilities

Table 4-77 identifies financial tools or resources that the City could potentially use to help fund mitigation activities.

Table 4-77 San Rafael – Fiscal Mitigation Capabilities

Funding Resource	Access/ Eligibility (Y/N)	Has the funding resource been used in past and for what type of activities? Could the resource be used to fund future mitigation actions?
Capital improvements project funding	Y	
Authority to levy taxes for specific purposes	Y	San Rafael City Charter
Fees for water, sewer, gas, or electric services	Y	San Rafael Sanitary District (sanitary sewers) San Rafael DPW (storm sewer), PG& E and Marin Clean Energy Utilities
Impact fees for new development	Y	
Storm water utility fee	Y	
Incur debt through general obligation bonds and/or special tax bonds	Y	Measure E-Public Safety Facility Retrofit Projects
Incur debt through private activities		
Community Development Block Grant	Y	
Other federal funding programs		
State funding programs		
Other		

4.4.4. Mitigation Education, Outreach, and Partnerships

Table 4-78 identifies education and outreach programs and methods already in place in the City that could be/or are used to implement mitigation activities and communicate hazard-related information.

Table 4-78 San Rafael – Mitigation Education, Outreach, and Partnerships

Program/Organization	Yes/No	Describe program/organization and how relates to disaster resilience and mitigation. Could the program/organization help implement future mitigation activities?
Local citizen groups or non-profit organizations focused on environmental protection, emergency preparedness, access and functional needs populations, etc.	Yes	Community Emergency Response Team, Marin Conservation League, City of San Rafael Climate Action Team
Ongoing public education or information program (e.g., responsible water use, fire safety, household preparedness, environmental education)	Yes	County Household Hazardous Waste Program, MCSTOPP, Marin County Environmental Health Services, The Bay Institute
Natural disaster or safety related school programs	Yes	Get Ready:
StormReady certification	No	
Firewise Communities certification	No	San Rafael is not a Fire Wise Community. Participation in the program could incentivize vegetation management staff to conduct more community outreach regarding wildfire protection.
Public-private partnership initiatives addressing disaster-related issues		
Other		
How can these capabilities be expanded and improved to reduce risk?		

4.4.5. Other Mitigation Efforts

The City has other mitigation efforts that were not captured in the above sections. Existing Mitigation Capabilities noted by Planning Team are denoted below.

- Wildfire
  - ✓ Established WUI Fire Code, that includes requirements for building materials, sprinkler requirements, etc.
  - ✓ Existing defensible space projects include: goat grazing, brush clearing, juniper and bamboo clearing programs, vegetation management program
  - ✓ Fuels management activities include high risk areas such as Robert Dillard Drive, San Rafael Hill
  - ✓ City Fire Department (and County Fire) have "Hot Shot" crews
- Flood
  - ✓ City has 12 pump stations for flood control, some with backup generators

- ✓ Existing code requires new development to upgrade drainage systems as necessary
- ✓ City has a wetlands overlay for new development

- Earthquake
  - ✓ City has an active URM inventory and retrofit program; all but 4 structures have been retrofitted

- Marin County OES does Tsunami Preparedness Community Workshops. It did one on March 29, 2016 at the Stinson Beach Community Center.

INSERT ANYTHING NOT CAPTURED IN THE TABLES ABOVE

THIS IS WHERE WE WANT TO INCLUDE ALL NOTABLE PAST AND ONGOING MITIGATION TYPE PROJECTS THAT HAVE BEEN OR ARE BEING IMPLEMENTED TO REDUCE THE RISK AND VULNERABILITY OF THE CITY TO HAZARD IMPACTS

Chapter 5 Mitigation Strategy

Requirement §201.6(c)(3): [The plan shall include] a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.

This chapter describes the mitigation strategy process and mitigation action plan for the San Rafael Local Hazard Mitigation Plan (LHMP). It describes how the City met the following requirements from the 10-step planning process:

- Planning Step 6: Set Goals
- Planning Step 7: Review Possible Activities
- Planning Step 8: Draft an Action Plan

5.1 Mitigation Strategy: Overview

The results of the planning process, the risk assessment, the goal setting, the identification of mitigation actions, and the hard work of the Hazard Mitigation Planning Committee (HMPC) led to the action plan in Section 5.4 Mitigation Action Plan. Taking all of the above into consideration, the HMPC developed the following umbrella mitigation strategy for this LHMP:

- **Communicate** the hazard information collected and analyzed through this planning process as well as HMPC success stories so that the community better understands what can happen where and what they can do to be better prepared.
- **Use** existing rules, regulations, policies, and procedures already in existence.
- **Implement** the action plan recommendations of this plan.
- **Monitor** multi-objective management opportunities so that funding opportunities may be shared and packaged and broader constituent support may be garnered.

5.1.1. Continued Compliance with NFIP

Given the flood hazard in the planning area, an emphasis will be placed on continued compliance with the National Flood Insurance Program (NFIP) by the City of San Rafael. Detailed below is a description of the City's flood management program to ensure continued compliance with the NFIP. Also to be considered are the numerous flood mitigation actions contained in this LHMP that support the ongoing efforts by the City to minimize the risk and vulnerability of the community to the flood hazard and to enhance their overall floodplain management program.

San Rafael's Flood Management Program

San Rafael has participated in the Regular Phase of the NFIP since 1984. Since then, the City has administered floodplain management regulations that meet the minimum requirements of the NFIP. Under

that arrangement, residents and businesses paid the same flood insurance premium rates as most other communities in the country.

The Community Rating System (CRS) was created in 1990. It is designed to recognize floodplain management activities that are above and beyond the NFIP's minimum requirements. If a community implements public information, mapping, regulatory, loss reduction and/or flood preparedness activities and submits the appropriate documentation to the FEMA, then its residents can qualify for a flood insurance premium rate reduction. The City does not currently participate in the CRS program, but will evaluate the overall value of joining CRS in the future during the implementation phase of this LHMP.

Presently, the City manages its floodplains in compliance with NFIP requirements and implements a floodplain management program designed to protect the people and property of the City. Floodplain regulations are a critical element in local floodplain management and are a primary component in the City's participation in the NFIP. As well, the City's floodplain management activities apply to existing and new development areas, implementing flood protection measures for structures and maintaining drainage systems to help reduce the potential of flooding within the City.

The City will continue to manage their floodplains in continued compliance with the NFIP. An overview of the City's NFIP status and floodplain management program are discussed on Table 5-1. TABLE NEEDS TO BE FILLED OUT

Table 5-1 San Rafael NFIP Status

NFIP Topic	Comments
Insurance Summary	
How many NFIP policies are in the community? What is the total premium and coverage?	1,966 $2,804,671 $561,195,100
How many claims have been paid in the community? What is the total amount of paid claims? How many of the claims were for substantial damage?	433 $5,644,337.14 11
How many structures are exposed to flood risk within the community?	2,249 improved residential parcels (1%) 2,442 improved residential parcels (0.2%)
Describe any areas of flood risk with limited NFIP policy coverage	
Community Floodplain Administration	
Is the Community Floodplain Administrator or NFIP Coordinator certified?	
Provide an explanation of NFIP administration services (e.g., permit review, GIS, education or outreach, inspections, engineering capability)	
What are the barriers to running an effective NFIP program in the community, if any?	
Compliance History	
Is the community in good standing with the NFIP?	Y
Are there any outstanding compliance issues (i.e., current violations)?	

NFIP Topic	Comments
When was the most recent Community Assistance Visit (CAV) or Community Assistance Contact (CAC)?	9/30/2008
Is a CAV or CAC scheduled or needed?	
Regulation	
When did the community enter the NFIP?	5/1/1984
Are the FIRMs digital or paper?	Digital
Do floodplain development regulations meet or exceed FEMA or State minimum requirements? If so, in what ways?	
Provide an explanation of the permitting process.	
Community Rating System (CRS)	
Does the community participate in CRS?	No
What is the community's CRS Class Ranking?	N/A
What categories and activities provide CRS points and how can the class be improved?	N/A
Does the plan include CRS planning requirements?	N/A

Source: FEMA/San Rafael

5.1.2. Integration of Mitigation with Post Disaster Recovery and Mitigation Strategy Funding Opportunities

Hazard Mitigation actions are essential to weaving long-term resiliency into all community recovery efforts so that at-risk infrastructure, development, and other community assets are stronger and more resilient for the next severe storm event. Mitigation measures to reduce the risk and vulnerability of a community to future disaster losses can be implemented in advance of a disaster event and also as part of post-disaster recovery efforts.

Mitigation applied to recovery helps communities become more resilient and sustainable. It is often most efficient to fund all eligible infrastructure mitigation through FEMA's Public Assistance mitigation program if the asset was damaged in a storm event. Mitigation work can be added to project worksheets if they can be proven to be cost-beneficial.

Integration of mitigation into post disaster recovery efforts should be considered by all communities as part of their post disaster redevelopment and mitigation policies and procedures. As described in Section 4.4, the Capability Assessment for San Rafael, post-disaster redevelopment and mitigation policies and procedures are being evaluated and updated as part of the Emergency Operations Plan (EOP) update.

The EOP, through its policies and procedures, seek to mitigate the effects of hazards, prepare for measures to be taken which will preserve life and minimize damage, enhance response during emergencies and provide necessary assistance, and establish a recovery system in order to return the community to their normal state of affairs. Mitigation is emphasized as a major component of recovery efforts.

Mitigation Strategy Funding Opportunities

An understanding of the various funding streams and opportunities will enable the communities to match identified mitigation projects with the grant programs that are most likely to fund them. Additionally, some of the funding opportunities can be utilized together. Mitigation grant funding opportunities available pre- and post- disaster include the following.

FEMA Hazard Mitigation Assistance (HMA) Grants

Cal OES administers three main types of HMA grants: (1) Hazard Mitigation Grant Program, (2) Pre-Disaster Mitigation Program, and (3) Flood Mitigation Assistance Program. Eligible applicants for the HMA include state and local governments, certain private non-profits, and federally recognized Indian tribal governments. While private citizens cannot apply directly for the grant programs, they can benefit from the programs if they are included in an application sponsored by an eligible applicant

FEMA Public Assistance Section 406 Mitigation

The Robert T. Stafford Disaster Relief and Emergency Assistance Act provides FEMA the authority to fund the restoration of eligible facilities that have sustained damage due to a presidentially declared disaster. The regulations contain a provision for the consideration of funding additional measures that will enhance a facility's ability to resist similar damage in future events.

Community Development Block Grants

The California Department of Housing and Community Development administers the State's Community Development Block Grant (CDBG) program with funding provided by the U.S. Department of Housing and Urban Development. The program is available to all non-entitlement communities that meet applicable threshold requirements. All projects must meet one of the national objectives of the program – projects must benefit 51 percent low- and moderate-income people, aid in the prevention or clearance of slum and blight, or meet an urgent need. Grant funds can generally be used in federally declared disaster areas for CDBG eligible activities including the replacement or repair of infrastructure and housing damaged during, or as a result of, the declared disaster.

Small Business Loans

SBA offers low-interest, fixed-rate loans to disaster victims, enabling them to repair or replace property damaged or destroyed in declared disasters. It also offers such loans to affected small businesses to help them recover from economic injury caused by such disasters. Loans may also be increased up to 20 percent of the total amount of disaster damage to real estate and/or leasehold improvements to make improvements that lessen the risk of property damage by possible future disasters of the same kind.

Increased Cost of Compliance

Increased Cost of Compliance (ICC) coverage is one of several resources for flood insurance policyholders who need additional help rebuilding after a flood. It provides up to $30,000 to help cover the cost of

mitigation measures that will reduce flood risk. ICC coverage is a part of most standard flood insurance policies available under NFIP.

5.2 Goals and Objectives

Requirement §201.6(c)(3)(i): [The hazard mitigation strategy shall include a] description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.

Up to this point in the planning process, the HMPC has organized resources, assessed hazards and risks, and documented mitigation capabilities. The resulting goals, objectives, and mitigation actions were developed based on these tasks. The HMPC held a series of meetings and exercises designed to achieve a collaborative mitigation strategy as described further throughout this section. Appendix C documents the information covered in these mitigation strategy meetings, including information on the goals development and the identification and prioritization of mitigation alternatives by the HMPC.

During the initial goal-setting meeting, the HMPC reviewed the results of the hazard identification, vulnerability assessment, and capability assessment. This analysis of the risk assessment identified areas where improvements could be made and provided the framework for the HMPC to formulate planning goals and objectives and to develop the mitigation strategy for San Rafael.

Goals were defined for the purpose of this mitigation plan as broad-based public policy statements that:

- Represent basic desires of the community;
- Encompass all aspects of community, public and private;
- Are nonspecific, in that they refer to the quality (not the quantity) of the outcome;
- Are future-oriented, in that they are achievable in the future; and
- A time-independent, in that they are not scheduled events.

Goals are stated without regard to implementation. Implementation cost, schedule, and means are not considered. Goals are defined before considering how to accomplish them so that they are not dependent on the means of achievement. Goal statements form the basis for objectives and actions that will be used as means to achieve the goals. Objectives define strategies to attain the goals and are more specific and measurable.

HMPC members were given a list of sample goals to consider. They were told that they could use, combine, or revise the statements provided or develop new ones, keeping the risk assessment in mind. Each member was each given three index cards and asked to write a goal statement on each card. Goal statements were collected and grouped into similar themes and pasted onto the wall of the meeting room. The goal statements were then grouped into similar topics. New goals from the HMPC were discussed until the team came to consensus. Some of the statements were determined to be better suited as objectives or actual mitigation actions and were set aside for later use. Next, the HMPC developed objectives that summarized strategies to achieve each goal.

Based on the risk assessment review and goal setting process, the HMPC identified the following goals and objectives, which provide the direction for reducing future hazard-related losses within San Rafael.

GOAL 1: Minimize risk and vulnerability of the City of San Rafael to the impacts of natural hazards, and protect lives and reduce damages and losses to property, public health, economy, and the environment.

Objectives:

- Protect life and reduce exposure and hazard losses to City residents, businesses, vulnerable populations, and visitors
- Increase community resiliency to the impacts of natural hazards and promote sustainable growth
- Protect and enhance quality of life in the City
- Assure long term protection and resiliency of existing and future redevelopment from natural hazards
- Protect critical facilities from natural hazards and minimize interruption of essential infrastructure, utilities, and services
- Plan for and prioritize measures to respond to and address potential short- and long- term hazard impacts associated with climate change

GOAL 2: Enhance public outreach, awareness, education, and preparedness for all hazards to minimize hazard related losses

Objectives:

- Engage the community in disaster awareness and prevention education to reduce the risk and vulnerability of natural hazard impacts on quality of life
- Improve the communities' understanding of natural hazards and how to effectively be prepared and take action to mitigate the impacts of hazard events
- Develop and target outreach and education for each hazard type and risk area
- Support and encourage public responsibility
- Enhance public outreach programs to target vulnerable populations, including multi-language communications

GOAL 3: Improve City's resiliency and capabilities to mitigate losses and to be prepared for, respond to, and recover from a disaster event

Objectives:

- Take a proactive approach to identifying and mitigating hazards
- Maintain current service levels
- Continued enhancements to community capabilities, leveraging new technologies to reduce losses and save lives
- Provide protection and increase safety for City employees and first responders from hazards

GOAL 4: Maintain FEMA Eligibility/Position Jurisdictions for Grant Funding

Objectives:

- Maintain good standing with FEMA and State hazard mitigation programs, regulations and requirements
- Develop an overall mitigation funding strategy to prioritize and pursue mitigation projects, including identification and tracking of federal, state, and local grant programs and funding mechanisms

5.3 Identification and Analysis of Mitigation Actions

Requirement §201.6(c)(3)(ii): [The mitigation strategy shall include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.

In order to identify and select mitigation actions to support the mitigation goals, each hazard identified in Section 4.1 Identifying Hazards was evaluated. Only those hazards that were determined to be a priority hazard at the completion of the risk assessment were considered further in the development of hazard-specific mitigation actions.

These priority hazards (in alphabetical order) are:

- Climate Change
- Coastal Flooding and sea level rise
- Drought and Water Shortage
- Earthquake
- Earthquake: Liquefaction
- Flood: (100/500 year)
- Flood: Localized/Stormwater
- Landslide, Mudslides, Hillside Erosion, and Debris Flows
- Levee Failure
- Severe Weather: Heavy Rains and Storms
- Wildfire

The HMPC eliminated the hazards identified below from further consideration in the development of mitigation actions because the risk of a hazard event in the City is unlikely or nonexistent, the vulnerability of the City is low, or capabilities are already in place to mitigate negative impacts. The eliminated hazards are:

- Dam Failure
- Severe Weather: Extreme Heat
- Tsunami

The dam failure and extreme heat hazards were determined not to be a priority hazard by the HMPC after completion of the Hazard Profiles component of the risk assessment; the Tsunami hazard was eliminated as a priority hazard to the City after completion of the full Risk Assessment.

It is important to note, however, that all the hazards addressed in this plan are included in the City multi-hazard public education and outreach mitigation action as well as in other multi-hazard, emergency management and technology improvement actions.

Once it was determined which hazards warranted the development of specific mitigation actions, the HMPC analyzed viable mitigation options that supported the identified goals and objectives. The HMPC was provided with the following list of categories of mitigation actions, which originate from the Community Rating System:

- Prevention (required to be evaluated)
- Property protection
- Structural projects
- Natural resource protection
- Emergency services
- Public information

The HMPC was provided with examples of potential mitigation actions for each of the above categories. The HMPC was also instructed to consider both existing and future buildings in considering possible mitigation actions. A facilitated discussion then took place to examine and analyze mitigation options by category. Also utilized in the review of possible mitigation measures is FEMA's publication on Mitigation Ideas, by hazard type. Prevention type mitigation alternatives were discussed for each of the priority hazards. This was followed by a brainstorming session that generated a list of preferred mitigation actions by hazard.

5.3.1. Prioritization Process

Once the mitigation actions were identified, the HMPC was provided with several decision-making tools, including FEMA's recommended prioritization criteria, STAPLEE sustainable disaster recovery criteria; Smart Growth principles; and others, to assist in deciding why one recommended action might be more important, more effective, or more likely to be implemented than another. STAPLEE stands for the following:

- Social: Does the measure treat people fairly? (e.g., different groups, different generations)
- Technical: Is the action technically feasible? Does it solve the problem?
- Administrative: Are there adequate staffing, funding, and other capabilities to implement the project?
- Political: Who are the stakeholders? Will there be adequate political and public support for the project?
- Legal: Does the jurisdiction have the legal authority to implement the action? Is it legal?
- Economic: Is the action cost-beneficial? Is there funding available? Will the action contribute to the local economy?
- Environmental: Does the action comply with environmental regulations? Will there be negative environmental consequences from the action?

In accordance with the DMA requirements, an emphasis was placed on the importance of a benefit-cost analysis in determining action priority. Other criteria used to assist in evaluating the benefit-cost of a mitigation action includes:

- Contribution of the action to save life or property
- Availability of funding and perceived cost-effectiveness
- Available resources for implementation
- Ability of the action to address the problem

The Mitigation Strategy Meeting Handout, which included hazard summaries, mitigation action categories, samplehazard actions, and prioritization criteria are included in Appendix C.

With initial lists of potential mitigation actions identified and the prioritization criteria in mind, HMPC members were each given a set of nine colored dots, three each of red, blue, and green. The dots were assigned red for high priority (worth five points), blue for medium priority (worth three points), and green

for low priority (worth one point). The team was asked to use the dots to prioritize actions considering the various prioritization criteria reviewed for this effort. The point score for each action was totaled. Appendix C contains the total score given to each identified mitigation action.

Figure 5-1 Mitigation Action Prioritization

Source: City of San Rafael

The process of identification and analysis of mitigation alternatives allowed the HMPC to come to consensus and to prioritize recommended mitigation actions. During the voting process, emphasis was placed on the importance of a benefit-cost review in determining project priority; however, this was not a quantitative analysis. The team agreed that prioritizing the actions collectively enabled the actions to be ranked in order of relative importance and helped steer the development of additional actions that meet the more important objectives while eliminating some of the actions which did not garner much support.

Benefit-cost was also considered in greater detail in the development of the Mitigation Action Plan detailed below in Section 5.4. The cost-effectiveness of any mitigation alternative will be considered in greater detail through performing benefit-cost project analyses when seeking FEMA mitigation grant funding for eligible actions associated with this plan.

Recognizing the limitations in prioritizing actions from multiple jurisdictions and departments and the regulatory requirement to prioritize by benefit-cost to ensure cost-effectiveness, the HMPC decided to pursue actions that contributed to saving lives and property as first and foremost, with additional consideration given to the benefit-cost aspect of a project. This process drove the development of a determination of a high, medium, or low priority for each mitigation action, and a comprehensive prioritized action plan for the City of San Rafael.

5.4 Mitigation Action Plan

Requirement §201.6(c)(3)(iii): [The mitigation strategy section shall include] an action plan describing how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.

This action plan was developed to present the recommendations developed by the HMPC for how the City of San Rafael can reduce the risk and vulnerability of people, property, infrastructure, natural and cultural resources, and economic impacts to future disaster losses. Emphasis was placed on both existing and future development. The action plan summarizes who is responsible for implementing each of the prioritized actions as well as when and how the actions will be implemented. Each action summary also includes a discussion of the benefit-cost review conducted to meet the regulatory requirements of the DMA 2000.

Table 5-2 provides a summary of mitigation actions and lead jurisdiction for each action. Following this summary table of mitigation actions, a detailed implementation description is included for each mitigation action identified in the table. Note that the table of mitigation actions and associated implementation descriptions for each action is organized in two section. The first section includes those mitigation actions provided by the City Planning Team for this LHMP and the second section includes mitigation actions submitted by the public and/or other key stakeholders. The implementation of any mitigation action in this plan is subject to available funding and partnership of the City as the primary implementing agency for this LHMP.

As described throughout this LHMP, San Rafael has many risks and vulnerabilities to identified hazards. Although many possible mitigation actions, as detailed in Appendix C, were brainstormed and prioritized during the mitigation strategy meetings, the resulting mitigation strategy presented in this Chapter 5 of this LHMP focuses only on those mitigation actions that are both reasonable and realistic for the community to consider for implementation over the next 5-years covered by this plan. Thus, only a portion of the actions identified in Appendix C have been carried forward into the mitigation strategy presented in Table 5-2. Although many good ideas were developed during the mitigation action brainstorming process, the reality of determining which priority actions to develop and include in this plan came down to the actual priorities of individuals and departments based in part on department direction, staffing, and available funding. The overall value of the mitigation action table in Appendix C is that it represents a wide-range of mitigation actions that can be consulted and developed for this plan at a later date during annual plan reviews and/or the formal 5-year update process.

It is important to note that San Rafael has numerous existing, detailed action descriptions, which include benefit-cost estimates, in other planning documents, such as community wildfire protection plan/fire plans, climate change and sea level rise plans, and capital improvement budgets and reports. These actions are considered to be part of this plan, and the details, to avoid duplication, should be referenced in their original source document. The HMPC also realizes that new needs and priorities may arise as a result of a disaster or other circumstances and reserves the right to support new actions, as necessary, as long as they conform to the overall goals of this plan.

It should also be clarified that the actions included in this mitigation strategy are subject to further review and refinement; alternatives analyses; and reprioritization due to funding availability and/or other criteria. The City of San Rafael is not obligated by this document to implement any or all of these projects. Rather this mitigation strategy represents the desires of the community to mitigate the risks and vulnerabilities from identified hazards. The actual selection, prioritization, and implementation of these actions will also be further evaluated in accordance with the CRS mitigation categories and criteria contained in Appendix C, and as always subject to funding availability.

Further, many of these mitigation efforts are collaborative efforts among multiple local, state, and federal agencies. In addition, the public outreach action, as well as many of the emergency services actions, apply to all hazards regardless of hazard priority.

Table 5-2 San Rafael's City Planning Team Mitigation Actions

Hazard/ Mitigation Action Title	Goals Addressed	Address Existing Development	Address Future Development	Continued Compliance with NFIP	CRS Category
Multi-Hazard Mitigation Actions					
1. Integrate Local Hazard Mitigation Plan into Safety Element of General Plan	1, 2, 3, 4	X	X	X	Prevention
2. Identify the locations then subsequently equip, stock and train staff in order to establish emergency evacuation shelters used to temporary house people during major emergencies.	1, 2, 3, 4	X	X		Emergency Services
3. Update the San Rafael Emergency Operations Center (EOC) Handbook	1, 2, 3	X	X		Emergency Services
4. Outfit and equip the City's new Emergency Operation's Center (EOC) scheduled for operation in Calendar Year 2019	1, 2, 3, 4	X	X		Emergency Services
5. Plan, prepare, conduct community outreach and deploy emergency evacuation exercises in neighborhoods prone to wildfire or tidal flooding during extreme wet weather periods.	1, 2, 3, 4	X	X	X	Emergency Services Public Information
6. Bayside Acres Beach Sewer Relocation/Replacement	1, 2, 3, 4	X	X	X	Property Protection Structural
7. Beach Drive (Fiberglass) Pump Station and Sewer Rehabilitation	1, 2, 3, 4	X	X	X	Property Protection Structural
8. Recruit and ultimate appoint a new Emergency Management Coordinator (EMC) to fill vacant post.	1, 2, 3	X	X		Emergency Services
9. Evaluate and Implement signal timing for first responders	1, 2, 3	X	X		Emergency Services
10. Tree Safety Maintenance Program	1, 2, 3	X	X		Property Protection
11. Purchase and installation of EMTRAC signal control equipment into 17 San Rafael Fire Vehicles and 25 intersections.	1, 2, 3	X	X		Emergency Services
Climate Change Actions					
12. Elevate/Raise Low Lying Roadways	1, 2, 3, 4	X	X	X	Property Protection Structural

Hazard/ Mitigation Action Title	Goals Addressed	Address Existing Development	Address Future Development	Continued Compliance with NFIP	CRS Category
13. Elevate Critical Infrastructure	1, 2, 3, 4	X	X	X	Property Protection Structural
14. Improvements to Existing Berms, Levees and Flood Control Systems	1, 2, 3, 4	X	X	X	Property Protection Structural Natural Resource Protection
15. Continued involvement in the BayWAVE county-wide vulnerability assessment (Phase 1 and 2); Implement resulting strategies from Phase 2 of the program.	1, 2, 3, 4	X	X	X	Prevention Property Protection Structural Natural Resource Protection Public Outreach
16. Develop a climate adaptation plan, and implement resulting strategies	1, 2, 3, 4	X	X	X	Prevention Property Protection Structural Natural Resource Protection Public Outreach
17. Develop an energy storage plan	1, 2, 3	X	X		Prevention Property Protection Structural
Drought Mitigation Actions					
18. Water Storage Facility Study	1, 2, 3, 4	X	X		Prevention Property Protection Structural
19. Leaky Pipe Replacement Program	1, 2, 3, 4	X	X		Property Protection
20. Marin Municipal Water District exploration of desalination plants	1, 2, 3	X	X		Property Protection Structural
21. Evaluate the use of reclaimed water/increase purple pipes	1, 2, 3	X	X		Property Protection Structural
22. Evaluate and enhance conservation measures to reduce water consumption	1, 2, 3, 4	X	X		Prevention Property Protection

Hazard/ Mitigation Action Title	Goals Addressed	Address Existing Development	Address Future Development	Continued Compliance with NFIP	CRS Category
Earthquake Mitigation Actions					
23. Retrofit/upgrade four remaining URM's	1, 2, 3, 4	X	X		Property Protection Structural
24. Earthquake Hazard Study	1, 2, 3, 4	X	X		Prevention
25. Public Facility Vulnerability Assessment and Improvements	1, 2, 3, 4	X	X		Property Protection Structural
Flood Mitigation Actions					
26. Develop and Maintain a Community Rating System (CRS)	1, 2, 3, 4	X	X	X	Prevention Property Protection Structural Natural Resource Protection Public Outreach Emergency Services
27. Beach Drive Structural Flood Protection	1, 2, 3, 4	X	X	X	Property Protection Structural
28. Adopt a Drain Program	1, 2, 3, 4	X	X	X	Prevention Property Protection
29. City Pump Station Analysis and Improvements	1, 2, 3, 4	X	X	X	Prevention Property Protection Structural
30. City Storm Drain System Analysis and Improvements	1, 2, 3, 4	X	X	X	Prevention Property Protection Structural
31. City Flood Alert System	1, 2, 3, 4	X	X	X	Emergency Services
Landslide Mitigation Actions					
32. 70-96 Bret Harte Sewer Easement Repair	1, 2, 3, 4	X	X		Property Protection Structural

Hazard/ Mitigation Action Title	Goals Addressed	Address Existing Development	Address Future Development	Continued Compliance with NFIP	CRS Category
33. Landslide Identification and Management Program	1, 2, 3, 4				Prevention Property Protection Structural Natural Resource Protection
Wildfire Mitigation Actions					
34. Funding for Vegetation Management Coordinator Position	1, 2, 3, 4	X	X		Prevention Property Protection
35. Create a City of San Rafael specific Community Wildfire Protection Plan (CWPP).	1, 2, 3, 4	X	X		Prevention Property Protection Natural Resource Protection
36. Create new strategic fuel interruption zones in WUI areas and maintain and expand existing fuel interruption zones already in place.	1, 2, 3, 4	X	X		Prevention Property Protection Natural Resource Protection
37. Juniper and Bamboo Clearing Program from Residential Properties within WUI.	1, 2, 3, 4	X	X		Prevention Property Protection Natural Resource Protection
38. Create new point specific wildfire prevention programs specifically targeting areas where homeless encampments are known to exist.	1, 2, 3, 4	X	X		Prevention Property Protection Natural Resource Protection

Table 5-3 Public/Other Stakeholder Mitigation Actions

Hazard/ Mitigation Action Title	Goals Addressed	Address Existing Development	Address Future Development	Continued Compliance with NFIP	CRS Category
39. East San Rafael Shore Project: Plan	1, 2, 3, 4	X	X	X	Prevention Property Protection Structural Natural Resource Protection Public Outreach
40. East San Rafael Shore Project: Permitting and Construction	1, 2, 3, 4	X	X	X	Prevention Property Protection Structural Natural Resource Protection Public Outreach

San Rafael's City Planning Team Mitigation Actions

Multi-Hazard Mitigation Actions

Action 1. Integrate Local Hazard Mitigation Plan into Safety Element of General Plan

Hazards Addressed: All hazards

Goals Addressed: 1, 2, 3, 4

Issue/Background: Local jurisdictional reimbursement for mitigation projects and cost recovery after a disaster is guided by Government Code Section 8685.9 (AB 2140). Specifically, this section requires that each jurisdiction adopt a local hazard mitigation plan (LHMP) in accordance with the federal Disaster Mitigation Act of 2000 as part of the Safety Element of its General Plan. Adoption of the LHMP into the Safety Element of the General Plan may be by reference or incorporation.

Other Alternatives: No action

Existing Planning Mechanisms through which Action will be Implemented: Safety Element of General Plan

Responsible Office: San Rafael Planning Department

Priority (H, M, L): High

Cost Estimate: City staff time

Potential Funding: Existing

Benefits (avoided Losses): Incorporation of an adopted LHMP into the Safety Element of the General Plan will help jurisdictions maximize the cost recovery potential following a disaster.

Schedule: As soon as possible

Action 2. Identify the Locations then Subsequently Equip, Stock and Train Staff in Order to Establish Emergency Evacuation Shelters used to Temporary House People During Major Emergencies.

Hazards Addressed: All Hazards, Disaster Management

Goals Addressed: 1, 2, 3, 4

Issue/Background: The City of San Rafael presently has no formally established capability to open emergency evacuation shelters should civilians need to be temporarily accommodated during a major emergency. There will likely be the need in the future to temporarily shelter civilians in a portion of the community that need to evacuate due to imminent danger or inhabitable conditions due to a major emergency.

Project Description: To research, identify and secure disaster shelter sites and subsequently purchase the equipment, supplies and materials needed. In addition, staff training, both initial and over the long term will be necessary.

Other Alternatives: American Red Cross

Existing Planning Mechanism(s) through which Action Will Be Implemented: Using staff from other City Departments that can assist, the City's emergency management coordinator (EMC) will oversee the planning and execution of this project. The American Red Cross and Salvation Army will be asked to partner with the research, planning and when necessary the activation of disaster shelters.

Responsible Office/Partners:

- City of San Rafael Fire Department, Emergency Management Coordinator
- American Red Cross
- Salvation Army

Project Priority: High

Cost Estimate: $250,000

Benefits (Losses Avoided): Due to geographical location, the City of San Rafael is prone to disaster stemming from earthquake, wildfire, flood and other types of regional disasters. Such incidents can, based on magnitude and duration, tax local resources, based on event magnitude and duration. It is likely that it will be necessary to temporarily accommodate evacuees from a disaster stricken area to a shelter that can accommodate basic needs until normalcy is restored. This effort will minimize impacts and protect the residents and visitors of the City.

Potential Funding: Grant Funding. General Funding possible.

Timeline: Immediate

Action 3. Update the San Rafael Emergency Operations Center (EOC) Handbook

Hazards Addressed: All Hazards, Disaster Management

Issue/Background: The City of San Rafael's existing EOC Handbook is a useful comprehensive document designed to provide succinct critical information to those City staff persons who have EOC responsibility. However, the current Handbook document is outdated, having been approved in 2007. Thus, much of the information in the document is out of date.

Goals Addressed: 1, 2, 3

Project Description: The City's Emergency Management Coordinator (EMC) will oversee the updated of the EOC document. The EMC will revise the document to reflect current terminology and address the facility technology advances that have occurred since the current document was drafted. Most significantly,

the EMC will publish the updated EOC Handbook to reflect the City's new EOC facility that will soon be in the construction phase in the City's new Public Safety Center.

Other Alternatives: None at this time.

Existing Planning Mechanism(s) through which Action Will Be Implemented: The City's EMC will utilize institutional knowledge ensuring that the updated EOC Handbook meets industry standard design and terminology. The EMC will ensure that the Handbook is published, tested and if necessary revised to ensure that the document is ready to be utilized in the new EOC by calendar year 2019.

Responsible Office/Partners: City of San Rafael Fire Department; Emergency Management Coordinator

Project Priority: High

Cost Estimate: $25,000

Benefits (Losses Avoided): Due to geographical location, the City of San Rafael is prone to disaster stemming from earthquake, wildfire, flood and other types of regional disasters. Such incidents can, based on magnitude and duration, tax local resources, based on event magnitude and duration. An EOC is essential towards assisting agency staff to properly manage the event. Due to the infrequency of large scale events needing EOC activation, a well prepared and up-to-date EOC Handbook is an important tool to enable City staff to quickly assemble and activate the EOC. This handbook will assist the City in minimizing losses and protecting the residents and visitors to the City.

Potential Funding: Grant Funding. General Funding possible.

Timeline: To be prepared during late 2017 and 2018 calendar years.

Action 4. Outfit and Equip the City's new Emergency Operation's Center (EOC) Scheduled for Operation in Calendar Year 2019.

Hazards Addressed: All Hazards, Disaster Management

Goals Addressed: 1, 2, 3, 4

Issue/Background: The City of San Rafael is now in the process of constructing a new joint police-fire public safety facility (PSC). Within the facility will be a new EOC. Although the space is formally designated into the design, equipment, supplies and materials are not part of the PSC budget. The identification and subsequent purchase will be necessary however other funding solutions will need to be located.

Project Description: To research, identify and subsequently purchase the equipment, supplies and materials for the City's new EOC.

Other Alternatives: None at this time.

Existing Planning Mechanism(s) through which Action Will Be Implemented: The City's emergency management coordinator (EMC) will oversee this function to ensure that when the PSC is ready to occupy in CY 2019, the EOC is ready to utilize.

Responsible Office/Partners: City of San Rafael Fire Department; Emergency Management Coordinator

Project Priority: High

Cost Estimate: $200,000

Benefits (Losses Avoided): Due to geographical location, the City of San Rafael is prone to disaster stemming from earthquake, wildfire, flood and other types of regional disasters. Such incidents can, based on magnitude and duration, tax local resources, based on event magnitude and duration. An EOC is essential towards assisting agency staff to properly manage the event. Due to the infrequency of large scale events needing EOC activation. If equipped properly, the City's new EOC will enable staff to effectively manage the incident over a long term period. This handbook will assist the City in minimizing losses and protecting the residents and visitors to the City.

Potential Funding: Grant Funding. General Funding possible.

Timeline: Planning in 2018 with purchase and installation in 2019.

Action 5. Plan, Prepare, Conduct Community Outreach and Deploy Emergency Evacuation exercises in Neighborhoods Prone to Wildfire or Tidal Flooding during Extreme Wet Weather Periods.

Hazards Addressed: All Hazards, Disaster Management

Goals Addressed: 1, 2, 3, 4

Issue/Background: The City of San Rafael has several neighborhoods that fall within either the WUI or flood zone areas. Systematic evacuation and emergency sheltering of those within these identified areas is critical to the mission of promoting life safety during times of disaster.

Project Description: To first identify the neighborhood areas that could be potentially impacted by wildfire or tidal flooding. (2). Conduct public outreach into these areas to solicit input and determine level of interest. (3). Establish and publish evacuation routes. (4) Identify disaster shelter locations appropriate for each neighborhood area. (5) Develop plans and procedures. (6) Hold neighborhood workshops and evacuation drills. (7) Adjust as needed.

Other Alternatives: None at this time.

Existing Planning Mechanism(s) through which Action Will Be Implemented: The City's emergency management coordinator (EMC) will oversee this process. Future updates to the City's EOP and Evacuation Plans will incorporate and address these items.

Responsible Office/Partners:

- City of San Rafael Fire Department, Emergency Management Coordinator.

- American Red Cross.
- Salvation Army

Project Priority: High

Cost Estimate: $200,000

Benefits (Losses Avoided): Due to geographical location, the City of San Rafael is prone to disaster stemming from wildfire and flooding. Such incidents can, based on magnitude and duration, tax local resources, based on event magnitude and duration. Safe and effective evacuation of those impacted by such emergencies and subsequent sheltering is essential to minimize loss of life, injury or excessive hardship. This type of planning and exercises will protect lives and minimize losses to the City.

Potential Funding: Grant Funding. General Funding possible.

Timeline: Planning in 2018 into 2019.

Action 6. Bayside Acres Beach Sewer Relocation/Replacement

Hazards Addressed: Climate change/Coastal Flooding/Sea Level Rise/Heavy Rains & Storms

Goals Addressed: 1, 2, 3, 4

Issue/Background: There are 20 homes located along a beach, where the homes are lower than the District sewers in the street. The sewer main that serves these homes are located on the beach within the tidal zone and were installed in 1972. The sewer main is difficult to maintain, since they are only accessible during low tide and the salt water has degraded the concrete and corroded the manhole access covers Some laterals are located above ground and being damaged from age and wave action erosion.

Project Description: Abandon the existing sewer main on the beach and reroute the laterals to the sewer main in the street, which will require a pumped collection system.

Other Alternatives: Replace/repair existing sewer main; however, it will require maintenance access to the manholes and permits from San Francisco Bay Conservation & Development Commission, Army Corps of Engineers, and State Regional Water Quality Control Board, which is unknown if it's allowed until District completes permit process.

Existing Planning Mechanism(s) through which Action Will Be Implemented: Capital Improvement Program

Responsible Office/Partners: San Rafael Sanitation District

Project Priority: High

Cost Estimate: $2.5 Million

Benefits (Losses Avoided): Wastewater discharging directly into San Francisco Bay; Maintenance accessibility

Potential Funding: Capital Improvement Program

Timeline: FY 16/17 to FY 18/19

Action 7. Beach Drive (Fiberglass) Pump Station and Sewer Rehabilitation

Hazards Addressed: Climate change/Coastal Flooding/Sea Level Rise/Heavy Rains & Storms

Goals Addressed: 1, 2, 3, 4

Issue/Background: In 1972, the pump station and 6,400 LF of 6" Vitrified Clay Pipe and Asbestos Concrete Pipe that flows into the pump station were built. The pump station and manhole lids are below flood elevation. Beach Drive, where the pump station is located, is a road where one side is the San Francisco Bay and the opposite side of the road is a low lying area, where high tides would flow in, under Beach Drive through a pipe. This low lying area has 1,350 LF of Asbestos Concrete Pipe with 4 manholes. During the January 2017 storms and high tide, the low lying area and Beach Drive was flooded and overwhelmed the sewer and pump station, resulting in a sanitary sewer overflow.

Project Description: Replace pump station and install above flood elevations; and replace 6,400 LF of pipe.

Other Alternatives: None

Existing Planning Mechanism(s) through which Action Will Be Implemented: Capital Improvement Program

Responsible Office/Partners: San Rafael Sanitation District

Project Priority: High

Cost Estimate: $ 3 million

Benefits (Losses Avoided): Damage to private property, including residential dwellings; Non-operational/undersized pump station; Sewer spills; Health & Safety

Potential Funding: Capital Improvement Program

Timeline: FY 18/19 to FY 19/20

Action 8. Recruit and ultimate appoint a new Emergency Management Coordinator (EMC) to Fill Vacant Post.

Hazards Addressed: All Hazards, Disaster Management

Goals Addressed: 1, 2, 3

Issue/Background: The City of San Rafael's EMC position has been vacant for several months. Due to budget constraints, the likelihood of filling the position using general fund revenues has been placed on hold. It will be necessary to locate other funding sources to at least partially fund this position.

Project Description: Once funding sources are located, the City would hold an open recruitment for the position of Emergency Management Coordinator. The person who fills this role will be directly responsible for overseeing all disaster management activities.

Other Alternatives: None at this time.

Existing Planning Mechanism(s) through which Action Will Be Implemented: Through the Fire Department, the effort to locate sustainable alternate funding sources will enable agency staff to move forward with a recruitment utilizing the existing job description for EMC.

Responsible Office/Partners: City of San Rafael Fire Department

Project Priority: High

Cost Estimate: $120,000 annual costs.

Benefits (Losses Avoided): Due to geographical location, the City of San Rafael is prone to disaster stemming from wildfire and flooding. Such incidents can, based on magnitude and duration, tax local resources, based on event magnitude and duration. Having a full time EMC to oversee all disaster management functions is essential to an all risk disaster management program. A full time EMC can reduce disaster related impacts to the people and property of San Rafael.

Potential Funding: Seeking grant funding opportunities.

Timeline: Immediate.

Action 9. Evaluate and Implement Signal Timing for First Responders

Hazards Addressed: All Hazards

Goals Addressed: 1, 2, 3

Issue/Background: Installation of preemption on traffic signal systems to improve First Responder response time.

Project Description: Installation of preemption on traffic signal systems.

Other Alternatives: Modification to response routes

Existing Planning Mechanism(s) through which Action Will Be Implemented: Review existing signal systems to determine if modifications are possible and determine the impacts to the existing signal system as well as the general public for a recovery time to the existing signals if this is implemented.

Responsible Office/Partners: Public Works – Traffic Operations

Project Priority: Low

Cost Estimate: $60,000

Benefits (Losses Avoided): Improve response times for emergency services. Life Safety, property protection.

Potential Funding: City General Fund

Timeline: FY 2017/18

Action 10. Tree Safety Maintenance Program

Hazards Addressed: Minimize public safety impacts from trees falling in the road right of way.

Issue/Background: The intent of this program is to manage tree issues along public roadways. Trees both on public and private property are that are not healthy and not maintained will lose branches or fall on public roads during storm events. This program is a proactive approach to examine all trees adjacent to public roads and initiate some notification or actual maintenance of these trees before they become a problem during a storm event.

Goals Addressed: 1, 2, 3

Project Description: The project includes the following:

1. Every two years obtain an outside firm to develop an arborists report showing potential trees that need maintenance or need to be removed based on their potential for falling.

2. Develop an outreach program to communicate these issues to private property owners to maintain their trees.

3. Develop a replacement tree program for trees in the right of way that need to be removed and replaced. Program to include funding and prioritization for actual removal.

4. Implement removal of the trees that have highest priority requiring removal.

Other Alternatives: Take no action and wait for overgrown and diseased trees to fall during storm events.

Existing Planning Mechanism(s) through which Action Will Be Implemented:

Responsible Office/Partners: Public Works – Traffic Operations

Project Priority: Medium

Cost Estimate:

1. $60,000 (Study - Biannually)

2. $40,000 (Outreach - Biannually)

3. $100,000 (Biannually for removal and replacement)

Benefits (Losses Avoided): Remove potential safety issue.

Potential Funding: City General Fund

Timeline: FY 2019/20

Action 11. Purchase and Installation of EMTRAC Signal Control Equipment into 17 San Rafael Fire Vehicles and 25 Intersections.

Hazards Addressed: Emergency Response

Goals Addressed: 1, 2, 3

Issue/Background: The City of San Rafael is an urban community along a central commute corridor. Due to a lack of effective public transit the primary transportation mode is personal vehicle. Traffic in the San Rafael area is compounded by numerous shopping centers, several schools and a large downtown business district. Traffic results in increased emergency response times and firefighter risk associated with crossing busy intersections against red traffic lights.

Project Description: EMTRAC equipment is installed on each emergency vehicle. The device is connected to an omni-directional antenna that receives location data and transmits priority requests to intersections through secure RF-communication. The positioning functionality is able to track vehicle location with precision, and the radio range allows reliable intersection response thus enabling emergency vehicles traveling with emergency lights and sirens to obtain green lights in the direction of travel. EMTRAC is also installed into the identified traffic signal control boxes.

Other Alternatives: None

Existing Planning Mechanism(s) through which Action Will Be Implemented: Fire Department staff would oversee the installation of EMTRAC equipment in fire vehicles through contract with a local qualified contractor. The Public Works Traffic Engineer would manage the installation of EMTRAC control equipment at certain pre-selected traffic signal control boxes.

Responsible Office/Partners:

- City of San Rafael Fire Department
- City of San Rafael Public Works Department

Project Priority: High

Cost Estimate: $225,000

Benefits (Losses Avoided): EMTRAC signal control equipment is the industry standard traffic preemption product used in this region. San Rafael is one of the last agencies in Marin County not to utilize EMTRAC. A side benefit of this equipment is San Rafael's ambulance units traveling to area hospitals through other jurisdictions where signals are controlled by EMTRAC would be able to control intersections thus reducing travel time. Besides improving response times, intersections are the number one most likely location for an emergency vehicle traveling with lights and sirens to be involved in a collision. EMTRAC will improve safety levels for personnel and the general public and reduce response times.

Potential Funding: Grant Funding. General Funding.

Timeline: 2017/18 Fiscal Budget.

Action 12. Develop an Energy Storage Plan

Hazards Addressed: Earthquakes, storms, SLR

Goals Addressed: 1, 2, 3

Issue/Background: San Rafael is home to many trees and hazards which can cause power outages during storms. In addition, power supply is vulnerable due to sea level rise, earthquakes and other disasters. Loss of power for extended periods of time is a significant hazard to those under hospital/health care, seniors, disabled people, businesses that rely on power, to public safety, etc.

Project Description: Explore the use of battery and other power storage, including micro-grids, as a means of securing electricity for vulnerable communities, health care institutions, and public safety among others. Identify opportunities to pilot energy storage and incorporate into facilities and systems throughout San Rafael.

Other Alternatives: Increasing renewable and other electricity production opportunities at the local level

Existing Planning Mechanism(s) through which Action Will Be Implemented: Climate Change Action Plan, General Plan

Responsible Office/Partners: Sustainability Coordinator, Community Development, Public Works Department

Project Priority: Medium

Cost Estimate: Unknown, mostly staff time to evaluate, and costs ranging in the hundreds of thousands to the millions depending on the technology.

Benefits (Losses Avoided): Human health impacts, business losses, and public safety impediments

Potential Funding: Rate mechanisms, grants, public-private partnerships

Timeline: Mid term

Climate Change and Sea Level Rise Mitigation Actions

Action 13. Elevate/Raise Low Lying Roadways

Hazards Addressed: Sea Level Rise – Climate Change – Storm Flooding

Goals Addressed: 1, 2, 3, 4

Issue/Background: Sea Level Rise is predicted to more than 3 feet in the next 100 years. Many of San Rafael's roadways are built just above the current high water level and will be under water with the expected sea level rise which will block access to citizens as well as emergency services and other vital access.

Project Description: This project involves performing a survey of all low lying roadways that could be impacted by sea level rise, evaluate and develop a way to bring these above the flood area. prioritize which roads to be raised first, design repairs, and implement construction on public and private property to raise the low lying roadways out of the flood area.

Other Alternatives: Construct barriers such as levees, pump system and canals that limit the amount of sea level rise impacting roadway in San Rafael.

Existing Planning Mechanism(s) through which Action Will Be Implemented: Hire a consultant team to review existing low lying roadways within the city that can be affected by sea level rise, develop a report that identifies where which roadway need to be raised and prioritizes these roadway, develop designs for these improvement and implement repairs over time to minimize impact to the citizens of San Rafael

Responsible Office/Partners: Public Works

Project Priority: Medium

Cost Estimate: $200,000 (Initial Study and Prioritization); $1,000,000 (Design); $35,000,000 (Construction); $36,200,000 Total Project Cost

Benefits (Losses Avoided): Identification of hazards, development of priorities and designs to minimize impacts.

Potential Funding: Grants, Capital Improvement Program

Timeline: FY2020 to 2050

Action 14. Elevate Critical Infrastructure

Hazards Addressed: Sea Level Rise – Climate Change – Storm Flooding

Goals Addressed: 1, 2, 3, 4

Issue/Background: Sea Level Rise is predicted to more than 3 feet in the next 100 years. Many of San Rafael's structures are built in low lying areas and will be under water with the expected sea level rise which will restrict their use.

Project Description: This project involves performing a survey of all low buildings that could be impacted by sea level rise, evaluate and develop a way to bring these above the flood area. prioritize which buildings need to be raised first, design repairs, and implement construction to protect these structures from damage.

Other Alternatives: Construct barriers such as levees, pump system and canals that limit the amount of sea level rise impacting roadway in San Rafael.

Existing Planning Mechanism(s) through which Action Will Be Implemented: Hire a consultant team to identify and review existing low critical buildings within the City that can be affected by sea level rise, develop a report that identifies which structure need to be raised or protected and prioritizes these repairs, develop designs for these improvements and implement improvements over time to minimize impact to the citizens of San Rafael

Responsible Office/Partners: Public Works

Project Priority: Medium

Cost Estimate: $100,000 (Initial Study and Prioritization); $500,000 (Design); $10,000,000 (Construction); $10,600,000 Total Project Cost

Benefits (Losses Avoided): Identification of hazards, development of priorities and designs to minimize impacts. Life safety and property protection.

Potential Funding: Grants, Capital Improvement Program

Timeline: FY2020 to 2050

Action 15. Improvements to Existing Berms, Levees and Flood Control Systems

Hazards Addressed: Sea Level Rise – Climate Change – Storm Flooding

Goals Addressed: 1, 2, 3, 4

Issue/Background: Sea Level Rise is predicted to more than 3 feet in the next 100 years. Many of San Rafael's levees, berms and flood control systems are inadequate to protect the City from the predicted Sea Level Rise. These existing systems may be upgraded, raised and reinforces to handle the predicted sea level rise.

Project Description: This project involves assessing the existing levees, berms, pump stations and flood protections systems available to the city that could be impacted by sea level rise, evaluate and develop improvements to these systems that can be implemented, prioritize which systems need improvements first, design repairs, and implement construction to protect the citizens of San Rafael from damage.

Other Alternatives: Raising Roadways and elevating private property structures above the low lying areas.

Existing Planning Mechanism(s) through which Action Will Be Implemented: Hire a consultant team to identify and review existing flood control systems, within the City that can be affected by sea level rise, develop a report that identifies several different alternatives that can be implemented for protection and prioritizes these repairs, develop designs for these improvements and implement improvements over time to minimize impact to the citizens of San Rafael

Responsible Office/Partners: Public Works

Project Priority: High

Cost Estimate: $300,000 (Initial Study and Prioritization); $2,000,000 (Design); $100,000,000 (Construction); $102,300,000Total Project Cost

Benefits (Losses Avoided): Identification of hazards, development of priorities and designs to minimize impacts. Life Safety and property protection.

Potential Funding: Grants, Capital Improvement Program

Timeline: FY2020 to 2050

Action 16. Continued Involvement in the BayWAVE County-wide Vulnerability Assessment (Phase 1 and 2); Implement Resulting Strategies from Phase 2 of the Program.

Hazards Addressed: Climate Change, SLR, coastal flooding

Goals Addressed: 1, 2, 3, 4

Issue/Background: San Rafael is located next to the San Francisco Bay and much of San Rafael sits at current seal level and has been identified as vulnerable to sea level rise and storm surge. San Rafael has experienced flooding during moderate to severe rain storms. Much of the downtown area and an area with disadvantaged and vulnerable populations lives in the flood zone, including our main transit center and downtown. The City has developed a Sea Level Rise White Paper and is participating in a county-wide SLR vulnerability assessment (BayWAVE), due to be out in April 2017 (Phase 1).

Project Description: Utilize the results of the SLR vulnerability assessment to identify more research necessary and conduct it. Utilize results to begin internal and public engagement to determine what programs can be implemented to begin to plan for the effects of SLR and increased flooding. Use the findings of Phase 2 (outreach) to develop an Adaptation Plan to be integrated into the General Plan (see Adaptation Plan Mitigation Action).

Other Alternatives: Conduct our own process separate from the County

Existing Planning Mechanism(s) through which Action Will Be Implemented: Climate Change Action Plan, General Plan

Responsible Office/Partners: Sustainability Coordinator, Community Development, Public Works Department, PIO, City Manager's Office

Project Priority: High

Cost Estimate: Unknown, mostly staff time to evaluate, and costs ranging in the hundreds of thousands depending on the scope.

Benefits (Losses Avoided): Human health impacts, business losses, property losses, environmental damage, and public safety impediments

Potential Funding: Grants, general fund, permit fees, public-private partnerships

Timeline: Short term

Action 17. Develop a Climate Adaptation Plan, and Implement Resulting Strategies

Hazards Addressed: Climate Change, SLR, coastal flooding

Goals Addressed: 1, 2, 3, 4

Issue/Background: San Rafael is located next to the San Francisco Bay and much of San Rafael sits at current seal level and has been identified as vulnerable to sea level rise and storm surge. San Rafael has experienced flooding during moderate to severe rain storms. Much of the downtown area and an area with disadvantaged and vulnerable populations lives in the flood zone, including our main transit center and downtown. The City has developed a Sea Level Rise White Paper and is participating in a county-wide SLR vulnerability assessment, due to be out in April 2017.

Project Description: Utilize the results of the SLR vulnerability assessment to identify more research necessary and conduct it. Utilize results to begin internal and public engagement to determine what programs can be implemented to begin to plan for the effects of SLR and increased flooding. Develop a plan to be integrated into the General Plan and begin implementation based on priority-setting process with community and other stakeholders.

Other Alternatives: Drown.

Existing Planning Mechanism(s) through which Action Will Be Implemented: Climate Change Action Plan, General Plan

Responsible Office/Partners: Sustainability Coordinator, Community Development, Public Works Department, PIO, City Manager's Office

Project Priority: High

Cost Estimate: Unknown, mostly staff time to evaluate, and costs ranging in the hundreds of thousands depending on the scope.

Benefits (Losses Avoided): Human health impacts, business losses, property losses, environmental damage, and public safety impediments

Potential Funding: Grants, general fund, permit fees, public-private partnerships

Timeline: Short term

Drought and Water Supply Mitigation Actions

Action 18. Water Storage Facility Study

Hazards Addressed: Drought and Water Shortage, Wildfire. Minimize dependency on outside water sources for irrigation

Goals Addressed: 1, 2, 3, 4

Issue/Background: With climate change aspect in our community changing this project is a study to identify any opportunities that may exist to decrease our dependency on outside water sources to irrigate parks and city facilities.

Project Description: This project includes a study of existing public facilities such as the AJB field to determine if a water storage system can be installed which can be used to water the fields.

Other Alternatives: Installation of recycled water pipe systems in our roadway systems to deliver recycled water to our public facilities.

Existing Planning Mechanism(s) through which Action Will Be Implemented: Review existing watering levels for parks, identify appropriate size of water tanks and develop estimates and priorities for implementation of water storage facilities. Implementation of water storage facilities over a period of time.

Responsible Office/Partners: Public Works – Parks

Project Priority: Low

Cost Estimate: $50,000 (Study); $120,000 annually for 10 years

Benefits (Losses Avoided): Allows for our parks facilities to remain active during times of drought. Property protection.

Potential Funding: City General Fund

Timeline: FY 2020 Study –

Action 19. Leaky Pipe Replacement Program

Hazards Addressed: Drought and Water Shortage

Goals Addressed: 1, 2, 3, 4

Issue/Background: Existing infrastructure related to city facilities over time leaks and needs replacement.

Project Description: This project includes a study of existing public irrigation systems and replacing the existing water systems to prevent future leakage. Replacing leaking pipes will minimize dependency on outside water sources for irrigation.

Other Alternatives:

Existing Planning Mechanism(s) through which Action Will Be Implemented: Evaluate and prioritize existing systems, prioritize worst case locations and repair these sites as resources become available.

Responsible Office/Partners: Public Works – Parks

Project Priority: Low

Cost Estimate: $35,000 annually for 5 years

Benefits (Losses Avoided): Allows for our parks facilities to remain active during times of drought and reduces cost associated with water consumption. Property protection.

Potential Funding: City General Fund

Timeline: FY 2020

Action 20. Marin Municipal Water District Exploration of Desalination Plants

Hazards Addressed: Drought and water supply

Goals Addressed: 1, 2, 3

Issue/Background: Marin County is susceptible to droughts, and just endured a 5-year drought that required substantial conservation efforts to manage. San Rafael is served by the Marin Municipal Water District (MMWD), which has 7 local reservoirs outside of the City limits and have limited capacity. Estimates are that they hold up to two years' worth of water for the county depending on conservation efforts. Droughts are expected to be more severe with climate change. Should a drought be worse than the recent experience, San Rafael could be subject to water rationing. Desalination was explored by MMWD several years ago and was found to be prohibitive cost-wise, as well as politically.

Project Description: Encourage MMWD to explore desalination plants in San Rafael or in other places as technology changes and costs decline, and as negative impacts to surrounding environment are reduced through new technologies.

Other Alternatives: Water catchment and storage facilities, purple pipe/reclaimed water, conservation efforts

Existing Planning Mechanism(s) through which Action Will Be Implemented: Climate Change Action Plan, General Plan

Responsible Office/Partners: Public Works Department, Sustainability Coordinator, Community Development, PIO

Project Priority: Low

Cost Estimate: Unknown, mostly staff time to evaluate, and costs ranging in the millions depending on the technology.

Benefits (Losses Avoided): Human health impacts, impacts to personal/local food production, business losses, and property values

Potential Funding: Rate mechanisms, grants

Timeline: Mid term

Action 21. Evaluate the Use of Reclaimed Water/Increase Purple Pipes

Hazards Addressed: Drought and water supply

Goals Addressed: 1, 2, 3

Issue/Background: Marin County is susceptible to droughts, and just endured a 5-year drought that required substantial conservation efforts to manage. San Rafael is served by the Marin Municipal Water District (MMWD), which has 7 local reservoirs outside of the City limits and have limited capacity. Estimates are that they hold up to two years' worth of water for the county depending on conservation efforts. Droughts are expected to be more severe with climate change. Should a drought be worse than the recent experience, San Rafael could be subject to water rationing.

Project Description: Conduct a feasibility assessment of reclaimed water and purple pipe infrastructure to see if it can be increased for irrigation, other non-potable, and potable water supplies. Create a priority list for implementation with other public partners such as MMWD and the County of Marin, including public agencies, residents and businesses and implement based on available resources.

Other Alternatives: Water catchment and storage facilities

Existing Planning Mechanism(s) through which Action Will Be Implemented: Climate Change Action Plan, General Plan

Responsible Office/Partners: Public Works Department, Sustainability Coordinator, Community Development, PIO

Project Priority: Medium

Cost Estimate: Unknown, mostly staff time to evaluate, and costs ranging in the hundreds of thousands depending on the measures.

Benefits (Losses Avoided): Human health impacts, impacts to personal/local food production, business losses, and property values

Potential Funding: Rate mechanisms, planning fees, grants

Timeline: Near term

Action 22. Evaluate and Enhance Conservation Measures to Reduce Water Consumption

Hazards Addressed: Drought and water supply

Goals Addressed: 1, 2, 3, 4

Issue/Background: Marin County is susceptible to droughts, and just endured a 5-year drought that required substantial conservation efforts to manage. San Rafael is served by the Marin Municipal Water District (MMWD), which has 7 local reservoirs outside of the City limits and have limited capacity. Estimates are that they hold up to two years' worth of water for the county depending on conservation efforts. Droughts are expected to be more severe with climate change. Should a drought be worse than the recent experience, San Rafael could be subject to water rationing.

Project Description: Conduct an evaluation of current measures both at the City level and at Marin Municipal Water District. Develop a list of potential activities the City and MMWD can take to increase our resiliency, then vet this list internally and with members of the public to create a set of actions to be performed. These may include but are not limited to physical/public works enhancements, behavior change and outreach programs, rebates, ordinances, and other proven techniques.

Other Alternatives: Subcontract with a conservation agency to conduct the project.

Existing Planning Mechanism(s) through which Action Will Be Implemented: Climate Change Action Plan, General Plan

Responsible Office/Partners: Sustainability Coordinator, City Manager's Office, Community Development, PIO

Project Priority: Medium

Cost Estimate: Unknown, mostly staff time to evaluate, and costs ranging from low thousands to hundreds of thousands depending on the measures.

Benefits (Losses Avoided): Human health impacts, impacts to personal/local food production, business losses, and property values

Potential Funding: Rate mechanisms, planning fees, grants

Timeline: Near term

Earthquake Mitigation Actions

Action 23. Retrofit/upgrade Four Remaining URM's

Hazards Addressed: Earthquake Damage

Goals Addressed: 1, 2, 3, 4

Issue/Background: A previous study identified un reinforced masonry structures within San Rafael. Many have been reinforced however 4 were identified as not be upgraded.

Project Description: Upgrade 4 URM's within the City to be compliant with current codes.

Other Alternatives: No action

Existing Planning Mechanism(s) through which Action Will Be Implemented: Evaluate and prioritize existing systems, prioritize worst case locations and repair these sites as resources become available.

Responsible Office/Partners: Community Development/Building Inspection

Project Priority: Medium

Cost Estimate: $ TBD

Benefits (Losses Avoided): Removes the threat of injury and damage to pedestrians and the general public access in and around these areas

Potential Funding: Privately funded.

Timeline: Within 5 years

Action 24. Earthquake Hazard Study

Hazards Addressed: Earthquake Hazards

Goals Addressed:

Issue/Background: San Rafael is close to many faults within the Bay Area. Many areas are underplayed with Bay mud, sands and other geological hazards that are affected by earthquakes. A study of hazards related to earthquake damage is needed to proactively address improvements to existing structures, new development, and existing geological features affected by earthquakes

Project Description: This study shall include examination of geological hazards within the City including but not limited to liquefaction, bay mud vibration effects, structural deficiencies on existing buildings as well as the development of local policies to mitigate hazards that can occur from an earthquake.

Other Alternatives: No action

Existing Planning Mechanism(s) through which Action Will Be Implemented: Hire a consultant team to address possible hazards to public and private property.

Responsible Office/Partners: Community Development/Building Inspection/Public Works

Project Priority: Medium

Cost Estimate: $ 250,000

Benefits (Losses Avoided): Identification of hazards, development of policies and procedures to address the hazards to protect the life and safety of the general public and reduce property damages.

Potential Funding: Grants

Timeline: Within 5 years

Action 25. Public Facility Vulnerability Assessment and Improvements

Hazards Addressed: Earthquake Hazards

Goals Addressed: 1, 2, 3, 4

Issue/Background: San Rafael has many structures that were built at different time with different level of earthquake code standards. Many are anticipated to be utilized a shelter areas however it is unknown now if these will withstand an earthquake in order to be a viable shelter.

Project Description: As study of the existing City facilities to determine if they can withstand an earthquake, identification of measures are needed to upgrade these facilities and implement these modifications on key public facilities.

Other Alternatives:

Existing Planning Mechanism(s) through which Action Will Be Implemented: Hire a consultant team review existing City buildings, develop a report which identifies the improvements needed, prioritize these improvements with City goals and constraints and then implement these modifications to the City Structures to have buildings in compliance with earthquake standards.

Responsible Office/Partners: Public Works

Cost Estimate: $80,000 (Initial Study and Prioritization); $150,000 (Design); $1,000,000 (Construction); $1,230,000 Total Project Cost

Benefits (Losses Avoided): Identification of hazards, development of policies and procedures to address the hazards to protect lives and safety of the general public and protect property.

Potential Funding: Grants

Timeline: FY2021

Project Priority: Medium

Flood Mitigation Actions

Action 26. Develop and Maintain a Community Rating System (CRS)

Hazards Addressed: 100/500-year and Storm Flooding

Goals Addressed: 1, 2, 3, 4

Issue/Background: This is a community rating system is a system developed by FEMA to notify residents of the current hazards of living in a flood area. Developing this system locally can reduce the flood insurance rates for property owners within the area.

Project Description: This project involves following FEMAS's procedures for developing and maintaining a Community Rating System. This includes but is not limited to public notification, community education classes, proactive measures such as signage and development criteria just to name a few.

Other Alternatives: No action

Existing Planning Mechanism(s) through which Action Will Be Implemented: Dedication of staff resources to manage this program is required.

Responsible Office/Partners: Public Works

Project Priority: High

Cost Estimate: $180,000 annually (Staff Resources)

Benefits (Losses Avoided): Reduction of Flood Insurance rates for the Citizens of San Rafael, better understanding of Flood issues by the citizens of San Rafael. Life safety, property protection

Potential Funding: Existing budgets, staff time

Timeline: FY2018/19

Action 27. Beach Drive Structural Flood Protection

Hazards Addressed: Storm Flooding

Goals Addressed: 1, 2, 3, 4

Issue/Background: Beach Drive is a low lying roadway that is affected by flooding and will be further affected by sea level rise.

Project Description: This project was identified to examine the roadway to determine what measures are possible for protecting properties. Develop a plan to provide this protection and implement these measures.

Other Alternatives: Improve the current levee, berm and storm drain systems to protect this area from flooding.

Existing Planning Mechanism(s) through which Action Will Be Implemented: Hiring a consultant to evaluate the roadway, identify improvements, design the improvements and implement modification is necessary for this project.

Responsible Office/Partners: Public Works

Project Priority: Medium

Cost Estimate: $100,000 (Evaluation); $250,000 (Design) $2,500,000 (Construction); $2,850,000 Estimated total cost

Benefits (Losses Avoided): Protection of properties along Beach Drive. Life safety.

Potential Funding: Grants

Timeline: FY2025

Action 28. Adopt a Drain Program

Hazards Addressed: 100/500-year and Storm Flooding

Goals Addressed: 1, 2, 3, 4

Issue/Background: With limited City Staff it is difficult to consistently have clean drainage structures. The adopt a drain program is geared toward allow fronting property owners to maintain drainage structures prior to and during rain events.

Project Description: This program includes education, safety instructions, and monitoring with staff to assure that storm drain systems are cleaned on a regular basis.

Other Alternatives: Continue to have City staff monitor and clean catch basin systems with limited staffing.

Existing Planning Mechanism(s) through which Action Will Be Implemented: Work with City staff and interested residents to develop a system for training, maintaining and documenting catch basin systems that are not in high traffic areas or areas that require special equipment or training to keep clear.

Responsible Office/Partners: Public Works/Volunteer Coordinator

Project Priority: Low

Cost Estimate: $30,000 (Annual Training)

Benefits (Losses Avoided): Community Involvement with Public Works Issues, relieves some staff to manage more important drainage systems.

Potential Funding: Existing budgets, staff time.

Timeline: FY19/20

Action 29. City Pump Station Analysis and Improvements

Hazards Addressed: 100/500-year and Storm Flooding

Goals Addressed: 1, 2, 3, 4

Issue/Background: San Rafael Manages 12 pump stations. The majority of these stations we constructed in the 1950's to the 1990's. Some are obsolete and cannot manage the new flow based on climate change. In addition there are areas in San Rafael that could benefit from a pump station system.

Project Description: This project includes several phases of development and implementation as follows:

1. Perform a detailed flood study of the entire City to determine which areas flood and what improvements can be made to existing system to improve their capacity.
2. Develop a priority listing of the improvements that must be made to existing systems as well as develop a list of areas where new pump stations are to be installed.
3. Develop construction plans for prioritized projects.
4. Construct improvements to existing systems to provide adequate flood protection and implement new construction for areas that need pump stations.

Other Alternatives: Not addressing these issues will cause the pump stations to fail. Having a robust pump station system is needed to keep the citizens of the City safe.

Existing Planning Mechanism(s) through which Action Will Be Implemented: Proactive action is needed to develop a system that protects the city from flooding. Development of a study, recommendations, concepts for new stations, design and construction is needed to address this issue as well as funding.

Responsible Office/Partners: Public Works

Project Priority: High

Cost Estimate:

1. $150,000 (Study and Priority Listing)
2. $250,000 (Design per Pump Station)
3. $3,000,000 (Construction Per Station)

These estimated costs will be needed over time for each pump station such that these are not one time costs.

Benefits (Losses Avoided): Minimize Flooding. Life safety and property protection.

Potential Funding: Grants, Capital Improvement Program

Timeline: FY19/20

Action 30. City Storm Drain System Analysis and Improvements

Hazards Addressed: 100/500-year and Storm Flooding

Goals Addressed: 1, 2, 3, 4

Issue/Background: San Rafael Manages 1over 3500 storm drain inlets and culvert systems with the City's 175 miles of roadways. Many of these systems were built many years ago with material such a corrugated metal pipes which deteriorates over time. This project addresses the replacement of these deteriorated systems and existing systems that cannot manage adequate storm water flow.

Project Description: This project includes several phases of development and implementation as follows:

1. Perform a detailed analysis of the current City Drainage systems to determine which systems require immediate replacement and upgrades.
2. Develop a priority listing of the improvements that must be made to existing systems as well as develop a list of areas where existing systems should be enlarged to accommodate future rainfall characteristics..
3. Develop construction plans for prioritized projects.
4. Construct improvements to existing systems to provide adequate flood protection and implement new construction for areas that require improvements.

Other Alternatives: Not addressing these issues will cause road failures in terms of sink holes, roadway base failure which become a safety issue to the public and can restrict access.

Existing Planning Mechanism(s) through which Action Will Be Implemented: Proactive action is needed to develop a system that protects the city from flooding. Development of a study, recommendations, design and construction is needed to address this issue as well as funding.

Responsible Office/Partners: Public Works

Project Priority: High

Cost Estimate:

1. $250,000 (Study and Priority Listing)
2. $400,000 (Design)
3. $15,000,000 (Construction)

Benefits (Losses Avoided): Minimize Flooding. Life safety and property protection.

Potential Funding: Grants, Capital Improvement Program

Timeline: Study – FY18/19 with subsequent work to be prioritized per the funds available.

Action 31. City Flood Alert System

Hazards Addressed: 100/500-year and Storm Flooding

Goals Addressed: 1, 2, 3, 4

Issue/Background: San Rafael does not have a current policy or notification to alert its residents of flooding. Many areas experience flooding from high tides while other areas experience flooding from significant rain events. Neighborhood notification systems are needed to alert the community of dangers, detours and where to seek help during these events.

Project Description: This project includes identifying the local flooding areas and developing systems to alert residents of hazards. This includes but is not limited to signage, siren systems, website notifications, education programs and all aspects of coordinating emergency responses to flooding.

Other Alternatives: Not addressing these issues will cause frustrating with the general public as may increase the likelihood of accidents occurring in areas that are flooded.

Existing Planning Mechanism(s) through which Action Will Be Implemented: Proactive action is needed to develop a system that protects the city from flooding. Development of this program will help inform the community as well as provide for a coordinated response by City Staff and Emergency Services.

Responsible Office/Partners: Public Works/Emergency Services

Project Priority: Medium

Cost Estimate: ½ FTE will be required to manage the project while an initial investment may be needed to develop a program that fits the City's needs. $75,000 Annual Staffing. $70,000 Initial set up cost with a consultant

Benefits (Losses Avoided): Minimize Flooding. Life safety and property protection.

Potential Funding: Grants

Timeline: Study – FY18/19

Landslide Mitigation Actions

Action 32. 70-96 Bret Harte Sewer Easement Repair

Hazards Addressed: Landslide

Goals Addressed: 1, 2, 3, 4

Issue/Background: The San Rafael Sanitation District has a 20-foot wide sewer easement, approximately 1,420 lineal feet, located behind the homes of #70 to #96 Bret Harte Road; it is approximately 200 feet downhill from the road. In 1966, a 6" cast iron sewer main was installed in a bench along the hillside. A portion of the easement has a wooden retaining wall that is supporting the uphill side. This hillside has had numerous slides in the past. In 1998, approximately 570 lineal feet of pipe was replaced with HDPE pipe. The retaining wall needs to be replaced; some portions are gone and some are failing. In the past, it was possible to drive on it and now, it can only be accessed by foot. During one of the storms in January 2017, a landslide occurred at 92 Bret Harte Road, which took out the retaining wall and top of a sewer manhole. There is also a sewer pipe that crosses a gully which is eroding and causing the sewer to be unsupported and creating unsafe access for maintenance crew.

Project Description: Re-establish the sewer easement for vehicle access; replace the existing wooden retaining wall; and support sewer across gully and provide access.

Other Alternatives: None

Existing Planning Mechanism(s) through which Action Will Be Implemented: Capital Improvement Program

Responsible Office/Partners: San Rafael Sanitation District

Project Priority: High

Cost Estimate: $ 1 Million

Benefits (Losses Avoided): Damage to private property, including residential dwellings; Compromising private sewer lateral and public sewer main; Sewer spills; Health and Safety

Potential Funding: Capital Improvement Program

Timeline: FY 17/18 to FY 18/19

Action 33. Landslide Identification and Management Program

Hazards Addressed: Landslides

Goals Addressed: 1, 2, 3, 4

Issue/Background: San Rafael is a community that has been built over time. Both residential areas and business are built below, on and above hilly slopes that can become instable over time or with seismic or rain events. At this time the City does not have a general idea where these areas are located. Identification of these potentially unstable areas will help city staff with potential development as well as alert residents of potential instabilities.

Project Description: This program includes an initial study prepared which generally identifies geotechnical areas in which soils could be considered as potentially unstable. This information will be used in conjunction with new development. Based on the information generated in the study, staff will evaluate roadways and public infrastructure in potentially hazardous areas that may be experiencing geotechnical instability. These studies will develop a list of projects to repair these roadways before they actually slide. Funding for these repairs or improvements will be needed such that this program will include a funding strategy to identify funds for high priority projects. As funding is developed project designs and construction of improvements will be required in order to proactively address instabilities before they become a hazard.

Other Alternatives: Not addressing these issues will continue to place the City in a reactionary response pattern, which is potentially dangerous for residents.

Existing Planning Mechanism(s) through which Action Will Be Implemented: Proactive action is needed to develop a system that protects the city from Landslides

Responsible Office/Partners: Public Works/Community Development

Project Priority: Medium

Cost Estimate: $100,000 (Initial Study); $80,000 (Staff Review and Priority Development of Roadway projects); $? (Develop Funding for repair); Design and Construction to be addressed on a site by site basis.

Benefits (Losses Avoided): Minimize Landslide Hazards. Life safety and property protection.

Potential Funding: Grants

Timeline: FY20/21

Wildfire Mitigation Actions

Action 34. Funding for Vegetation Management Coordinator Position

Hazards Addressed: Wildfire

Goals Addressed: 1, 2, 3, 4

Issue/Background: The City of San Rafael has several hundred acres of wildland urban interface (WUI) areas. Residential development has significantly encroached into the WUI that presents both the risk to the residents who live in these areas but to the Fire Department charged with the responsibility of providing outreach, public education, code enforcement, the delivery of creative and effective vegetation management and removal programs, and when necessary, firefighting and property preservation.

Project Description: Assist with the funding of a Fixed Term 37.5 hour per week employee who will manage outreach, vegetation management programs and code enforcement. Coordinator responsibilities will include overseeing programs associated with the management of flammable vegetation, removal, public outreach and the enforcement of codes and ordinances that restrict these materials.

Other Alternatives: No other viable alternatives at this time.

Existing Planning Mechanism(s) through which Action Will Be Implemented: Currently, the position is funded through Measure A, a nine year County tax measure that allocates a portion of funding to each city and town to be used for the purposes of parks projects and vegetation maintenance programs.

Responsible Office/Partners: City of San Rafael Fire Department

Project Priority: High

Cost Estimate: $75,000

Benefits (Losses Avoided): Year around programs are necessary to educate and inform residents to the threat of wildfire. To facilitate the reduction of flammable fuels, developing programs such as free curbside pickup, goat grazing and partnering with County Open Space and State Parks to address areas that are within our WUI but reach into other jurisdictional areas are of vital importance. Additionally, active enforcement of the City's fire code and municipal ordinances targeting flammable vegetation is necessary to help manage the problem. Ultimately, filling this position will result in a comprehensive approach to wildfire management to protect property, potentially save lives, and reduce fire-related losses.

Potential Funding: This position is only possible through tax measure or grant funding options.

Timeline: Immediate.

Action 35. Create a City of San Rafael specific Community Wildfire Protection Plan (CWPP).

Hazards Addressed: Wildfire

Goals Addressed: 1, 2, 3, 4

Issue/Background: The City of San Rafael has several hundred homes located within WUI areas. Many are located below or directly adjacent to Open Space lands. The City recently assisted the County of Marin with the development of a County-wide CWPP that was completed in 2016. Although the Marin CWPP includes lands within San Rafael, it is not specific nor detailed enough to meet our needs to scientifically assess the wildfire threat in the many WUI areas within the City.

Project Description: Fire Department staff will conduct a three-phase process that includes, (1) Stakeholder Collaboration, (2) Identifying and prioritizing areas for fuel reduction activities, and (3) addressing structural ignitability. A science-based hazard, asset, and risk assessment will be performed using up-to-date high resolution topography and fuels information combined with local fuel moisture and weather data. From the results of the analysis, the following strategies will be deployed: (1) Pre-fire planning, (2) outreach and public education, (3) vegetation management and fuels reduction, and, (4) reducing structural ignitability by promoting and enforcing building codes, ordinances and statues.

Other Alternatives: None at this time.

Existing Planning Mechanism(s) through which Action Will Be Implemented: Fire Department staff presently utilizes a non-science based approach to wildfire prevention that consists primarily of public education upon request, answering complaints and visual fire inspections of various WUI areas along with sporadic partnering for fuel management programs. The San Rafael CWPP will provide for a more thorough, systematic and programmed approach based on the data results produced by the CWPP document.

Responsible Office/Partners: City of San Rafael Fire Department

Project Priority: High

Cost Estimate: $75,000

Benefits (Losses Avoided): It is essential that the City take a more scientific and systematic approach to wildfire prevention through the utilization of a document that provides the basis and the path to effectively address the problem. Development and implementation of a City-specific CWPP addressing WUI areas in the City will protect property, potentially save lives, and reduce fire-related losses.

Potential Funding: FEMA PDM and HMGP grants.

Timeline: Immediate.

Action 36. Create New Strategic Fuel Interruption Zones in WUI Areas and Maintain and Expand Existing Fuel Interruption Zones Already in Place.

Hazards Addressed: Wildfire

Goals Addressed: 1, 2, 3, 4

Issue/Background: The City of San Rafael has several hundred homes located within WUI areas. Many are located below or directly adjacent to Open Space lands. In addition to overseeing vegetation management programs for private parcels, it is essential that the City partner with the below listed agencies to create more substantial fuel breaks in order to slow the spread or the momentum of a wildfire that could potentially have catastrophic impact to nearby neighborhoods. Fuel interruption zones both slow the progress of wildfire and enables firefighters to get into position in order to both control the fire and protect private property.

Project Description: Fire Department staff will partner with the listed agencies to identify key locations for fuel interruption zones, evaluate the state and integrity of existing fuel interruption zones and then subsequently plan and financially support projects. Work will be undertaken by Marin County Open Space District staff and Marin County Fire Department Tamalpais Fire Crew. This project will entail cutting and removing flammable vegetation in strategic areas within the WUI to slow the potential spread of wildfire in order to reduce the risk to homes located in high hazard hillside areas.

Other Alternatives: None at this time.

Existing Planning Mechanism(s) through which Action Will Be Implemented: Fire Department staff presently has an effective and long running collaboration with these agencies. Several fuel interruption zone projects have been completed in prior years. However, funding from the City of San Rafael to help with the costs associated with planning, public outreach, crew staffing, equipment and supplies, and logistical support is needed. Without this funding, crews from the two partnering agencies will deploy to other regions of the County where financial support can be garnered. Work will also be done in coordination with the County of Marin CWPP.

Responsible Office/Partners:

- City of San Rafael Fire Department
- Marin County Open Space District
- Marin County Fire Department – Tamalpais Fire Crew

Project Priority: Very High

Cost Estimate: $125,000 for CY 2017, with similar funding annually.

Benefits (Losses Avoided): It is essential that the City take proactive steps on multiple fronts in order to effectively address the wildfire problem within our WUI areas. Fuel interruption zones effectively rid the open space areas of non-native pyrofitic vegetation that then enables the native species to proper. Simultaneously, fuel interruption zones constructed based on topography, slope, exposure and proximity to structures can slow the momentum of wildfire and provide firefighters with the extra time needed to access and establish a firefighting hold on the incident. These fuel interruption zones will reduce the likelihood of a devastating wildfire, which will protect property, save lives, and reduce other wildfire-related losses to the City.

Potential Funding: Grant Funding. General Funding unlikely . FEMA PDM and HMGP grants.

Timeline: Immediate. The highly unusual wet winter of 2016-17 will help in the yield of substantial amounts of rapidly growing pyrofitic vegetation that coupled with the region's Mediterranean climate which ensures little to no rain between the months of May through October could result in a catastrophic fire season.

Action 37. Juniper and Bamboo Clearing Program from Residential Properties within WUI.

Hazards Addressed: Wildfire

Goals Addressed: 1, 2, 3, 4

Issue/Background: Flammable vegetation around or within close proximity to structures in WUI areas is one of the leading causes of the uninterrupted spread of fire from vegetation to structures. Defensible space combined with a landscape plan that utilizes fire resistant planting and non-combustible materials can significantly improve the probability of flame impingement or heat exposure on buildings in the path of an advancing wildfire.

Project Description: Overseen by a community volunteer, the City offers residents within WUI areas free curbside pickup and disposal of flammable vegetation that has been cut and piled by the property owner. The resident simply needs to place a call advising that the material has been cut and piled at the curb. The city's landscape contractor then removes and disposes of the material at no cost to the resident. This project is primarily focused on the clearing of Juniper and Bamboo, but can include other types of pyrofitic vegetation.

Other Alternatives: No other alternatives at this time.

Existing Planning Mechanism(s) through which Action Will Be Implemented: The San Rafael Fire Department oversees this program and it is known as the Juniper and Bamboo Removal Program. The program is currently up and running, but needs a funding source in order to continue.

Responsible Office/Partners: City of San Rafael Fire Department

Project Priority: High

Cost Estimate: $50,000/year

Benefits (Losses Avoided): Promotes the removal of flammable non-native vegetation from WUI neighborhoods by offering a fire pick up and removal service to our residents. Clearing pyrofitic vegetation protects structures and other property, limits the potential for a fire getting out of control, and potentially saves lives.

Potential Funding: Presently, Marin County Measure A has funded the program. However this is a funding source that will sunset in FY 2019 so other funding mechanisms are being sought.

Timeline: Immediate

Action 38. Create New Point specific Wildfire Prevention Programs Specifically Targeting Areas where Homeless Encampments are Known to Exist.

Hazards Addressed: Wildfire

Goals Addressed: 1, 2, 3, 4

Issue/Background: The City of San Rafael is considered a host city for homeless people. Various agencies in the City offer a wider range of services that can be obtained by homeless people on a daily basis. Additionally a pleasant, Mediterranean climate combined with an abundance of open space/undeveloped area in close proximity to our downtown makes the City of San Rafael an attractive option for those without homes seeking daily support services.

Project Description: Fire Department staff will partner with the San Rafael Police Department Open Space Ranger and the City's Homeless Outreach Coordinator to identify areas in the community where homeless encampments are known to exist. The Fire Department will then partner with the Public Works Department park maintenance staff, Marin County Open Space District or private property owners to develop and subsequently deploy vegetation management strategies in these areas with the objectives to safeguard nearby structures, create fuel interruption zones and reduce garbage, rubbish or other debris left by homeless than can help propagate fire.

Other Alternatives: None at this time.

Existing Planning Mechanism(s) through which Action Will Be Implemented: Fire Department staff presently has an effective and long running collaboration with the agencies listed above. The objective of the program is to improve community fire safety and will not be used as an enforcement tool to reduce homeless populations. With funding assistance, the City will be able to utilize the effective goat grazing strategy that has been used in previous years but that has only been used on a limited basis due to funding shortfalls.

Responsible Office/Partners:

- City of San Rafael Fire Department
- City of San Rafael Homeless Outreach Coordinator
- City of San Rafael Police Department – Open Space Ranger
- City of San Rafael Public Works Department
- Marin County Open Space District
- Marin County Fire Department – Tamalpais Fire Crew

Project Priority: Very High

Cost Estimate: $100,000 annual funding.

Benefits (Losses Avoided): A significant percentage of the wildfire emergencies in San Rafael are the directly result of the abundance of dry vegetation and debris located in or within the vicinity of homeless encampments. These fires have a direct negative impact on the wellbeing of the community and place nearby structures at risk. Many homeless encampment areas are actually not in the WUI but are located in

low lying regions of the community, in marsh land or on vacant private property. Thus, wildfire prevention measures in these areas are as important as those deployed in the WUI. Effective wildfire mitigation in these areas will reduce the potential for an out of control wildfire, thus protecting lives and reducing hazard related impacts to property, environment and the economy of San Rafael.

Potential Funding: Grant Funding. General Funding unlikely. FEMA PDM and HMGP grants.

Timeline: Immediate.

Public/Other Stakeholder Mitigation Actions

Action 39. East San Rafael Shore Project: Plan

Hazards Addressed: Maritime and fluvial flooding in the Central and East San Rafael valley, adaptation for sea level rise

Goals Addressed: 1, 2, 3, 4

Issue/Background: The 2016 FIRM indicates most of the valley floor containing Marin's urban center is at risk of maritime and fluvial flooding. A 1% (100 year) flood has the potential of impacting a broad range of public and private facilities and Marin's largest disadvantaged community; the Canal Neighborhood. Regional infrastructure including US 101, I 580 and SMART are at risk. Major concentrations of housing, jobs and business inventories including automobile dealerships are located within the flood zone. This area is not part of a flood control district.

Project Description: This project includes shore resiliency planning and design for the reach extending from the Richmond San Rafael Bridge to City owned lands in the vicinity of Bay Way on the north side of the San Rafael Canal.

The purpose of East San Rafael Shore Project is to reduce maritime and fluvial flood risk for Central and East San Rafael. Additionally, the project is to provide for sea level rise adaptation, restore wetlands and habitat for additional resiliency, enhance public access to open space and provide for of the maintenance of the San Rafael Canal for flood risk reduction and maritime access.

The plan entails: planning level mapping of existing context, literature search and compilation, community engagement and education, community design charrette, feasibility analysis of potential design solutions, development of a Shore Plan Document.

Other Alternatives: Continuation of current ad hoc conditions, fragmented land ownership and responsibilities without mitigating identified risk.

Existing Planning Mechanism(s) through which Action Will Be Implemented: TBD May include a public private partnership with the city of San Rafael, a nonprofit project such as Resilient Shore, Shore Up Marin and stakeholders

Responsible Office/Partners: TBD May include City of San Rafael/Resilient Shore/Shore Up Marin

Project Priority: Extremely High

Cost Estimate: TBD, initial estimate - $2,000,000

Benefits (Losses Avoided): Prepare a community based consensus plan to facilitate flood risk reduction, sea level rise adaptation, implementation of nature based solutions, improved public access to open space, habitat restoration. (Losses avoided: $2BN+)

Potential Funding: Proposition AA, RbD Competition, other sources to be determined

Timeline: 24 months from project initiation

Action 40. East San Rafael Shore Project: Permitting and Construction

Hazards Addressed: Maritime and fluvial flooding in the Central and East San Rafael valley, adaptation for sea level rise

Goals Addressed: 1, 2, 3, 4

Issue/Background: The 2016 FIRM indicates most of the valley floor containing Marin's urban center is at risk of maritime and fluvial flooding. A 1% (100 year) flood has the potential of impacting a broad range of public and private facilities and Marin's largest disadvantaged community, the Canal Neighborhood. Regional infrastructure including US 101, I 580 and SMART are at risk. Major concentrations of housing, jobs and business inventories including automobile dealerships are located within the flood zone. This area is not part of a flood control district.

Project Description: Implementation of projects identified in a companion East San Rafael Shore Plan. Includes governance, finance, permitting, environmental clearance, acquisition of right of way and maintenance easements, construction. Projects will be prioritized based on cost benefit.

The purpose of East San Rafael Shore Project is to reduce maritime and fluvial flood risk for Central and East San Rafael. Additionally, the project is to provide for sea level rise adaptation, restore wetlands and habitat for additional resiliency, enhance public access to open space and provide for of the maintenance of the San Rafael Canal for flood risk reduction and maritime access.

Other Alternatives: Continuation of current ad hoc conditions, fragmented land ownership and responsibilities without mitigating identified risk.

Existing Planning Mechanism(s) through which Action Will Be Implemented: TBD City of San Rafael and/or Special Improvement Districts or alternative state chartered districts such as Geological Hazard Abatement Districts (GHAD)

Responsible Office/Partners: TBD May include the city of San Rafael and /or a special district such as a GHAD

Project Priority: Extremely High

Cost Estimate: $250,000,000 for all projects

Benefits (Losses Avoided): Implement physical projects resulting in flood risk reduction, sea level rise adaptation, implementation of nature based solutions, improved public access to open space, habitat restoration. (Losses avoided: $2BN+)

Potential Funding: Proposition AA, district assessments, redirected flood insurance premiums, and other sources to be determined

Timeline: 5-10 years

Chapter 6 Plan Adoption

Requirement §201.6(c)(5): [The local hazard mitigation plan shall include] documentation that the plan has been formally approved by the governing body of the jurisdiction requesting approval of the plan (e.g., City Council, county commissioner, Tribal Council).

The purpose of formally adopting this plan is to secure buy-in from the City of San Rafael, raise awareness of the plan, and formalize the plan's implementation. The adoption of this plan completes Planning Step 9 of the 10-step planning process: Adopt the Plan, in accordance with the requirements of DMA 2000. This adoption also establishes compliance with AB 2140 requiring adoption by reference or incorporation into the Safety Element of the San Rafael General Plan.

The San Rafael City Council has adopted this Local Hazard Mitigation Plan by passing a resolution. A copy of the sample resolution and the executed copy for the City (pending) are included in Appendix D: Adoption Resolution.

Chapter 7 Plan Implementation and Maintenance

Requirement §201.6(c)(4): [The plan maintenance process shall include a] section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.

Implementation and maintenance of the plan is critical to the overall success of hazard mitigation planning. This is Planning Step 10 of the 10-step planning process. This chapter provides an overview of the overall strategy for plan implementation and maintenance and outlines the method and schedule for monitoring, updating, and evaluating the plan. The chapter also discusses incorporating the plan into existing planning mechanisms and how to address continued public involvement.

7.1 Implementation

Once adopted, the plan faces the truest test of its worth: implementation. While this plan contains many worthwhile actions, the City will need to decide which action(s) to undertake first. Two factors will help with making that decision: the priority assigned the actions in the planning process and funding availability. Low or no-cost actions most easily demonstrate progress toward successful plan implementation.

An important implementation mechanism that is highly effective and low-cost is incorporation of the hazard mitigation plan recommendations and their underlying principles into other plans and mechanisms, such as general plans, Community Wildfire Protection Plans (CWPPs), stormwater plans, Emergency Operations Plans (EOPS), evacuation plans, and other hazard and emergency management planning efforts for San Rafael. The City already implements policies and programs to reduce losses to life and property from hazards. This plan builds upon the momentum developed through previous and related planning efforts and mitigation programs and recommends implementing actions, where possible, through these other program mechanisms.

Mitigation is most successful when it is incorporated into the day-to-day functions and priorities of government and development. Implementation can be accomplished by adhering to the schedules identified for each action and through constant, pervasive, and energetic efforts to network and highlight the multi-objective, win-win benefits to each program, the City, the greater community and its stakeholders. This effort is achieved through the routine actions of monitoring agendas, attending meetings, and promoting a safe, sustainable community. Additional mitigation strategies could include consistent and ongoing enforcement of existing policies and vigilant review of programs for coordination and multi-objective opportunities.

Simultaneous to these efforts, it is important to maintain a constant monitoring of funding opportunities that can be leveraged to implement some of the more costly recommended actions. This could include creating and maintaining a bank of ideas on how to meet local match or participation requirements. When funding does become available, the City will be in a position to capitalize on the opportunity. Funding opportunities to be monitored include special pre- and post-disaster funds, state and federal programs and

earmarked funds, benefit assessments, and other grant programs, including those that can serve or support multi-objective applications.

Responsibility for Implementation of Goals and Activities

The elected officials and officials appointed to head each department within the City are charged with implementation of various activities in the plan. During the annual reviews as described later in this section, an assessment of progress on each of the goals and activities in the plan should be determined and noted. At that time, recommendations were made to modify timeframes for completion of activities, funding resources, and responsible entities. On an annual basis, the priority standing of various activities may also be changed. Some activities that are found not to be doable may be deleted from the plan entirely and activities addressing problems unforeseen during plan development may be added.

7.1.1. Role of Hazard Mitigation Planning Committee in Implementation and Maintenance

With adoption of this plan, the City will be responsible for the plan implementation and maintenance. The HMPC identified in Appendix A (or a similar committee) will reconvene each year to ensure mitigation strategies are being implemented and the City continues to maintain compliance with the NFIP. As such, the City will continue its relationship with each other, and with the Hazard Mitigation Planning Committee (HMPC) and:

- Act as a forum for hazard mitigation issues;
- Disseminate hazard mitigation ideas and activities to all participants;
- Pursue the implementation of high-priority, low/no-cost recommended actions;
- Ensure hazard mitigation remains a consideration for community decision makers;
- Maintain a vigilant monitoring of multi-objective cost-share opportunities to help the community implement the plan's recommended actions for which no current funding exists;
- Monitor and assist in implementation and update of this plan;
- Report on plan progress and recommended changes to the City Council; and
- Inform and solicit input from the public.

The primary duty of the City is to see the plan successfully carried out and to report to their community governing boards and the public on the status of plan implementation and mitigation opportunities. Other duties include reviewing and promoting mitigation proposals, considering stakeholder concerns about hazard mitigation, passing concerns on to appropriate entities, and posting relevant information on the City website (and others as appropriate).

7.2 Maintenance

Plan maintenance implies an ongoing effort to monitor and evaluate plan implementation and to update the plan as progress, roadblocks, or changing circumstances are recognized.

7.2.1. Maintenance Schedule

The City of San Rafael Fire Department (SRFD) is responsible for initiating plan reviews and consulting with the other City departments and LHMP stakeholders. In order to monitor progress and update the mitigation strategies identified in the action plan, SRFE and the individual department representatives will revisit this plan annually and following a hazard event. The HMPC should communicate often to review progress on plan implementation and each implementing department will provide annual status reports. The HMPC will also submit a five-year written update to the State and FEMA Region IX, unless disaster or other circumstances (e.g., changing regulations) require a change to this schedule. With this plan anticipated to be fully approved and adopted in 2017, the next plan update for the City of San Rafael will occur in 2022.

7.2.2. Maintenance Evaluation Process

Evaluation of progress can be achieved by monitoring changes in vulnerabilities identified in the plan. Changes in vulnerability can be identified by noting:

- Decreased vulnerability as a result of implementing recommended actions;
- Increased vulnerability as a result of failed or ineffective mitigation actions; and/or
- Increased vulnerability as a result of new development (and/or annexation).
- Increased vulnerability resulting from unforeseen or new circumstances.

Updates to this plan will:

- Consider changes in vulnerability due to action implementation;
- Document success stories where mitigation efforts have proven effective;
- Document areas where mitigation actions were not effective;
- Document any new hazards that may arise or were previously overlooked;
- Incorporate new data or studies on hazards and risks;
- Incorporate new capabilities or changes in capabilities;
- Incorporate growth and development-related changes to infrastructure inventories; and
- Incorporate new action recommendations or changes in action prioritization.

Changes will be made to the plan to accommodate for actions that have failed or are not considered feasible after a review of their consistency with established criteria, time frame, community priorities, and/or funding resources. All mitigation actions will be reviewed as well during the monitoring and update of this plan to determine feasibility of future implementation. Updating of the plan will be by written changes and submissions, as the HMPC deems appropriate and necessary. In keeping with the five-year update process, the HMPC will convene public meetings to solicit public input on the plan and its routine maintenance and the final product will be adopted by the San Rafael City Council.

Annual Plan Review Process

For the LHMP review process, the SRFD will be responsible for facilitating, coordinating, and scheduling reviews and maintenance of the plan. The review of the LHMP will normally occur on an annual basis each year and will be conducted by the HMPC as follows:

- The SRFD will place an advertisement in the local newspaper advising the public of the date, time, and place for each annual review of the plan and will be responsible for leading the meeting to review the plan.
- Notices will be mailed to the members of the HMPC, federal, state, and local agencies, non-profit groups, local planning agencies, representatives of business interests, neighboring communities, and others advising them of the date, time, and place for the review.
- City/County/District officials will be noticed by email and telephone or personal visit and urged to participate.
- Members of the City's Planning Commission and other appointed commissions and groups will also be noticed by email and either by telephone or personal visit.
- Prior to the review, department heads and others tasked with implementation of the various activities will be queried concerning progress on each activity in their area of responsibility and asked to present a report at the review meeting.
- The local news media will be contacted and a copy of the current plan will be available for public comment at the City of San Rafael.
- After the review meeting, minutes of the meeting and an annual report will be prepared by the HMPC and forwarded to the news media (public) and other interested stakeholders. The report will also be presented to the San Rafael City Council for review, and a request will be made that the Council take action to recognize and adopt any changes resulting from the review.

Criteria for Annual Reviews

The criteria recommended in 44 CFR 201 and 206 will be utilized in reviewing and updating the plan. More specifically, the annual reviews will include the following information:

- Community growth or change in the past year.
- The number of substantially damaged or substantially improved structures by flood zone
- The renovations to public infrastructure including water, sewer, drainage, roads, bridges, gas lines, and buildings
- Natural hazard occurrences that required activation of the Emergency Operations Center (EOC) and whether or not the event resulted in a presidential disaster declaration.
- Natural hazard occurrences that were not of a magnitude to warrant activation of the EOC or a federal disaster declaration but were severe enough to cause damage in the community or closure of businesses, schools, or public services
- The dates of hazard events descriptions
- Documented damages due to the event
- Closures of places of employment or schools and the number of days closed
- Road or bridge closures due to the hazard and the length of time closed
- Assessment of the number of private and public buildings damaged and whether the damage was minor, substantial, major, or if buildings were destroyed. The assessment will include residences, mobile homes, commercial structures, industrial structures, and public buildings, such as schools and public safety buildings
- Review of any changes in federal, state, and local policies to determine the impact of these policies on the community and how and if the policy changes can or should be incorporated into the LHMP. Review of the status of implementation of projects (mitigation strategies) including projects completed will be noted. Projects behind schedule will include a reason for delay of implementation.

7.2.3. Incorporation into Existing Planning Mechanisms

Another important implementation mechanism that is highly effective and low-cost is incorporation of the LHMP recommendations and their underlying principles into other City plans and mechanisms. Where possible, plan participants will use existing plans and/or programs to implement hazard mitigation actions. As previously stated in Section 7.1 of this plan, mitigation is most successful when it is incorporated into the day-to-day functions and priorities of government and development. The point is re-emphasized here. As described in this plan's capability assessment, the City already implements policies and programs to reduce losses to life and property from hazards. This plan builds upon the momentum developed through previous and related planning efforts and mitigation programs and recommends implementing actions, where possible, through these other program mechanisms. These existing mechanisms include:

- City general plans (especially the Safety Element)
- City Emergency Operations Plans and other emergency management efforts
- City ordinances
- Flood/stormwater management/master plans
- Community Wildfire Protection Plans
- Capital improvement plans and budgets
- Climate Adaptation and other Climate plans
- Other plans and policies outlined in the capability assessments
- Other plans, regulations, and practices with a mitigation focus

Any HMPC members who are involved in these other organizations are invited to integrate their findings and recommendations of this LHMP with these other plans, programs, etc., as appropriate. As described in Section 7.1 Implementation, incorporation into existing planning mechanisms should routinely

- monitor other planning/program agendas;
- attend other planning/program meetings;
- participate in other planning processes; and
- monitor community budget meetings for other community program opportunities.

Hazard mitigation is not merely about planning, it should focus on implementation mitigation measures. In that light, a structure for periodic review of the plan assures the plan does not sit on a shelf. The successful implementation of this mitigation strategy should be constantly reviewed and new multi-objective opportunities that promote a safe, sustainable community should be considered.

Examples of incorporation of the LHMP into existing planning mechanisms include:

1. As recommended by Assembly Bill 2140, the City should adopt (by reference or incorporation) this LHMP into the Safety Element of their General Plan. Evidence of such adoption (by formal, certified resolution) shall be provided to CAL OES and FEMA.
2. Integration of wildfire actions identified in this mitigation strategy and those established in existing and in process CWPPs and other City fire mitigation plans and programs. Key people responsible for mitigation of the wildfire hazard in the City participated on the HMPC. City wildfire projects were identified and integrated into the this LHMP. Actual implementation of these projects will likely occur through existing fire department plans and programs and as part of the City-specific CWPP to be developed as identified in the mitigation strategy of this LHMP.

3. Continued support of the BayWAVE (Sea Level Rise) program through integration of mitigation actions identified in this mitigation strategy with implementation actions and priorities of the BayWAVE initiative. The City has been involved in the Phase I BayWAVE efforts and will continue to be involved through Phase II which focuses on action implementation.
4. Integration of this LHMP Update into the City's Climate Adaptation Plan (CAP). It is anticipated that this LHMP will being used to inform the development of the CAP and conversely risk and vulnerability data and climate adaptation strategies developed for the CAP will be integrated into future updates of this LHMP for the City.
5. Use of the LHMP risk assessment and other information to update the hazard analysis in future updates of the City's Emergency Operations Plans and other emergency planning efforts for the City.

Efforts should continuously be made to monitor the progress of mitigation actions implemented through these other planning mechanisms and, where appropriate, their priority actions should be incorporated into future updates of this LHMP.

7.2.4. Continued Public Involvement

Continued public involvement is imperative to the overall success of the plan's implementation. The update process provides an opportunity to solicit participation from new and existing stakeholders and to publicize success stores from the plan implementation and seek additional public comment. The plan maintenance and update process will include continued public and stakeholder involvement and input through attendance at designated committee meetings, web postings, press releases to local media, and through public meetings.

Public Involvement Process for Annual Reviews

The public will be noticed by placing an advertisement in local media and social media specifying the date and time for the review and inviting public participation. The HMPC, local, state, and regional agencies will also be notified and invited to attend and participate.

Public Involvement for Five-year Update

When the HMPC reconvenes for the update, they will coordinate with all stakeholders participating in the planning process—including those that joined the committee since the planning process began—to update and revise the plan. In reconvening, the HMPC will be responsible for coordinating the activities necessary to involve the greater public. The HMPC will develop a plan for public involvement and will be responsible for disseminating information through a variety of media channels detailing the plan update process. As part of this effort, public meetings will be held and public comments will be solicited on the LHMP Update draft.

Appendix A Planning Process

A.1 Lists of HMPC Invites/Stakeholders

Table A-1 Initial LHMP Invite List

Department	Title	Name	Email
Internal Stakeholders			
SNR Fire	BC	Jason Hatfield	Jason.Hatfield@cityofsanrafael.org
SNR Fire	Vegetation Specialist	Jared McDaniel	Jared.McDaniel@cityofsanrafael.org
SR Office of Emergency Services	Emergency Management Coordinator	John Bruckbauer	John.Bruckbauer@cityofsanrafael.org
SR Police	Chief	Diana Bishop	563@srpd.org
SR Public Works	Assistant Director	Kevin McGowan	Kevin.McGowan@cityofsanrafael.org
SR Public Works	Director	Bill Guerin	Bill.Guerin@cityofsanrafael.org
SR Public Works	GIS Specialist	Zak Baron	Zak.Baron@cityofsanrafael.org
SR Public Works	Parks Superintendent	Dave Davenport	Dave.Davenport@cityofsanrafael.org
SR Economic Development	Sustainablity Coordinator	Cory Bytof	Cory.Bytof@cityofsanrafael.org
SR Community Development	Planning Director	Paul Jensen	Paul.Jensen@cityofsanrafael.org
SR Community Development	Chief Building Official	Thomas Ahrens	Thomas.Ahrens@cityofsanrafael.org
SR Commuity Services	Director	Carlene McCart	Carlene.McCart@cityofsanrafael.org
SR Public Information Officer	PIO	Rebecca Woodbury	Rebecca.Woodbury@cityofsanrafael.org
SR Information Technology	Director	Gus Bush	gus.bush@cityofsanrafael.org
SR Sanitation District	Manager	Doris Toy	doris.toy@cityofsanrafael.org
External Stakeholders			
Marin County Office of Emergency Services	Emergency Services Coordinator	Thomas Jordan	tjordan@marinsheriff.org
Marin County Fire		Scott Alber	SAlber@marincounty.org
California Office of Emergency Services		Victoria LaMar	Victoria.LaMar-Haas@CalOES.ca.gov
California Office of Emergency Services		Lori Newquist	Lori.Newquist@CalOES.ca.gov
California Office of Emergency Services		Jose Lara	Jose.Lara@CalOES.ca.gov

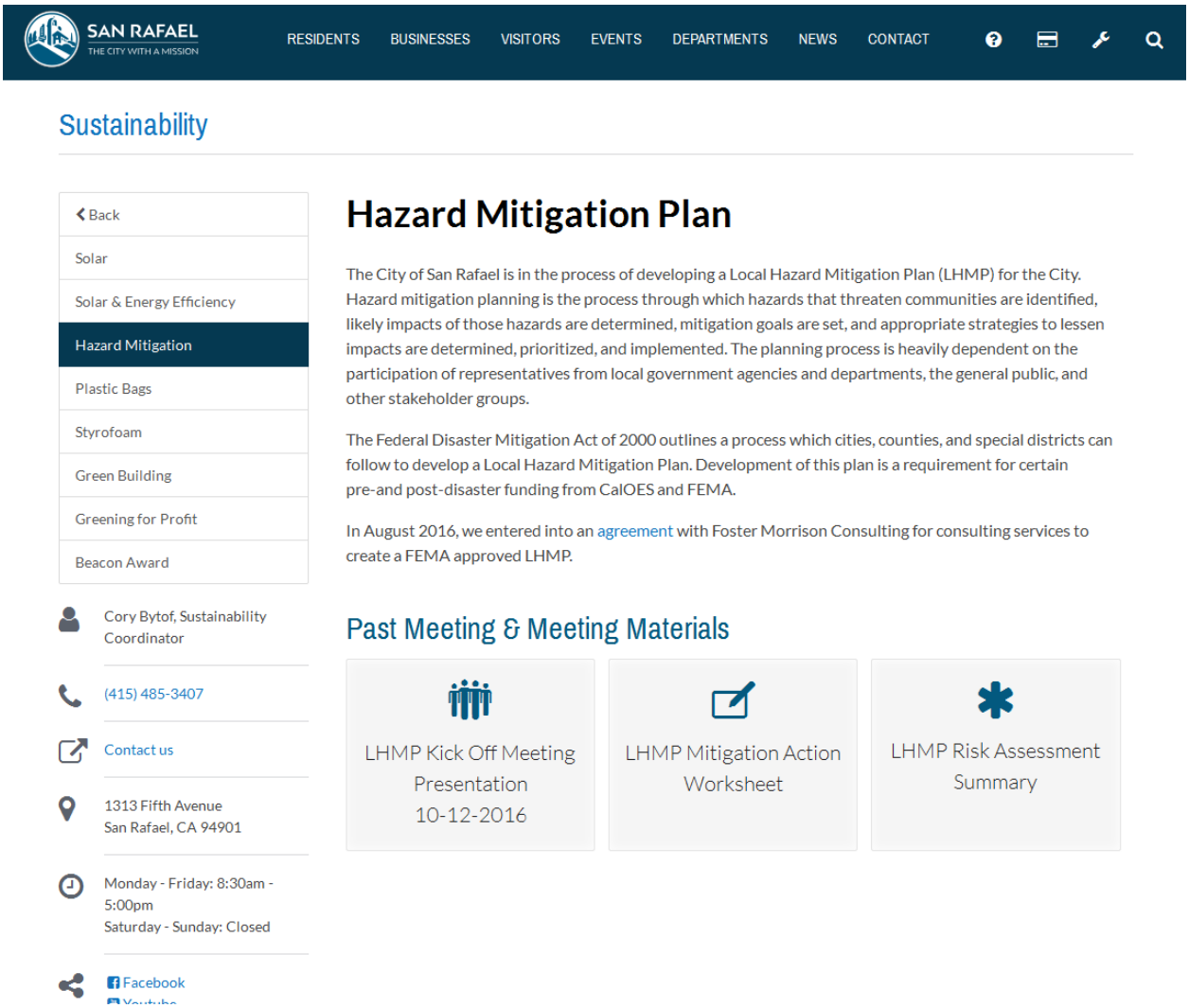
Department	Title	Name	Email
Federal Emergency Management Agency		Helen Dubios-	Helen.DuBois@fema.dhs.gov
Federal Emergency Management Agency		Juliette Hayes	Juliette.Hayes@fema.dhs.gov
Federal Emergency Management Agency		Michael Hornick	Michael.Hornick@fema.dhs.gov
Pacific Gas & Electric	Public Safety Specialist	Jim Wickham	jpwq@pge.com
Red Cross	Disaster Service Representative	Philippa Lockwood	philippa.lockwood@redcross.org
National Weather Service	Warning Coordination Meteorologist	Brian Garcia	brian.garcia@noaa.gov
Sonoma Marin Area Rail Transit (SMART)		Jennifer Welch	JWelch@sonomamarintrain.org
ShoreUp Marin / Canal Welcome Center		Douglas Mundo	dmundo@cwcenter.org
ShoreUp Marin		Hannah Doress	hannah@wordoutconsulting.com
Canal Alliance		Cesar Lopez	CesarL@canalalliance.org
Marin Transit	Director of Operations and Planning	Robert Betts	rbetts@marintransit.org
Center for Volunteer and Nonprofit Leadership	Volunteer Manager	Anton Timms	atimms@cvnl.org
Marin Municipal Water District	Facilities and Watershed Division Mgr.	Crystal Yezman	cyezman@marinwater.org
Marin Sanitary Service		Steve Rosa	Steve.Rosa@marinsanitary.com
San Rafael Chamber of Commerce	Executive Director	Joanne Webster	jwebster@srchamber.com
Marin Builder's Association	Executive Director	Rick Wells	rick@marinba.org
San Rafael City Schools	Facilities Manager	Cori Castro	ccastro@srcs.org

Table A-2 HMPC Participant List

TO BE INSERTED

*Did not attend meetings, but provided information valuable to the plan or planning process

A.2 Website for Hazard Mitigation Plan



A.3 Kickoff Meeting

A.3.1. Kickoff Meeting Invite to Stakeholders

From: John Bruckbauer [mailto:John.Bruckbauer@cityofsanrafael.org]
Sent: Friday, September 09, 2016 10:03 AM
To: Chris Gray <Chris.Gray@cityofsanrafael.org>; Robert Sinnott <Robert.Sinnott@cityofsanrafael.org>; Jason Hatfield <Jason.Hatfield@cityofsanrafael.org>; Jared McDaniel <Jared.McDaniel@cityofsanrafael.org>; John Bruckbauer <John.Bruckbauer@cityofsanrafael.org>; Diana Bishop <563@srpd.org>; Kevin McGowan <Kevin.McGowan@cityofsanrafael.org>; Bill Guerin <Bill.Guerin@cityofsanrafael.org>; Zak Baron <Zak.Baron@cityofsanrafael.org>; Dave Davenport <Dave.Davenport@cityofsanrafael.org>; Cory Bytof <Cory.Bytof@cityofsanrafael.org>; Paul Jensen <Paul.Jensen@cityofsanrafael.org>; Thomas Ahrens <Thomas.Ahrens@cityofsanrafael.org>; Carlene McCart <Carlene.McCart@cityofsanrafael.org>; Rebecca Woodbury <Rebecca.Woodbury@cityofsanrafael.org>; Gus Bush <Gus.Bush@cityofsanrafael.org>; Doris Toy <Doris.Toy@cityofsanrafael.org>; Thomas Jordan (tjordan@marinsheriff.org) <tjordan@marinsheriff.org>; SAlber@marincounty.org; Lori.Newquist@CalOES.ca.gov; Helen.DuBois@fema.dhs.gov; James Wickham (jpwq@pge.com) <jpwq@pge.com>; Victoria.LaMar-Haas@CalOES.ca.gov; Juliette.Hayes@fema.dhs.gov; Philippa Lockwood - ARC <philippa.lockwood@redcross.org>; JWelch@sonomamarintrain.org; brian.garcia@noaa.gov; Douglas Mundo <dmundo@cwcenter.org>; Hannah Doress <hannah@wordoutconsulting.com>; CesarL@canalalliance.org; rbetts@marintransit.org; cyezman@marinwater.org; Anton Timms <atimms@cvnl.org>; Steve.Rosa@marinsanitary.com; jwebster@srchamber.com; rick@marinba.org; ccastro@srcs.org
Cc: Jim Schutz <Jim.Schutz@cityofsanrafael.org>; Cristine Alilovich <Cristine.Alilovich@cityofsanrafael.org>; Jeanine Foster <jeanine.foster@fostermorrison.com>
Subject: Local Hazard Mitigation Plan Kickoff Meeting

City of San Rafael LHMP: Kickoff meeting email invite

Good morning!

The City of San Rafael is kicking off efforts to develop a Local Hazard Mitigation Plan (LHMP) for the City. The purpose of the LHMP process is to help reduce the impacts of natural hazards to the citizens, property, and critical infrastructure in the City. The Disaster Mitigation Act of 2000 (DMA 2000) requires that local governments have a FEMA-approved Hazard Mitigation Plan in place in order to be eligible for certain pre- and post-disaster mitigation funding utilized to protect communities from future disaster-related losses. You are receiving this notice because we would like to invite you to take part in this plan as a member of the Hazard Mitigation Planning Committee (HMPC).

City and agency participation and coordination is a requirement of an approved plan, as is the inclusion of any hazard data, information, and mitigation projects your department or agency may want to see included in the plan. Thus, your participation in this process is important and encouraged. Your input will be critical to the success of this project. Participation includes:

- Attending and participating in the HMPC meetings (4 anticipated over the next 6-7 months)
- Providing available data/information requested of the HMPC

Reviewing and providing comments on the plan drafts

The City of San Rafael, Office of Emergency Services (OES) is taking the lead on coordinating this planning project for the City. A project kickoff meeting will be held at the following location and time:

10/12, 1pm-4pm, B Street Community Center, 618 B Street San Rafael, CA 94901

The kickoff meeting will explain the process and how you can be involved. A public stakeholder meeting will also be held the evening of the same day of the kickoff meeting. Details on the public meetings will be forthcoming.

Please RSVP and plan on attending or delegating attendance to this important meeting.

John Bruckbauer
Emergency Management Coordinator
San Rafael Fire Department
Office of Emergency Services
1039 C Street
San Rafael, CA 94901
(415) 458-5002

A.3.2. Kickoff Meeting Agenda

CITY OF SAN RAFAEL
LOCAL HAZARD MITIGATION PLAN (LHMP)
HMPC MEETING #1
OCTOBER 12, 2016

1. Introductions
2. Marin County's Multi-jurisdictional LHMP
3. Hazard Mitigation & the Disaster Mitigation Act Planning Requirements
4. The Role of the Hazard Mitigation Planning Committee (HMPC)
5. Planning for Public Input
6. Coordinating with other Agencies
7. Hazard Identification
8. Schedule
9. Data Needs
10. Questions and Answers

A.3.3. Kickoff Meeting Sign-in Sheets

SIGN-IN SHEET
City of San Rafael
LOCAL HAZARD MITIGATION PLANNING PROJECT
HMPC Kickoff Meeting #1
October 12, 2016

Name/Title	Email Address	Phone	Department/Organization/ Affiliation
Jeanine Foster	jeanine.fosterfostermorrison.com	303/717-7171	Foster Morrison Consulting
Tom Jordan	tjordan@marinsheriff.org	415 473 5040	MCSO OES
Jan Lee	jan.lee@marinsanitary.com	415-458-5501	Marin Sanitary Service.
Rosario Gonzalez	rosario.gonzalez@marinsanitary.com	415-4585532	MSS.
Zachary Bacon	zak.bacon@cityofsanrafael.com	415-485-3366	City of San Rafael D.P.W.
Kevin McGowan	kevin.mcgowan@cityofsanrafael.org	485 3359	DPW
Ashley Howe	ashley.howe@cityofsanrafael.org	(415)485-3413	City - Comm. Service Dept.
Brain Garcia	brain.garcia@noaa.gov	(206) 852-2925	National Weather Service Bay Area
Carlene Mulcahy	carlene.mulcahy@cityofsanrafael.org	485-3346	Community Services
Paul Jensen	paul.jensen@cityofsanrafael.org	415-485-5064	Community Development
Amy VanDam	avandam@marinmass.org	455 226-0859	Marin Transit
Bob Simmons	rsimmons@cityofsanrafael.org	415 485 5067	SR Fire
Gus Bush / IT Manager San Rafael	gus.bush@cityofsanrafael.org	415-458-5302	city of San Rafael

SIGN-IN SHEET
City of San Rafael
LOCAL HAZARD MITIGATION PLANNING PROJECT
HMPC Kickoff Meeting #1
October 12, 2016

Name/Title	Email Address	Phone	Department/Organization/ Affiliation
DIANA BISHOP CHIEF OF POLICE	563@SRPD.ORG	415 485 3009	CITY OF SR
Cory Bytof	cory.bytof@cityofsanrafael.org	415 485 3407	" "
THOMAS AHRENS	thomas.ahrens@CITYOF...	415-485-3359	CITY OF S.R. /CWD
BILL GUERIN	BILL.GUERIN@CITYOFSANRAFAEL.ORG	415 485-3110	DPW SAN RAFAEL
DOUGLAS Mundo	dmundo@cwcenter.org.	415-526-2486	CANAL WELCOME CENTER SHORE-UP MARIN
DORIS TOY	DORIS.TOY@CITYOFSANRAFAEL.ORG	415-485-3484	SAN RAFAEL SANITATION DISTRICT
DANIELLE FERRIGNO	DANIELLE.FERRIGNO@cityofsanrafael.org	415-485-3138	SAN RAFAEL FIRE
Jim Wickham	JPNQ@PGE.COM	925-337-5132	PG&E

A.4 Risk Assessment Meetings

A.4.1. Emailed Invites to Risk Assessment Meetings

From: Danielle Ferrigno [mailto:Danielle.Ferrigno@cityofsanrafael.org]
Sent: Tuesday, January 24, 2017 7:26 PM
To: Danielle Ferrigno; Kevin McGowan; Sarah Houghton; Jim Schutz; Amy Van Doren; Paul Jensen; Cristine Alilovich; tjordan@marinsheriff.org; Alber, Scott; Zak Baron; Thomas Ahrens; Crystal Yezman; Joanne Webster; dmundo@cwcenter.org; Carlene McCart; Rebecca Woodbury; jr@argonautcompany.com; Diana Bishop; Danielle O'Leary; Gus Bush; Lauren Crandell; Cory Bytof; Jason Hatfield; Jeanine Foster; Room FD OES Conf; hannah@wordoutconsulting.com; Chris Gray; Bill Guerin; Robert Sinnott; Dave Davenport; Doris Toy; Glenn McElderry
Subject: Local Hazard Mitigation Plan-Risk Assessment Meeting
When: Wednesday, January 25, 2017 9:00 PM to Thursday, January 26, 2017 12:00 AM (UTC+00:00) Monrovia, Reykjavik.
Where: Room FD OES Conf

City of San Rafael LHMP: Risk Assessment Meeting Invite In October of 2016 the City of San Rafael kicked-off its Local Hazard Mitigation Planning effort with planning consultants Foster Morrison. Over the past two months, Foster Morrison has been coordinating with many of you to collect data that has informed Chapter 4 of our Local Hazard Mitigation Plan, the Risk Assessment.

During this Risk Assessment meeting (agenda attached), we will be reviewing the risk assessment data developed to date and will be looking for your feedback in refining and adding to this in-process Risk Assessment Chapter.

The meeting will be held on Wednesday January, 25th at 1033 C Street, at the Fire Department Emergency Operations Center<https://www.google.com/maps/place/1033+C+St,+San+Rafael,+CA+94901/@37.9740612,-122.532808,17z/data=!3m1!4b1!4m5!3m4!1s0x808599fb6e427389:0xca88c2663101242a!8m2!3d37.9740612!4d-122.5306193>, from 1pm-4pm.

Please RSVP and plan on attending or delegating attendance to this important meeting.
City and agency participation and coordination is a requirement of an approved plan, as is the inclusion of any hazard data, information, and mitigation projects your department or agency may want to see included in the plan. Thus, your participation in this process is important and encouraged. Your input will be critical to the success of this project. Participation includes:

> Attending and participating in the HMPC meetings (2 more anticipated after the risk assessment meeting)
> Providing available data/information requested of the HMPC
> Reviewing and providing comments on the plan drafts

Thank You

Danielle Ferrigno| City of San Rafael
MANAGEMENT ANALYST
1400 5th Avenue, Room 203
San Rafael, CA 94901
Desk: 415.485.3138
Office: 415.686.6977

A.4.2. Risk Assessment Meeting Agenda

City of San Rafael
Local Hazard Mitigation Plan (LHMP) Update
Risk Assessment Meeting
January 25, 2016

1. Introductions
2. Status of the DMA Planning Process
3. Review (and discussions/input) of the Risk Assessment
4. Review of Data Needs
5. Questions
6. Next Steps

A.4.3. Risk Assessment Meeting Sign in Sheets

SIGN-IN SHEET
City of San Rafael
LOCAL HAZARD MITIGATION PLANNING PROJECT
HMPC Risk Assessment Meeting #2
January 25, 2017

Name/Title	Email Address	Phone	Department/Organization/ Affiliation
Jeanine Foster	jeanine.foster@fostermorrison.com	303 717-7171	Consultant
DANIELE FERRIGNO	DANIELLE.FERRIGNO@cityofsanrafael.org	415-485-3138	MANAGEMENT ANALYST FINANCE SAN RAFAEL
Kevin McGowan	kevin.mcgowan@cityofsanrafael.org	415 4853389	DPW
JEFF RHOADS	jr@aarconautcompany.com	702 682 9829	RESILIENT SHORE
BILL GUERIN	BILL.GUERIN@CITYOFSANRAFAEL.ORG	415 485 3110	PW
Gus Bush / IT Manager	gus.bush@cityofsanrafael.org	415-458-5302	CoSR/ITD
Lauren Blanchard	lauren.crandell@cityofsanrafael.org	485-3056	City Mgr. Ofc.
Bob Sinnott	robert.sinnott@cityofsr.org	415-485-5067	Fire
Carlene McCart	carlene.mccart@cityofsanrafael	415-485-3346	Comm. Services
Cory Bytof	cory.bytof@cityofsanrafael.org	415 485 3407	COSR - city mgr's office
DORIS TOY	DORIS.TOY@CITYOFSANRAFAEL.ORG	415 485-3484	SRSD
Danielle O'Leary	danielle.oleary@cityofsanrafael.org	415-485-3460	COSR-Econ Dev.
Paul Jensen	paul.jensen@cityofsanrafael.org	415.485.5064	Comm. Development

SIGN-IN SHEET
City of San Rafael
LOCAL HAZARD MITIGATION PLANNING PROJECT
HMPC Risk Assessment Meeting #2
January 25, 2017

415 226-0859

Name/Title	Email Address	Phone	Department/Organization/ Affiliation
Amy Van Doren	Marin Transit avandoren@marintransit.org		
Christopher Gray	Chris.gray@cityofsanrafael.org	415/485-3084	SRFD
THOMAS ARENS / CBO	thomas.arens@cityof...	415.485.3357	CDD/BUILDING

A.5 Mitigation Strategy Meetings

A.5.1. Email Invites to Mitigation Strategy Meetings

From: Danielle Ferrigno [mailto:Danielle.Ferrigno@cityofsanrafael.org]
Sent: Friday, January 20, 2017 11:36 AM
To: Danielle Ferrigno; Chris Gray; Robert Sinnott; Jason Hatfield; Diana Bishop; Kevin McGowan; Bill Guerin; Zak Baron; Dave Davenport; Cory Bytof; Paul Jensen; Thomas Ahrens; Carlene McCart; Rebecca Woodbury; Gus Bush; Doris Toy; tjordan@marinsheriff.org; Jeanine Foster; dmundo@cwcenter.org; hannah@wordoutconsulting.com; Sarah Houghton; Danielle O'Leary; Jim Schutz; Cristine Alilovich; Room FD OES Conf; Alber, Scott; Joanne Webster; Crystal Yezman
Subject: Local Hazard Mitigation Plan: Mitigation Planning Meeting
When: Tuesday, February 21, 2017 9:00 AM-12:00 PM (UTC-08:00) Pacific Time (US & Canada).
Where: Room FD OES Conf

City of San Rafael LHMP: Mitigation Planning Meeting Invite

The meeting will be held on Tuesday February 21st at from 9am to Noon in the Large Community Development Conference Room located at City Hall,1400 5th avenue on the 2nd floor.

Please RSVP and plan on attending or delegating attendance to this important meeting.

City and agency participation and coordination is a requirement of an approved plan, as is the inclusion of any hazard data, information, and mitigation projects your department or agency may want to see included in the plan. Thus, your participation in this process is important and encouraged. Your input will be critical to the success of this project. Participation includes:

Attending and participating in the HMPC meetings (1 more anticipated after this mitigation planning meeting)
Providing available data/information requested of the HMPC
Reviewing and providing comments on the plan drafts

Thank You

Danielle Ferrigno| City of San Rafael
MANAGEMENT ANALYST
1400 5th Avenue
San Rafael, CA 94901
Desk: 415.485.3138
Office: 415.686.6977

From: Danielle Ferrigno [mailto:Danielle.Ferrigno@cityofsanrafael.org]
Sent: Friday, January 20, 2017 11:36 AM
To: Danielle Ferrigno; Chris Gray; Robert Sinnott; Jason Hatfield; Diana Bishop; Kevin McGowan; Bill Guerin; Zak Baron; Dave Davenport; Cory Bytof; Paul Jensen; Thomas Ahrens; Carlene McCart; Rebecca Woodbury; Gus Bush; Doris Toy; tjordan@marinsheriff.org; Jeanine Foster; dmundo@cwcenter.org; hannah@wordoutconsulting.com; Sarah Houghton; Danielle O'Leary; Jim Schutz; Cristine Alilovich; Room FD OES Conf; Alber, Scott; Joanne Webster; Crystal Yezman; Room CH3 CD Large Conf
Subject: Local Hazard Mitigation Plan: Mitigation Planning Meeting
When: Wednesday, February 22, 2017 1:00 PM-4:00 PM (UTC-08:00) Pacific Time (US & Canada).
Where: Room FD OES Conf

City of San Rafael LHMP: Mitigation Planning Meeting Invite

The meeting will be held on Tuesday February 21st at from 9am to Noon in the Large Community Development Conference Room located at City Hall,1400 5th avenue on the 2nd floor.

Please RSVP and plan on attending or delegating attendance to this important meeting.

City and agency participation and coordination is a requirement of an approved plan, as is the inclusion of any hazard data, information, and mitigation projects your department or agency may want to see included in the plan. Thus, your participation in this process is important and encouraged. Your input will be critical to the success of this project. Participation includes:

Attending and participating in the HMPC meetings (this should be the final planning meeting)
Providing available data/information requested of the HMPC
Reviewing and providing comments on the plan drafts

Thank You

Danielle Ferrigno| City of San Rafael
MANAGEMENT ANALYST
1400 5th Avenue
San Rafael, CA 94901
Desk: 415.485.3138
Office: 415.686.6977

From: Danielle Ferrigno [mailto:Danielle.Ferrigno@cityofsanrafael.org]
Sent: Wednesday, February 15, 2017 1:51 PM
To: Chris Gray <Chris.Gray@cityofsanrafael.org>; Robert Sinnott <Robert.Sinnott@cityofsanrafael.org>; Jason Hatfield <Jason.Hatfield@cityofsanrafael.org>; Diana Bishop <563@srpd.org>; Kevin McGowan <Kevin.McGowan@cityofsanrafael.org>; Bill Guerin <Bill.Guerin@cityofsanrafael.org>; Zak Baron <Zak.Baron@cityofsanrafael.org>; Dave Davenport <Dave.Davenport@cityofsanrafael.org>; Cory Bytof <Cory.Bytof@cityofsanrafael.org>; Paul Jensen <Paul.Jensen@cityofsanrafael.org>; Thomas Ahrens <Thomas.Ahrens@cityofsanrafael.org>; Carlene McCart <Carlene.McCart@cityofsanrafael.org>; Rebecca Woodbury <Rebecca.Woodbury@cityofsanrafael.org>; Gus Bush <Gus.Bush@cityofsanrafael.org>; Doris Toy <Doris.Toy@cityofsanrafael.org>; tjordan@marinsheriff.org; 'SAlber@marincounty.org'; 'Lori.Newquist@CalOES.ca.gov'; 'Helen.DuBois@fema.dhs.gov'; 'Victoria.LaMar-Haas@CalOES.ca.gov'; 'Juliette.Hayes@fema.dhs.gov'; 'brian.garcia@noaa.gov'; 'CesarL@canalalliance.org'; 'rbetts@marintransit.org'; 'cyezman@marinwater.org'; 'Steve.Rosa@marinsanitary.com'; 'jwebster@srchamber.com'; 'rick@marinba.org'; 'ccastro@srcs.org'; Jeanine Foster <jeanine.foster@fostermorrison.com>; dmundo@cwcenter.org; hannah@wordoutconsulting.com; Sarah Houghton <Sarah.Houghton@cityofsanrafael.org>; Danielle O'Leary <Danielle.OLeary@cityofsanrafael.org>; Jim Schutz <Jim.Schutz@cityofsanrafael.org>; Cristine Alilovich <Cristine.Alilovich@cityofsanrafael.org>; Room FD OES Conf <FDOESConf.Room@cityofsanrafael.org>; Alber, Scott <SAlber@marincounty.org>; Joanne Webster <jwebster@srchamber.com>; Crystal Yezman <cyezman@marinwater.org>; Dave Starnes <372@srpd.org>; rbetts@marintransit.org; Cori Castro <ccastro@srcs.org>; Rick Wells <rick@marinbuilders.org>; LaMar-Haas, Victoria@CalOES <Victoria.LaMar-Haas@CalOES.ca.gov>
Subject: Mitigation Action Ideas

Hello San Rafael Local Hazard Mitigation Planning Team-

Next week we will begin the most important phase of our local hazard mitigation planning process; the mitigation strategy. In these upcoming meetings the planning team will be working to identify and evaluate potential mitigation actions for reducing the community's risk to natural hazards and disasters. I want to send along the attached Mitigation Action Ideas guidance document from FEMA. This document explains what a "mitigation action" is and it should help give you a better understanding of what types of projects we may be able to include in the plan.

Please note, there has been a location change. Both meetings with be in the Community Development conference room at 1400 5th Ave San Rafael.

- Meeting 1: Tuesday February 21st is from 9am to 12pm.
- Meeting 2: Tuesday February 22nd is from 2pm-5pm.

Please attend **BOTH** meetings if possible. Thank you for your continued participation in this important planning process.

Danielle Ferrigno| **City of San Rafael**
MANAGEMENT ANALYST
1400 5th Avenue
San Rafael, CA 94901

A.5.2. Mitigation Strategy Meeting Agenda

City of San Rafael
Local Hazard Mitigation Plan (LHMP)
Mitigation Strategy Meetings
February 21 & 22, 2017

HMPC Meeting #3:

1. Introductions
2. Status of the DMA Planning Process
3. Risk Assessment Update
4. Outstanding Items
5. Develop Updated Plan Goals and Objectives
6. Identify and Review Mitigation Alternatives/Projects

HMPC Meeting #4:

1. Introductions
2. Identify and discuss Mitigation Alternatives/Projects
3. Review Mitigation Selection Criteria
4. Prioritize Mitigation Projects
5. Mitigation Action Worksheet
6. Review of Schedule/Next Steps

SIGN-IN SHEET
City of San Rafael
LOCAL HAZARD MITIGATION PLAN UPDATE PROJECT
HMPC Mitigation Strategy Meeting #3
February 21, 2017

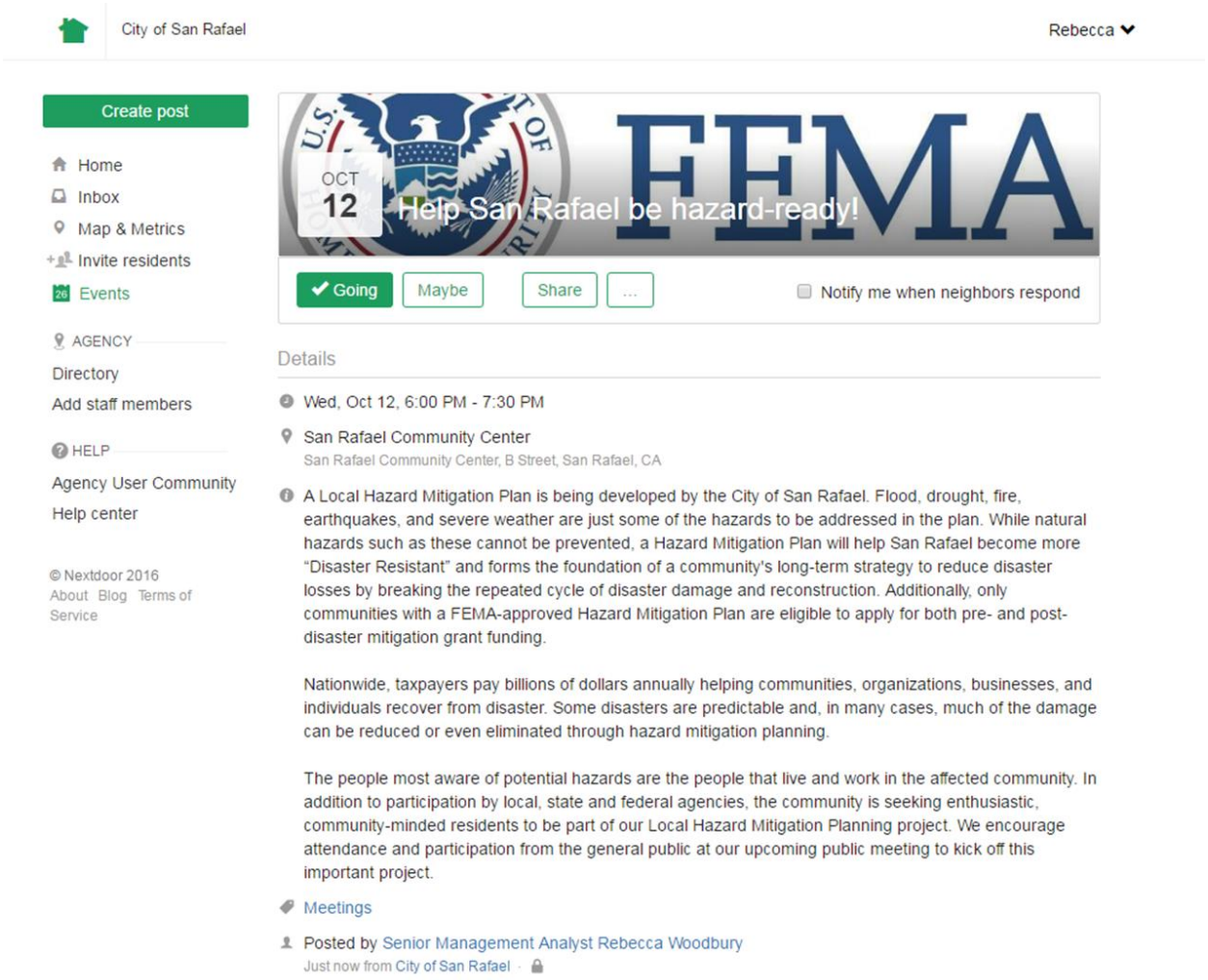
Name/Title	Email Address	Phone	Jurisdiction/Organization/ Affiliation
Jeanine Foster	Jeanine.foster@fostermorrison.com	303 717 7171	foster Morrison
DAVE STARNES/ POLICE CAPTAIN	372@SRPD.ORG	415-485-3471	SRPD
Bob Sinnott	robert.Sinnott@cityofsanrafael.org	415.485.3067	SRFD
Zachary Baron	Zach.baron@cityofsanrafael.org ~~Zach.baron@cityo~~	415-485-3366	Public Works
Keegan McGoldrick	Keegan.McGoldrick@CityofSanRafael.org	485-3389	DPW
Cory Bytof, SUSTAINABILITY & RESILIENCE COORDINATOR	cory.bytof@cityofsanrafael.org	4154853407	City Manager CDSR
DANIELLE FERRIGNO	DANIELLE.FERRIGNO@CITYOFSANRAFAEL.ORG	415-~~485~~-3134	CITY OF SAN RAFAEL
PAUL JENSEN	paul.jensen@cityofsanrafael.org	415-485-3064	City of San Rafael
Rebecca Woodbury			
Dave Davenport	dave.davenport@cityofsanrafael.org	4154853377	SR
DORIS TOY	DORIS.TOY@CITYOFSANRAFAEL.ORG	415-485-3484	SRSD
Gus Bush	gus.bush@cityofsanrafael.org	415-458-5302	SR ITD

SIGN-IN SHEET
City of San Rafael
LOCAL HAZARD MITIGATION PLAN UPDATE PROJECT
HMPC Mitigation Strategy Meeting #4
February 22, 2017

Name/Title	Email Address	Phone	Jurisdiction/Organization/ Affiliation
DAVE DAVENPORT	dave.davenport@cityofsanrafael.org	415-485-	SR
DANIELLE FERRIGNO	DANIELLE.FERRIGNO@CITYOFSANRAFAEL.ORG	415-485-	SR
Zachary Baron GIS Analyst	zach.baron@cityofsanrafael.org	415-485-3366	Public Works
DAVE STARNES	372@SRPD.ORG	415-485-3471	SRPD
Bob SINNOTT	RobertSinnott@cityofsanrafael.org	415-485-3067	Fire Dept
Kevin McGeeson	Kevin.mcgeeson@cityofsanrafael.org	485 3388	DPW
DORIS TOY	DORIS.TOY@CITYOFSANRAFAEL.ORG	415 485 3484	SRSD
Gus Bush	gus.bush@cityofsanrafael.org	415-458-5302	SR ITD
Rebecca Woodbury			
Paul Jensen	paul.jensen@cityofsanrafael.org	415-485-5064	City of San Rafael
Bill Guerin	BILL.GUERIN@CITYOFSANRAFAEL.ORG	415 485-3110	SR
Amy Bytof	On file		

A.6 Public Involvement

A.6.1. Invite to Kickoff Meeting – Public



A.6.2. Kickoff Meeting Article

CITY OF San Rafael

MAYOR GARY O. PHILLIPS
VICE MAYOR KATE COLIN
COUNCILMEMBER ANDREW MCCULLOUGH
COUNCILMEMBER MARIBETH BUSHEY
COUNCILMEMBER JOHN GAMBLIN

FIRE DEPARTMENT
FIRE CHIEF, CHRISTOPHER GRAY
PHONE: 415-485-3304
FAX: 415-453-1627

Get Involved!

HELP YOUR COMMUNITY BE HAZARD-READY!

City of San Rafael, CA: A Local Hazard Mitigation Plan is being developed by the City of San Rafael. Flood, drought, fire, earthquakes, and severe weather are just some of the hazards to be addressed in the plan. While natural hazards such as these cannot be prevented, a Hazard Mitigation Plan will help San Rafael become more "Disaster Resistant" and forms the foundation of a community's long-term strategy to reduce disaster losses by breaking the repeated cycle of disaster damage and reconstruction. Additionally, only communities with a FEMA-approved Hazard Mitigation Plan are eligible to apply for both pre- and post-disaster mitigation grant funding.

Nationwide, taxpayers pay billions of dollars annually helping communities, organizations, businesses, and individuals recover from disaster. Some disasters are predictable and, in many cases, much of the damage can be reduced or even eliminated through hazard mitigation planning.

The people most aware of potential hazards are the people that live and work in the affected community. In addition to participation by local, state and federal agencies, the community is seeking enthusiastic, community-minded residents to be part of our Local Hazard Mitigation Planning project. We encourage attendance and participation from the general public at our upcoming public meeting to kick off this important project:

October 12, 2016

Public Meeting: 6:00 - 7:30 PM
San Rafael Community Center
618 B St, San Rafael, CA 94901

1039 C STREET, SAN RAFAEL, CA 94901
WWW.SRFD.ORG

Placed on Fire Department Twitter, City of San Rafael Nextdoor account, City website, City Manager's Snapshot newsletter, and fire Hotshot newsletter.

A.6.3. Kickoff Meeting – Public Agenda

CITY OF SAN RAFAEL
LOCAL HAZARD MITIGATION PLAN (LHMP)
PUBLIC MEETING #1
OCTOBER 12, 2016

1. Introductions
2. Hazard Mitigation & the Disaster Mitigation Act Planning Requirements
3. Hazard Identification and Profiles
4. Opportunities for Public Participation and Input
5. Schedule
6. Questions and Answers

A.6.4. Kickoff Meeting – Public Sign in Sheets

SIGN-IN SHEET
City of San Rafael
LOCAL HAZARD MITIGATION PLANNING PROJECT
Public Meeting #1
October 12, 2016

Name/Title	Email Address	Phone	Organization/ Affiliation
Dr. Cherie Saxapan	IcherieJoan@gmail.com	415-686 3807	OFA/Show-UP
Pamela Reaves	pamreaves@sbcglobal.net	415 450-5616	MCL
Greg Brockbank	greg@marinlawcenter.com	415-717-7056	Sustainable Marin
Carolyn Lenert	carolynlenert@msn.com	4999234	SR Fire Commission
Lori Schifrin	Lori.Sch@att.net	415-485-1101	too many to list Public
BILL CARNEY	WILLIAMCARNEY@COMCAST.NET	415-457-7656	SUSTAINABLE SAN RAFAEL
Kay KARCHEVSKI	kay@H2OLADY.com		SSR, LSHNA
CHRIS YALONIS	CHRIS@VENTUREPAD.WORKS	415 309 6331	VENTUREPAD SR CHAMBER

A.6.5. Emailed Invite to Mitigation Strategy Meeting – Public

From: Danielle Ferrigno [mailto:Danielle.Ferrigno@cityofsanrafael.org]
Sent: Friday, January 20, 2017 11:06 AM
To: Danielle Ferrigno; Jeanine Foster
Subject: Public Hazard Mitigation Planning Meeting
When: Wednesday, February 22, 2017 6:00 PM-7:30 PM (UTC-08:00) Pacific Time (US & Canada).
Where: Room CH3 CD Large Conf

San Rafael, CA: A Local Hazard Mitigation Plan is being developed by the City of San Rafael. Flood, drought, fire, earthquakes, and severe weather are just some of the hazards to be addressed in the plan. While natural hazards such as these cannot be prevented, a Hazard Mitigation Plan will help San Rafael become more "Disaster Resistant" and forms the foundation of a community's long-term strategy to reduce disaster losses by breaking the repeated cycle of disaster damage and reconstruction. Additionally, only communities with a FEMA-approved Hazard Mitigation Plan are eligible to apply for both pre- and post-disaster mitigation grant funding.

Nationwide, taxpayers pay billions of dollars annually helping communities, organizations, businesses, and individuals recover from disaster. Some disasters are predictable and, in many cases, much of the damage can be reduced or even eliminated through hazard mitigation planning.

The people most aware of potential hazards are the people that live and work in the affected community. In addition to participation by local, state and federal agencies, the community is seeking enthusiastic, community-minded residents to be part of our Local Hazard Mitigation Planning project. We encourage attendance and participation from the general public at our upcoming public meeting to kick off this important project:

February 22, 2016
Public Meeting: 6:00 - 7:30 PM
San Rafael City Hall
Community Development Conference Room
1400 5th Avenue, San Rafael Ca 94901

A.6.6. Public Outreach for Mitigation Strategy Meeting

SAN RAFAEL
THE CITY WITH A MISSION

RESIDENTS BUSINESSES VISITORS EVENTS DEPARTMENTS NEWS CONTACT

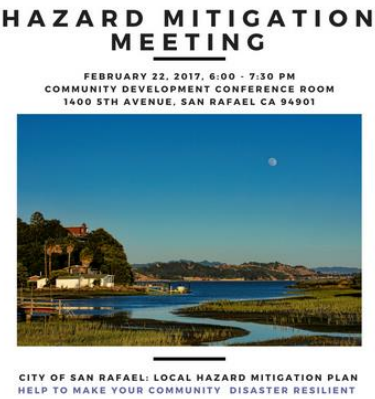
Local Hazard Mitigation Community Meeting

February
22
2017

06:00 pm ▸ Community Development Conference Room (second floor of City Hall)

1400 5th Avenue , San Rafael , California 94901

Share | Add to calendar | Directions



On February 22nd from 6:00 to 7:30 pm, the City of San Rafael will be holding a mitigation planning meeting in the Community Development conference room on the second floor of City Hall. At this meeting, participants will receive an overview of the LHMP project and review the City's risk assessment maps, data and findings to date. The City will also be soliciting feedback on possible mitigation strategies and projects that address hazards of concern in the Community. If you can't make it to the meeting on the 22nd please give us your feedback by completing this survey.

More upcoming events

City Council Meeting
March 20, 2017

Cancelled Design Review Board Meeting
March 21, 2017

Park & Recreation Commission Meeting
March 22, 2017

Planning Commission Meeting
March 28, 2017

Hack for Health
April 1, 2017

All events »

Add your event

A.6.7. Mitigation Strategy Meeting – Public Agenda

CITY OF SAN RAFAEL
LOCAL HAZARD MITIGATION PLAN (LHMP)
PUBLIC MEETING #2
FEBRUARY 22, 2017

1. Introductions
2. LHMP Project Overview and Status
3. Risk Assessment Overview
4. Next Steps/Schedule
5. Questions and Answers

A.6.8. Mitigation Strategy Meeting – Public Sign in Sheets

SIGN-IN SHEET
City of San Rafael
LOCAL HAZARD MITIGATION PLAN UPDATE PROJECT
Public Meeting #2
February 22, 2017

Name/Title	Email Address	Phone	Organization/ Affiliation
RAY LORBER	RAYLORBER@YAHOO.COM	415-479-9127	
TERRIE GREEN	Terriegreen1@comcast.net	415 336-6421	Shore Up MARIN / MARIN City CSD Emg Prep
JEFF RHOADS	jr@argonautcompany.com	702 682 9829	RESILIENT SHORE
KATHY SCHAEFER	Kathy.Schaefer@comcast.net	510.292.9075	RESILIENT SHORE
Dan Dunnigan	dandunnigan@hotmail.com	415 418 0145	SFFD - Retired.
NORMAN DAVIS	nsdpa@sbcglobal.net	4157714060	PEACOCK GAP
Lori Schifrin	Lori.Schoatt.net		[illegible] Citizen
Roger Byars	rogerbyars@comcast.net	415453-7835	Glenwood

A.6.9. Emailed Invite to Final Review of Plan – Public

A.6.10. Advertisement Flyer to Public for Final Plan Review

A.6.11. Radio and Public Service Announcements

INSERT

A.6.12. Final Review of Plan – Public Agenda

A.6.13. Final Review of Plan – Public Sign in Sheets

A.6.14. Board of Supervisors Meeting Presentation

A.7 Meeting Handouts

Below are the handouts for each meeting. Handouts specific to the Risk Assessment Meeting can be found in Appendix C.

Modoc County Hazard Identification and Profiles – 2015

Modoc County Historic Hazard Occurrences

Table A-3 NCDC Severe Weather Events for Marin County 1950–6/30/2016

Event Type	Number of Events	Deaths	Deaths (indirect	Injuries	Injuries (indirect)	Property Damage	Crop Damage
Coastal Flood	9	0	0	0	0	$340,000	$0
Debris Flows	6	1	0	0	0	$27,905,500	$20,000,000
Dense Fog	1	0	0	0	2	$100,000	$0
Extreme Cold/Wind Chill	1	0	1	0	0	$0	$0
Flash Flood	16	0	0	0	0	$5,556,000	$500,000
Flood	22	0	0	0	0	$216,183,100	$0
Frost/Freeze	3	0	0	0	0	$60,000	$3,000,000
Hail	1	0	0	0	0	$0	$0
Heat	5	1	0	0	0	$0	$0
Heavy Rain	7	1	0	0	0	$264,000	$0
Heavy Snow	1	0	0	0	0	$0	$0
High Surf	6	8	0	0	0	$75,000	$0
High Wind	44	2	0	0	0	$713,500	$0
Landslide	6	0	0	0	0	$1,132,000	$0
Lightning	1	0	0	0	0	$30,000	$0
Rip Current	1	0	0	0	0	$0	$0
Sneakerwave	4	5	0	1	0	$0	$0
Storm Surge/Tide	3	0	0	0	0	$10,000	$0
Strong Wind	93	2	1	1	0	$3,131,200	$0
Thunderstorm Winds	1	0	0	0	0	$0	$0
Tornado	1	0	0	0	0	$200,000	$5,000
Wildfire	3	0	0	0	0	$505,000	$5,000
Winter Weather	1	2	0	15	0	$0	$0
Total	**236**	**22**	**2**	**17**	**2**	**$256,205,300**	**$23,510,000**

Source: NCDC

Table A-4 Marin County Disaster Declaration History 1950-2015

Year	Disaster Name	Disaster Type	Disaster Cause	Disaster #	State Declaration #	Federal Declaration #
2014	California Drought	Drought	Drought	GP 2014-13	1/17/2014	–
2007	Bay Area Oil Spill	Other	Accident	GP 2007-15	11/9/2007	–
2006	2006 June Storms	Flood	Storms	DR 1646	–	6/5/2006
2005/2006	2005/06 Winter Storms	Flood	Storms	DR-1628	–	2/3/2006
2005	Hurricane Katrina Evacuations	Economic	Hurricane	EM-3248 2005	–	9/13/2005
2003	State Road Damage	Road Damage	Flood	GP 2003	1/1/2003	–
2001	Energy Emergency	Economic	Greed	GP 2001	1/1/2001	–
1998	1998 El Nino Floods	Flood	Storms	DR-1203	Proclaimed	2/19/1998
1997	1997 January Floods	Flood	Storms	DR-1155	1/2/97-1/31/97	1/4/1997
1995	Vision Fire	Fire	Fire	DC 95-05	10/95	–
1995	1995 Severe Winter Storms	Flood	Storms	DR-1044	1/6/95-3/14/95	1/13/1995
1990	1990 Freeze	Freeze	Freeze	DR-894	12/19/90-1/18/91	2/11/1991
1989	Loma Prieta Earthquake	Earthquake	Earthquake	DR-845	10/18/89-10/30/89	10/18/1989
1986	1986 Storms	Flood	Storms	DR-758	2/18-86-3/12/86	2/18/1986
1983	Winter Storms	Flood	Flood	DR-677	12/8/82-3/21/83	2/9/1983
1982	1982 Winter Storms	Flood	Storms	DR-651	1/5/82-1/9/82	1/7/1982
1980	April Storms	Flood	Storms	–	4/1/1980	–
1979	Gasoline Shortage	Economic	OPEC	–	5/8/1979-11/13/79	–
1978	Heavy Rains (Marin)	Flood	Storms	DC 78-02	1/1/1978	–
1976	1976 Drought	Drought	Drought	–	2/9/76-7/6/76	–

Year	Disaster Name	Disaster Type	Disaster Cause	Disaster #	State Declaration #	Federal Declaration #
1973	Coastal Flooding	Flood	Storms	DR 364	1/23/73-2/28/73	2/3/1973
1970	1970 Northern California Flooding	Flood	Flood	DR 283	1/27/1970 - 3/2/1970	2/16/1970
1969	1969 Storms	Flood	Storms	DR-253	1/23/69-3/12/69	1/26/1969
1965	1965 Fires	Fire	Fire	–	9/18/1965	–
1964	1964 Late Winter Storms	Flood	Storms	DR-183	-	12/24/1964
1964	1964 Tsunami	Tsunami	Earthquake	–	9/15/1964	–
1963	1963 Floods	Flood	Storms	-	2/14/1964	–
1958	1958 April Storms and Floods	Flood	Storms	DR-52	4/5/1958	4/4/1958
1958	1958 February Storms and Floods	Flood	Storms	CDO 58-03	2/26/1958	–
1955	1955 Floods	Flood	Flood	DR-47	12/22/1955	12/23/1955
1950	1950 Floods	Flood	Flood	OCD 50-01	11/21/1950	–

City of San Rafael Hazard Identification and Profiles – 2017

Table A-5 Hazards Comparison List

City of San Rafael Draft LHMP	2013 State of California Plan Applicable Hazards	Proposed 2016 Hazards
Drought	Climate Change & Related Hazards	Climate Change
Earthquake	Coastal Flooding, erosion, sea level rise	Coastal Flooding and sea level rise
Extreme Heat	Dam Failure	Dam Failure
Floods	Droughts and Water Shortage	Drought and Water Shortage
Fire	Earthquake	Earthquake
Landslides	Extreme Heat	Flood: (100/500 year)
Tsunami & Seiches	Flood	Flood: Localized/Stormwater
Additional Hazards?	Landslide and Other Earth Movements	Landslides, mudslides, hillside erosion, and Debris Flows
Marin County LHMP	Levee Failure	Levee Failure
Earthquake	Severe Weather and Storms	Severe Weather: Extreme Heat
Fire	Tsunami	
Flood	Wildfire	Severe Weather: Heavy Rains and Storms
Climate Change		Tsunami
Other Hazards:		Wildfire
Agricultural (drought)		
Terrorism		
Tsunami		
Landslides		

Table A-6 Modoc County Hazard Identification Table

Hazard	Geographic Extent	Probability of Future Occurrences	Magnitude/ Severity	Significance
Climate Change	Extensive	Likely	Limited	Medium
Coastal Flooding and sea level rise	Significant	Likely	Critical	Medium
Dam Failure	Limited	Unlikely	Negligible	Low
Drought and Water Shortage	Extensive	Likely	Critical	Medium
Earthquake	Extensive	Occasional	Catastrophic	High
Flood: (100/500 year)	Significant	Occasional/Unlikely	Critical	High
Flood: Localized/Stormwater	Extensive	Highly Likely	Limited	Medium
Landslide, Mudslides, Hillside Erosion, and Debris Flows	Significant	Likely	Limited	Medium
Levee Failure	Significant	Occasional	Limited	Medium
Severe Weather: Extreme Heat	Extensive	Highly Likely	Critical	Medium
Severe Weather: Heavy Rains and Storms	Extensive	Highly Likely	Critical	Medium
Tsunami	Limited	Unlikely	Limited	Medium
Wildfire	Significant	Likely	Catastrophic	High

Geographic Extent
Limited: Less than 10% of planning area
Significant: 10-50% of planning area
Extensive: 50-100% of planning area

Probability of Future Occurrences
Highly Likely: Near 100% chance of occurrence in next year, or happens every year.
Likely: Between 10 and 100% chance of occurrence in next year, or has a recurrence interval of 10 years or less.
Occasional: Between 1 and 10% chance of occurrence in the next year, or has a recurrence interval of 11 to 100 years.
Unlikely: Less than 1% chance of occurrence in next 100 years, or has a recurrence interval of greater than every 100 years.

Magnitude/Severity
Catastrophic—More than 50 percent of property severely damaged; shutdown of facilities for more than 30 days; and/or multiple deaths
Critical—25-50 percent of property severely damaged; shutdown of facilities for at least two weeks; and/or injuries and/or illnesses result in permanent disability
Limited—10-25 percent of property severely damaged; shutdown of facilities for more than a week; and/or injuries/illnesses treatable do not result in permanent disability
Negligible—Less than 10 percent of property severely damaged, shutdown of facilities and services for less than 24 hours; and/or injuries/illnesses treatable with first aid

Significance
Low: minimal potential impact
Medium: moderate potential impact
High: widespread potential impact

City of San Rafael
2017 Local Hazard Mitigation Plan
Participating Jurisdiction: Vulnerability & Capability Worksheets

Risk and Vulnerability Questions

Localized/Stormwater Flooding

1. Please describe the localized/stormwater flood issue specific to your jurisdiction in paragraph form. In addition, please complete a table similar to the below example detailing types and location of localized/stormwater flooding problems. If available, also attach a map of problem areas.

Text Description:

Table 7 Localized Flooding Areas

Road Name	Flooding	Pavement Deterioration	Washouts	High Water/ Creek Crossing	Landslides/ Mudslides	Debris	Downed Trees

Earthquake Vulnerability

1. Number of unreinforced masonry buildings. If available, please provide an inventory of URM buildings specific to your jurisdiction. Include any tables and/or maps. Is this a layer available in GIS?

Special Populations

1. Describe any hazard-related concerns or issues regarding the vulnerability of special needs populations, such as the elderly, disabled, low-income, or migrant farm workers.

Development Trends

1. Describe development trends and expected growth areas and how they relate to hazard areas and vulnerability concerns/issues. Please provide zoning maps and maps and tables detailing areas targeted for future development within your jurisdiction.

CAPABILITY ASSESSMENT

Capabilities are the programs and policies currently in use to reduce hazard impacts or that could be used to implement hazard mitigation activities. Please complete the tables and questions in the worksheet as completely as possible.

Planning and Regulatory

The following planning and land management tools are typically used by local jurisdictions to implement hazard mitigation activities. Please indicate which of the following your jurisdiction has in place. If your jurisdiction does not have this capability or authority, please indicate in the comments column if a higher level of government has the authority.

Plans	Y/N Year	Does the plan/program address hazards? Does the plan identify projects to include in the mitigation strategy? Can the plan be used to implement mitigation actions?
General Plan		
Capital Improvements Plan		
Economic Development Plan		
Local Emergency Operations Plan		
Continuity of Operations Plan		
Transportation Plan		
Stormwater Management Plan/Program		
Engineering Studies for Streams		
Community Wildfire Protection Plan		
Other special plans (e.g., brownfields redevelopment, disaster recovery, coastal zone management, climate change adaptation)		
Building Code, Permitting, and Inspections	**Y/N**	**Are codes adequately enforced?**
Building Code		
Building Code Effectiveness Grading Schedule (BCEGS) Score		
Fire department ISO rating:		
Site plan review requirements		
Land Use Planning and Ordinances	**Y/N**	**Is the ordinance an effective measure for reducing hazard impacts?** **Is the ordinance adequately administered and enforced?**
Zoning ordinance		
Subdivision ordinance		
Floodplain ordinance		

Natural hazard specific ordinance (stormwater, steep slope, wildfire)
Flood insurance rate maps
Elevation Certificates
Acquisition of land for open space and public recreation uses
Erosion or sediment control program
Other
How can these capabilities be expanded and improved to reduce risk?

Administrative/Technical

Identify the technical and personnel resources responsible for activities related to hazard mitigation/loss prevention within your jurisdiction. For smaller jurisdictions without local staff resources, if there are public resources at the next higher level government that can provide technical assistance, please indicate so in the comments column.

Administration	Y/N	Describe capability Is coordination effective?
Planning Commission		
Mitigation Planning Committee		
Maintenance programs to reduce risk (e.g., tree trimming, clearing drainage systems)		
Mutual aid agreements		
Other		
Staff	**Y/N FT/PT**	**Is staffing adequate to enforce regulations? Is staff trained on hazards and mitigation? Is coordination between agencies and staff effective?**
Chief Building Official		
Floodplain Administrator		
Emergency Manager		
Community Planner		
Civil Engineer		
GIS Coordinator		
Other		
Technical	**Y/N**	**Describe capability Has capability been used to assess/mitigate risk in the past?**
Warning systems/services (Reverse 911, outdoor warning signals)		

Hazard data and information
Grant writing
Hazus analysis
Other
How can these capabilities be expanded and improved to reduce risk?

Fiscal

Identify whether your jurisdiction has access to or is eligible to use the following financial resources for hazard mitigation

Funding Resource	Access/ Eligibility (Y/N)	Has the funding resource been used in past and for what type of activities? Could the resource be used to fund future mitigation actions?
Capital improvements project funding		
Authority to levy taxes for specific purposes		
Fees for water, sewer, gas, or electric services		
Impact fees for new development		
Storm water utility fee		
Incur debt through general obligation bonds and/or special tax bonds		
Incur debt through private activities		
Community Development Block Grant		
Other federal funding programs		
State funding programs		
Other		
How can these capabilities be expanded and improved to reduce risk?		

Education and Outreach

Identify education and outreach programs and methods already in place that could be/or are used to implement mitigation activities and communicate hazard-related information.

Program/Organization	Yes/No	Describe program/organization and how relates to disaster resilience and mitigation. Could the program/organization help implement future mitigation activities?
Local citizen groups or non-profit organizations focused on environmental protection, emergency preparedness, access and functional needs populations, etc.		
Ongoing public education or information program (e.g., responsible water use, fire safety, household preparedness, environmental education)		
Natural disaster or safety related school programs		
StormReady certification		
Firewise Communities certification		
Public-private partnership initiatives addressing disaster-related issues		
Other		
How can these capabilities be expanded and improved to reduce risk?		

National Flood Insurance Program (NFIP) Worksheet

Use this worksheet to collect information on your community's participation in and continued compliance with the NFIP, as well as identify areas for improvement that could be potential mitigation actions.

NFIP Topic	Comments
Insurance Summary	
How many NFIP policies are in the community? What is the total premium and coverage?	41 policies FM TO GET PREMIUMS $10,798,700 coverage
How many claims have been paid in the community? What is the total amount of paid claims? How many of the claims were for substantial damage?	1 paid claim $750.00 No substantial damage claims
How many structures are exposed to flood risk within the community?	FM to complete
Describe any areas of flood risk with limited NFIP policy coverage	
Staff Resources	
Is the Community Floodplain Administrator or NFIP Coordinator certified?	
Provide an explanation of NFIP administration services (e.g., permit review, GIS, education or outreach, inspections, engineering capability)	
What are the barriers to running an effective NFIP program in the community, if any?	
Compliance History	
Is the community in good standing with the NFIP?	
Are there any outstanding compliance issues (i.e., current violations)?	
When was the most recent Community Assistance Visit (CAV) or Community Assistance Contact (CAC)?	
Is a CAV or CAC scheduled or needed?	
Regulation	
When did the community enter the NFIP?	FM to complete
Are the FIRMs digital or paper?	FM to complete
Do floodplain development regulations meet or exceed FEMA or State minimum requirements? If so, in what ways?	
Provide an explanation of the permitting process.	
Community Rating System	
Does the community participate in CRS?	
What is the community's CRS Class Ranking?	
What categories and activities provide CRS points and how can the class be improved?	
Does the plan include CRS planning requirements?	

Prepared by:	Date	Email	Phone

HISTORIC HAZARD EVENTS WORKSHEET

Please fill out one sheet for each significant hazard event with as much detail as possible. Attach supporting documentation, photocopies of newspaper articles, or other original sources.

Type of event	
Nature and magnitude of event	
Location	
Date of event	
Injuries	
Deaths	
Property damage	
Infrastructure damage	
Crop damage	
Business/economic impacts	
Road/school/other closures	
Other damage	
Insured losses	
Federal/state disaster relief funding	
Opinion on likelihood of occurring again	
Source of information	
Comments	

	Please return worksheets by mail, email, or fax to: Jeanine Foster, Foster Morrison 5628 West Long Place Littleton, CO 80123 fax: (720) 893-0863 email: jeanine.foster@fostermorrison.com
Prepared by:	
Phone:	
Email:	
Date:	

Appendix B References

MORE TO BE INSERTED AT END OF PROCESS

ArkStorm at Tahoe - Stakeholder Perspectives on Vulnerabilities and Preparedness for an Extreme Storm Event in the Greater Lake Tahoe, Reno and Carson City Region. 2014.

California Department of Finance.

California Department of Fish and Game.

California Department of Forestry and Fire Protection.

California Department of Parks and Recreation Office of Historic Preservation.

California Department of Water Resources.

California Drought Contingency Plan.

California Office of Emergency Services.

California Environmental Quality Act.

California Geological Survey.

California Historical Landmarks.

California Natural Diversity Database.

California Points of Historical Interest.

California Register of Historic Places.

California Volcanoes and Volcanics. U.S. Geological Survey, Cascades Volcano Observatory.

Canal - An Immigrant Gateway in San Rafael at Risk. Case Study on Gentrification and Displacement Pressures in The Canal Neighborhood of San Rafael, CA

Census 2010. U.S. Census Bureau.

Cities/Counties Ranked by Size, Numeric, and Percent Change. State of California Department of Finance. 2014.

City of San Rafael 2020 General Plan.

City of San Rafael 2020 General Plan Background Report.

City of San Rafael Climate Change Action Plan, 2009.

City of San Rafael Community Emergency Preparedness Plan, 2009.

City of San Rafael Greenhouse Gas Reduction Strategy Report, 2014.

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Appendix C Mitigation Strategy

City of San Rafael
Local Hazard Mitigation Plan
HMPC Mitigation Strategy Meetings #3 & #4
February 21 & 22, 2017

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Agenda

Day 1:

Day 2:

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AGENDA

City of San Rafael
Local Hazard Mitigation Plan
Mitigation Strategy Meetings
February 21 & 22, 2016

HMPC Meeting #3:

1. Introductions
2. Status of the DMA Planning Process
3. Risk Assessment Update
4. Outstanding Items
5. Develop Updated Plan Goals and Objectives
6. Identify and Review Mitigation Alternatives/Projects

HMPC Meeting #4:

1. Introductions
2. Identify and Review Mitigation Alternatives/Projects
3. Review Mitigation Selection Criteria
4. Prioritize Mitigation Projects
5. Mitigation Action Worksheet
6. Review of Schedule/Next Steps

Risk Assessment & Mitigation Strategy Meetings
Day 1

Hazard Identification & Profiles

Table 1 San Rafael Hazard Identification Table

Hazard	Geographic Extent	Likelihood of Future Occurrences	Magnitude / Severity	Significance	Climate Change Impacts
Climate Change	Extensive	Highly Likely	Limited	Medium	N/A
Coastal Flooding and sea level rise	Significant	Likely	Critical	Medium	High
Dam Failure	Limited	Unlikely	Negligible	Low	Medium
Drought and Water Shortage	Extensive	Likely	Critical	Medium	High
Earthquake	Extensive	Occasional/Likely	Catastrophic	High	Low
Earthquake: Liquefaction	Limited	Occasional/Likely	Catastrophic	Medium	Low
Flood: (100/500 year)	Significant	Occasional/Unlikely	Critical	High	High
Flood: Localized/Stormwater	Extensive	Highly Likely	Limited	Medium	High
Landslide, Mudslides, Hillside Erosion, and Debris Flows	Significant	Likely	Limited	Medium	Medium
Levee Failure	Significant	Occasional	Limited	Medium	High
Severe Weather: Extreme Heat	Extensive	Highly Likely	Critical	Medium	High
Severe Weather: Heavy Rains and Storms	Extensive	Highly Likely	Critical	Medium	Medium
Tsunami	Limited	Unlikely	Limited	Medium	High
Wildfire	Significant	Likely	Catastrophic	High	Medium

Geographic Extent
Limited: Less than 10% of City
Significant: 10-50% of City
Extensive: 50-100% of City

Probability of Future Occurrences
Highly Likely: Near 100% chance of occurrence in next year, or happens every year.
Likely: Between 10 and 100% chance of occurrence in next year, or has a recurrence interval of 10 years or less.
Occasional: Between 1 and 10% chance of occurrence in the next year, or has a recurrence interval of 11 to 100 years.
Unlikely: Less than 1% chance of occurrence in next 100 years, or has a recurrence interval of greater than every 100 years.

Magnitude/Severity
Catastrophic—More than 50 percent of property severely damaged; shutdown of facilities for more than 30 days; and/or multiple deaths
Critical—25-50 percent of property severely damaged; shutdown of facilities for at least two weeks; and/or injuries and/or illnesses result in permanent disability
Limited—10-25 percent of property severely damaged, shutdown of facilities for more than a week; and/or injuries/illnesses treatable do not result in permanent disability
Negligible—Less than 10 percent of property severely damaged, shutdown of facilities and services for less than 24 hours; and/or injuries/illnesses treatable with first aid

Significance
Low: minimal potential impact
Medium: moderate potential impact
High: widespread potential impact

Climate Change Impact:
Low: Climate change is not likely to increase the probability of this hazard.
Medium: Climate change is likely to increase the probability of this hazard.
High: Climate change is very likely to increase the probability of this hazard.

Risk Assessment Methodology

Calculating Likelihood of Future Occurrence

The frequency of past events is used in this section to gauge the likelihood of future occurrences. Based on historical data, the likelihood of future occurrence is categorized into one of the following classifications:

- **Highly Likely**: Near 100% chance of occurrence in next year, or happens every year.
- **Likely**: Between 10 and 100% chance of occurrence in next year, or has a recurrence interval of 10 years or less.
- **Occasional**: Between 1 and 10% chance of occurrence in the next year, or has a recurrence interval of 11 to 100 years.
- **Unlikely**: Less than 1% chance of occurrence in next 100 years, or has a recurrence interval of greater than every 100 years.

Calculating Vulnerability

Vulnerability is measured in general, qualitative terms, and is a summary of the potential impact based on past occurrences, spatial extent, and damage and casualty potential:

- **Extremely Low**: The occurrence and potential cost of damage to life and property is very minimal to non-existent.
- **Low**: Minimal potential impact. The occurrence and potential cost of damage to life and property is minimal.
- **Medium**: Moderate potential impact. This ranking carries a moderate threat level to the general population and/or built environment. Here the potential damage is more isolated and less costly than a more widespread disaster.
- **High**: Widespread potential impact. This ranking carries a high threat to the general population and/or built environment. The potential for damage is widespread. Hazards in this category may have already occurred in the past.
- **Extremely High**: Very widespread and catastrophic impact.

Defining Significance (Priority) of a Hazard

Defining the significance or priority of a hazard to a community is based on a subjective analysis of several factors. This analysis is used to focus and prioritize hazards and associated mitigation measures for the plan. These factors include the following:

- **Past Occurrences**: Frequency, extent, and magnitude of historic hazard events.
- **Likelihood of Future Occurrences**: Based on past hazard events.
- **Ability to Reduce Losses through Implementation of Mitigation Measures**: This looks at both the ability to mitigate the risk of future occurrences as well as the ability to mitigate the vulnerability of a community to a given hazard event.

Risk Assessment Summary: City of San Rafael

Climate Change

- The 2013 State of California Multi-Hazard Mitigation Plan stated that climate change is already affecting California. Sea levels have risen by as much as seven inches along the California coast over the last century, increasing erosion and pressure on the state's infrastructure, water supplies, and natural resources. The State has also seen increased average temperatures, more extreme hot days, fewer cold nights, a lengthening of the growing season, shifts in the water cycle with less winter precipitation falling as snow, and both snowmelt and rainwater running off sooner in the year. Climate Change has the potential to alter the nature and frequency of most hazards.
- ANY HMPC INPUT ON CLIMATE CHANGE ISSUES IN THE CITY?
- Likelihood of Future Occurrence: Likely
- Vulnerability: Medium
- Priority Hazard

Coastal Flooding and Sea Level Rise

- The NCDC reported 18 events of coastal flooding for Marin County. None of these events were reported to have had a direct effect on San Rafael.
- Bay Conservation & Development Commission (2007) predicts, based on information available to date (FEMA flood zones, existing watersheds, and former tidelands/bay lands), that water levels in the San Francisco Bay will raise 16-inches by 2050 and 55-inches by 2100.
- BayWAVE SLR report Community Profile for San Rafael modeled 6 SLR scenarios that predicts water levels to rise from 10 inches (near term) to 20 inches (medium term) to 60 inches (long term) – with and without 100 year storm surge.
- ANY HMPC INPUT ON COASTAL FLOODING AND SEA LEVEL RISE IN THE CITY?
- Likelihood of Future Occurrence: Likely
- Vulnerability: High to Extremely High?
- Priority Hazard

Dam failure

- Only 4 dams (3 High and 1 Significant hazard rating) in vicinity of the City. The dam of potentially the greatest concern – The Phoenix Lake dam inundation area does not threaten the City.
- ANY PAST DAM FAILURE EVENTS OF CONCERN?
- Non-Priority Hazard

Drought and Water Shortage

- Historically California has experience multiple droughts. Data indicates there have been 3 significant droughts in the last 66 years.
- Since 2012, snowpack levels in California have dropped dramatically, with a slight increase in 2015. This year's storms have done much to alleviate drought conditions.
- 1 federal disaster declarations in 1977; 1 state proclamation in 1976; 1 drought State of Emergency in 2014

- HMPC – CAN YOU PROVIDE DAMAGES OR RESTRICTIONS THAT HAVE OCCURRED IN THE COUNTY RECENTLY DUE TO THE CURRENT DROUGHT. WHAT HAS BEEN IMPACTED THE MOST? WHAT IS THE PRIMARY SOURCE OF WATER AND HOW HAS WATER SUPPLY BEEN AFFECTED IN THE COUNTY?
- Likelihood of Future Occurrence: Likely
- Vulnerability: High?
- Priority Hazard

Earthquake (& Liquefaction)

- At least eight faults in the Bay Area are capable of producing earthquakes of magnitude 6.7 or larger. There are five faults that threaten the City.
- Significant number (35) of 5.0 and greater earthquake history within 90 miles of the City. There has been one federal and one state disaster declaration in Marin County. Both were related to the Loma Prieta earthquake in 1989.
- WHAT IS THE CITY'S PAST EARTHQUAKE HISTORY? HAVE THERE BEEN DAMAGES, FELT OCCURRENCES, OTHER? CAN WE GET SPECIFICS SURROUNDING THE LOMA PRIETA EARTHQUAKE?
- WERE THERE ISSUES IN THE COUNTY FROM THE MORE RECENT EARTHQUAKES?
- Likelihood of Future Occurrence: Occasional – large, damaging earthquake; Likely – minor earthquake
- Vulnerability: Extremely High
- Priority Hazard

Flood Hazard

100/500 year

- There are three types of freshwater flood events in the San Rafael area: riverine, flash, and urban stormwater. Regardless of the type of flood, the cause is often the result of severe weather and excessive rainfall, either in the flood area or upstream reaches.
- San Rafael is also subject to saltwater flooding and intrusions -Coastal Flooding.
- Marin County has experience multiple federal and state declarations related to flooding since 1950. 6 of the federal declarations were associated with flood events, 6 with severe storm, and 1 with coastal storm. 17 of the state declarations were associated with flood events.
- CAN WE GET INPUT ON PAST DAMAGES/IMPACTS OF HOW THE CITY WAS SPECIFICALLY AFFECTED?
- Likelihood of Future Occurrence: 100-Occasional; 500-Unlikely
- Vulnerability: High
- Priority Hazard

Localized/Stormwater flooding

- According to the City, numerous parcels and roads throughout San Rafael not included in the FEMA 100- and 500-year floodplains are subject to flooding in heavy rains.
- Significant localized flood history in the County – occurs annually
- CAN WE GET INPUT ON THE NATURE OF LOCALIZED FLOODING IN THE CITY? WE HAVE LOCATIONS. WHAT TYPE OF PROBLEMS DOES IT CAUSE?

- Likelihood of Future Occurrence: Highly Likely
- Vulnerability: Medium
- Priority Hazard

Landslides, Mudslides, Hillside Erosion, & Debris Flows

- The 2020 General Plan Background Report noted that landslides constitute a significant geologic hazard to structures, roads, and utilities in San Rafael. Flows and slides are the most common type of land movement in the City.
- There are no recorded federal or state disasters related to landslide, mudslide, or debris flows.
- The NCDC contains 6 events that have affected Marin County. However, only one of these events was reported to have had direct effects on the City of San Rafael: April 1, 2006.
- Other sources identified a mudslide in January of 1982 where heavy rains fell in much of Marin County during an El Nino event. 12 inches of rain fell in a 32-hour period. This caused mudslides throughout the County and in San Rafael. According to the Marin Independent Journal, four people died, including residents in Tiburon, Sausalito and San Rafael whose homes collapsed in mudslides.
- CAN YOU IDENTIFY OTHER PAST OCCURENCES AND SPECIFIC PROBLEM AREAS?
- Likelihood of Future Occurrence: Likely
- Vulnerability: Medium
- Priority Hazard

Levee Failure

- The 2016 FIS noted that there are no levees in the County or City of San Rafael that are certified as protecting against the 1% annual chance flood. It was noted that local interests have constructed approximately 75 miles of levees in the county. These levees are concentrated in the low-lying areas around Richardson Bay and the Cities of San Rafael and Novato. There is one certified levee in the County.
- There have been no federal or state disaster declarations related to levee failure.
- HAVE THERE EVER BEEN ANY LEVEE FAILURE EVENTS IN THE COUNTY?
- Likelihood of Future Occurrence: Unlikely?
- Vulnerability: Low – Medium?
- Priority Hazard?

Severe weather

Extreme heat

- Annual occurrences – it gets hot every summer
- Record highs for the City have exceeded 100 degrees in May through October with a record high of 110 degrees recorded in September 1904.
- There have been no federal or state disaster declarations due to extreme heat.
- The NCDC database reported 5 extreme heat events for the County since 1993. These 5 events occurred on 2 dates: 2006 and 2009.
- CAN THE CITY PROVIDE ANY INPUT ON PAST HEAT EVENTS AND DAMAGES/IMPACTS TO THE CITY? HOW MANY TIMES WERE COOLING CENTERS OPENED? HOW CAN THIS HAZARD BE CHARACTERIZED IN THE CITY?

- Climate change will likely affect this hazard in the future
- Likelihood of Future Occurrence: Highly Likely
- Vulnerability: Low – Medium?
- Non-Priority Hazard

Heavy rains and storms

- According to the NWS Office in Monterey, storms in the City are generally characterized by heavy rain often accompanied by strong winds and sometimes lightning and hail.
- Heavy rains and severe storms occur primarily during the late fall, winter, and spring (i.e., November through April). Damaging winds often accompany winter storm systems moving through the area. Tornadoes may also occur, but are very rare in Marin County and the City. DO YOU GET MUCH THUNDERSTORMS WITH HAIL AND LIGHTNING?
- Heavy storms can cause both widespread flooding as well as extensive localized drainage issues.
- Significant City history: annual occurrences
- Multiple state and federal disaster declarations associated with Heavy Rains and Storms
- The NCDC data shows 147 heavy rains and storm events for Marin County since 1950.
- HOW HAS THE CITY BEEN AFFECTED BY SEVERE STORM EVENTS?
- Likelihood of Future Occurrence: Highly Likely
- Vulnerability: High
- Priority Hazard?

Tsunami

- There has been one state disaster declaration and no federal disaster declarations due to tsunami. On March 27, 1964, a 9.2 magnitude earthquake in Alaska sent a tsunami surging down the western coastline of the United States, causing $1 million damage in Marin as 8-foot waves bounced boats around Loch Lomond Marina in San Rafael and knocked out pilings at Lawson's Landing near the mouth of Tomales Bay. No deaths were recorded in the City of San Rafael, but 11 deaths were reported in Crescent City due to this event.
- DOES ANYONE HAVE ANY DATA ON TSUNAMI SPECIFIC TO THE MARIN COUNTY/CITY?
- Likelihood of Future Occurrence: Unlikely – Occasional?
- Vulnerability: Medium
- Non-Priority Hazard?

Wildfire

- Wildfires occur on an annual basis in the City and surrounding County.
- There have been two disaster declaration (state) events that have occurred in Marin County: Vision Fire 1995 and 1965 Fires. Neither of these fire events threatened the City of San Rafael directly.
- WHAT IS THE FIRE SEASON IN SAN RAFAEL?
- CITY-SPECIFIC - HISTORIC AND FIRE CONDITIONS DATA?
- Any ignition has the potential to become an out of control wildfire.
- Likelihood of Future Occurrence: Highly Likely
- Vulnerability: High to Extremely high?
- Priority Hazard

Outstanding Items

City and HMPC

- Please provide input on past events and how these hazards have impacted the City (see Historic Hazard Worksheet) and Draft Chapter 4
- EOC activation history, other disaster history?
- Description, photos, etc. of damage/impacts from these January storms
- Other data needs: future development layer, other City input?
- Pictures for the plan – past disaster impacts and past mitigation type project works. Even a few pictures of the City in general

San Rafael Priority Hazards

- Climate Change
- Coastal Flooding and Sea Level Rise
- Drought & Water Shortage
- Earthquake
- Earthquake Liquifaction
- Flood: 100/500–year
- Flood: Localized/Stormwater
- Landslide, Mudslides, Hillside Erosion, and Debris Flows
- Levee Failure
- Severe Weather: Extreme Temperatures - Heat
- Severe Weather: Heavy rains and Storms
- Tsunami
- Wildfire

Mitigation Strategy: Goals

The most important element of the LHMP is the resulting mitigation strategy which serves as the long-term blueprint for reducing the potential losses identified in the risk assessment. The mitigation strategy is comprised of three components:

1. Mitigation Goals
2. Mitigation Actions
3. Action (Implementation) Plan

Mitigation Goals

Up to now, the HMPC has been involved in collecting and providing data for the Modoc County Local Hazard Mitigation Plan Update. From this information, a Risk Assessment has been developed that describes the risk and vulnerability of the Modoc County planning area to identified hazards and includes an assessment of the area's current capabilities for countering these threats through existing policies, regulations, programs, and projects.

This analysis identifies areas where improvements could or should be made. Formulating Goals will lead us to incorporating these improvements into the Mitigation Strategy portion of the plan. Our planning goals should provide direction for what loss reduction activities can be undertaken to make the planning area more disaster resistant.

Mitigation Goals are general guidelines that represent the community's vision for reducing or avoiding losses from identified hazards. Goals are stated without regard for achievement, that is, implementation cost, schedule, and means are not considered. Goals are public policy statements that:

- Represent basic desires of the jurisdiction;
- Encompass all aspects of planning area, public and private;
- Are nonspecific, in that they refer to the quality (not the quantity) of the outcome;
- Are future-oriented, in that they are achievable in the future; and
- Are time-independent, in that they are not scheduled events.

While goals are not specific (quantitative), they should not be so general as to be meaningless or unachievable.

Goals statements will form the basis for objectives. They should be stated in such a way as to develop one or more objectives related to each goal.

The key point in writing goals is to remember that they must deal with results, not the activities that produce those results.

Finally, before we formulate our goals, we should discuss other planning area goals from other regional/county/city programs and priorities. This keeps us from "reinventing the wheel," as well as being consistent with Multi-Objective Management --- or "MOM" --- where communities strive for efficiency by combining projects/needs that are similar in nature or location. Utilizing "MOM" effectively can result in

identifying multiple sources of funding that can be "packaged" and broadening the supporting constituency base by including "outcomes" desired by various stakeholder groups.

Types/Sources of other area mitigation plans and programs include:

- Emergency Operations Plans
- General Plans
- Stormwater Program and Plans
- Flood/Watershed Management Plans and Studies
- Drought Plans
- Community Wildfire Protection Plans
- Dam Failure Plans
- Other?

Sample Goals from other Plans

Goals from the 2013 California State Hazard Mitigation Plan

4. Significantly reduce life loss and injuries
5. Minimize damage to structures and property, as well as minimizing interruption of essential services and activities
6. Protect the environment
7. Promote hazard mitigation as an integrated public policy and as a standard business practice

Goals from the San Rafael General Plan

SAFETY ELEMENT: It is the goal of San Rafael, as the first priority for city government, to provide excellent fire, public safety and paramedic services and to be prepared in the case of disaster or emergency. San Rafael residents deserve to feel safe and secure wherever they live, work and play.

Objective S-1. Location of Future Development.

Objective S-2. Location of Public Improvements.

Objective S-3. Use of Hazard Maps in Development Review.

Objective S-4. Geotechnical Review.

Objective S-5. Minimize Potential Effects of Geological Hazards.

Objective S-6. Seismic Safety of New Buildings.

Objective S-7. Minimize Potential Effects of Landslides.

Objective S-8. Seismic Safety of Existing Buildings.

Objective S-9. Post Earthquake Inspections.

Objective S-17. Flood Protection of New Development.

Objective S-18 Storm Drainage Improvements.

Objective S-19. Flood Control Improvements Funding.

Objective S-20. Levee Upgrading.

Objective S-21. Rise in Sea Level.

Objective S-22. Erosion.

Objective S-24. Creeks and Drainageways.

Objective S-30. Maintenance and Landscaping for Fire Safety.

Objective S-31. New Development in Fire Hazard Areas.

Objective S-33. Disaster Preparedness Planning.

Objective S-34. Emergency Operation Center.

Objective S-38. Building Code and Fire Code Update.

Objective S-39. Public Safety Facilities.

Objective S-40. Outreach.

Goals Development

You will each be given 3 sticky notes. On each note you will write what you think the goals for this mitigation planning effort should be. To get you started, provided below are possible goals for this mitigation plan. You may reword these or develop your own. These goal statements should serve as examples. It is vital that our Hazard Mitigation Planning Committee establish its own goals. Use one note for each goal. The purpose of the goal development is to reach a consensus on plan goals.

- Minimize risk and vulnerability from natural hazards
- Increase communities' awareness of vulnerability to hazards
- Increase the use of shared resources
- Improve communities' capabilities to mitigate losses
- Maintain coordination of disaster plans with changing DHS/FEMA needs
- Maintain FEMA eligibility/position jurisdictions for grant funding
- Maintain/enhance the flood mitigation program to provide 200/500-year flood protection
- Maintain current service levels
- Provide protection for existing buildings from hazards
- Provide protection for future development from hazards
- Provide protection for natural and cultural resources from hazard impacts
- Provide protection for people's lives from hazards
- Provide protection for public health
- Provide protection for critical services (fire, police, etc.) from hazard impacts
- Provide protection for critical lifeline utilities from hazard impacts
- Reduce exposure to hazard related losses
- Reduce the number of emergency incidents
- Make better use of technology

When done, we will:

- Pin/tape them to the wall/easel-chart and arrange them by category
- Combine and reword them into 3-4 goals for the plan.

Risk Assessment and Mitigation Strategy Meetings
Day 2

Mitigation Strategy: Actions

Mitigation actions are specific projects and activities that help achieve the goals and accomplish risk reduction in the community.

Categories of Mitigation Measures

PREVENTION: Preventive measures are designed to keep the problem from occurring or getting worse. Their objective is to ensure that future development is not exposed to damage and does not increase damage to other properties.

- Planning
- Zoning
- Open Space Preservation
- Land Development Regulations
  - ✓ Subdivision regulations
  - ✓ Building Codes
    - Fire-Wise Construction
  - ✓ Floodplain development regulations
  - ✓ Geologic Hazard Areas development regulations (for roads too!)
- Storm Water Management
- Fuels Management, Fire-Breaks

EMERGENCY SERVICES: protect people during and after a disaster. A good emergency services program addresses all hazards. Measures include:

- Warning (flooding, tornadoes, winter storms, geologic hazards, fire)
  - ✓ NOAA Weather Radio
  - ✓ Sirens
  - ✓ "Reverse 911" (Emergency Notification System)
- Emergency Response
  - ✓ Evacuation & Sheltering
  - ✓ Communications
  - ✓ Emergency Planning
    - Activating the EOC (emergency management)
    - Closing streets or bridges (police or public works)
    - Shutting off power to threatened areas (utility company)
    - Holding/releasing children at school (school district)
    - Ordering an evacuation (mayor)
    - Opening emergency shelters (Red Cross)
    - Monitoring water levels (engineering)
    - Security and other protection measures (police)
- Critical Facilities Protection (Buildings or locations vital to the response and recovery effort, such as police/fire stations, hospitals, sewage treatment plants/lift stations, power substations)

- ✓ Buildings or locations that, if damaged, would create secondary disasters, such as hazardous materials facilities and nursing homes
- ✓ Lifeline Utilities Protection

- Post-Disaster Mitigation
- Building Inspections
  - ✓ ID mitigation opportunities & funding before reconstruction

PROPERTY PROTECTION: Property protection measures are used to modify buildings subject to damage rather than to keep the hazard away. A community may find these to be inexpensive measures because often they are implemented by or cost-shared with property owners. Many of the measures do not affect the appearance or use of a building, which makes them particularly appropriate for historical sites and landmarks.

- Retrofitting/disaster proofing
  - ✓ Floods
    - Wet/Dry floodproofing (barriers, shields, backflow valves)
    - Relocation/Elevation
    - Acquisition
    - Retrofitting
  - ✓ High Winds/Tornadoes
    - Safe Rooms
    - Securing roofs and foundations with fasteners and tie-downs
    - Strengthening garage doors and other large openings
  - ✓ Winter Storms
    - Immediate snow/ice removal from roofs, tree limbs
    - "Living" snow fences
  - ✓ Geologic Hazards (Landslides, earthquakes, sinkholes)
    - Anchoring, bracing, shear walls
    - Dewatering sites, agricultural practices
    - Catch basins
  - ✓ Drought
    - Improve water supply (transport/storage/conservation)
    - Remove moisture competitive plants (Tamarisk/Salt Cedar)
    - Water Restrictions/Water Saver Sprinklers/Appliances
    - Grazing on CRP lands (no overgrazing-see Noxious Weeds)
    - Create incentives to consolidate/connect water services
    - Recycled wastewater on golf courses
  - ✓ Wildfire, Grassfires
    - Replacing building components with fireproof materials
    - Roofing, screening
    - Create "Defensible Space"
    - Installing spark arrestors
    - Fuels Modification

- ✓ Noxious Weeds/Insects
  - Mowing
  - Spraying
  - Replacement planting
  - Stop overgrazing
  - Introduce natural predators
- Insurance

NATURAL RESOURCE PROTECTION: Natural resource protection activities are generally aimed at preserving (or in some cases restoring) natural areas. In so doing, these activities enable the naturally beneficial functions of floodplains and watersheds to be better realized. These natural and beneficial floodplain functions include the following:

- storage of floodwaters
- absorption of flood energy
- reduction in flood scour
- infiltration that absorbs overland flood flow
- groundwater recharge
- removal/filtering of excess nutrients, pollutants, and sediments from floodwaters
- habitat for flora and fauna
- recreational and aesthetic opportunities

Methods of protecting natural resources include:

- Wetlands Protection
- Riparian Area/Habitat Protection/Threatened-Endangered Species
- Erosion & Sediment Control
- Best Management Practices

Best management practices ("BMPs") are measures that reduce nonpoint source pollutants that enter the waterways. Nonpoint source pollutants come from non-specific locations. Examples of nonpoint source pollutants are lawn fertilizers, pesticides, and other farm chemicals, animal wastes, oils from street surfaces and industrial areas and sediment from agriculture, construction, mining and forestry. These pollutants are washed off the ground's surface by stormwater and flushed into receiving storm sewers, ditches and streams. BMPs can be implemented during construction and as part of a project's design to permanently address nonpoint source pollutants. There are three general categories of BMPs:

8. Avoidance: setting construction projects back from the stream.
9. Reduction: Preventing runoff that conveys sediment and other water-borne pollutants, such as planting proper vegetation and conservation tillage.
10. Cleanse: Stopping pollutants after they are en route to a stream, such as using grass drainageways that filter the water and retention and detention basins that let pollutants settle to the bottom before they are drained

- Dumping Regulations
- Set-back regulations/buffers

- Fuels Management
- Water Use Restrictions
- Landscape Management
- Weather Modification

STRUCTURAL: Projects that have traditionally been used by communities to control flows and water surface elevations. Structural projects keep flood waters away from an area. They are usually designed by engineers and managed or maintained by public works staff. These measures are popular with many because they "stop" flooding problems. However, structural projects have several important shortcomings that need to be kept in mind when considering them for flood hazard mitigation:

- They are expensive, sometimes requiring capital bond issues and/or cost sharing with Federal agencies, such as the U.S. Army Corps of Engineers or the Natural Resources Conservation Service.
- They disturb the land and disrupt natural water flows, often destroying habitats or requiring Environmental Assessments.
- They are built to a certain flood protection level that can be exceeded by a larger flood, causing extensive damage.
- They can create a false sense of security when people protected by a structure believe that no flood can ever reach them.
- They require regular maintenance to ensure that they continue to provide their design protection level.

Structural measures include:

- Detention/Retention structures
- Erosion and Sediment Control
- Basins/Low-head Weirs
- Channel Modifications
- Culvert resizing/replacement/Maintenance
- Levees and Floodwalls
- Anchoring, grading, debris basins (for landslides)
- Fencing (for snow, sand, wind)
- Drainage System Maintenance
- Reservoirs (for flood control, water storage, recreation, agriculture)
- Diversions
- Storm Sewers

PUBLIC INFORMATION: A successful hazard mitigation program involves both the public and private sectors. Public information activities advise property owners, renters, businesses, and local officials about hazards and ways to protect people and property from these hazards. These activities can motivate people to take protection

- Hazard Maps and Data
- Outreach Projects (mailings, media, web, speakers, displays)
- Library Resources
- Real Estate Disclosure
- Environmental Education

Mitigation Strategy: Action Plan

The mitigation action plan describes how the mitigation actions will be implemented, including how those actions will be prioritized, administered, and incorporated into the community's existing planning mechanism. Each participating jurisdiction must have a mitigation actions and an action plan specific to that jurisdiction and its priority hazards and vulnerabilities.

Mitigation Criteria

For use in selecting and prioritizing Proposed Mitigation Measures

1. STAPLEE

Social: Does the measure treat people fairly? (different groups, different generations)

- Community Acceptance
- Effect on Segment of Population
- Social Benefits

Technical: Will it work? (Does it solve the problem? Is it feasible?)

- Technical Feasibility
- Reduce Community Risk
- Long Tem Solution/Sustainable
- Secondary Impacts

Administrative: Do you have the capacity to implement & manage project?

- Staffing
- Funding Allocated
- Maintenance/Operations

Political: Who are the stakeholders? Did they get to participate? Is there public support? Is political leadership willing to support?

- Political Support
- Local Champion
- Public Support
- Achieves Multiple Objectives
- Supported by a broad array of Stakeholders

Legal: Does your organization have the authority to implement? Is it legal? Are there liability implications?

- Existing Local Authority
- State Authority
- Potential Legal Challenges

Economic: Is it cost-beneficial? Is there funding? Does it contribute to the local economy or economic development?

- Benefit of Action
- Cost of Action
- Cost Effective/Economic Benefits
- Economically Viable
- Outside Funding Required

Environmental: Does it comply with Environmental regulations?

- Effect on Land/Water
- Effect on Endangered Species
- Effect on Cultural Resources
- Effect on Hazmat sites
- Consistent with Community Environmental Goals
- Consistent with Environmental Laws
- Environmental Benefits

2. SUSTAINABLE DISASTER RECOVERY

- Quality of Life
- Social Equity
- Hazard Mitigation
- Economic Development
- Environmental Protection/Enhancement
- Community Participation

3. SMART GROWTH PRINCIPLES

- Infill versus Sprawl
- Efficient Use of Land Resources
- Full Use of Urban Resources
- Mixed Uses of Land
- Transportation Options
- Detailed, Human-Scale Design

4. OTHER

- Does measure address area with highest risk?
- Does measure protect …
  - ✓ The largest # of people exposed to risk?
  - ✓ The largest # of buildings?
  - ✓ The largest # of jobs?
  - ✓ The largest tax income?
  - ✓ The largest average annual loss potential?
  - ✓ The area impacted most frequently?

- ✓ Critical Infrastructure (access, power, water, gas, telecommunications)
- Timing of Available funding
- Visibility of Project
- Community Credibility

Mitigation Action Prioritization Instructions

Our Team recommendations are listed on flip-chart paper around the room.

You each have 3 sets of colored dots:

- 3 red dots
- 3 blue dots
- 3 green dots

The red dots are for high priority (5 points each)

The blue dots are for medium priority (3 points each)

The green dots are for low priority (1 point each)

Place your dots on the recommendations, using the different colors to indicate your priority. You may use as many of your dots, of any color, on any recommendation --- or you may spread them out using as few of your dots as you wish. The dots will indicate the consensus of the team.

Use your list of criteria to help you make your determinations.

After the totals are counted, we will discuss them further to confirm or change any of the results as we see fit.

Mitigation Action Worksheet

Mitigation Action/Project Title:	
Hazards Addressed:	
Issue/Background:	
Project Description:	
Other Alternatives:	
Existing Planning Mechanism(s) through which Action Will Be Implemented:	
Responsible Office/Partners:	
Cost Estimate:	
Benefits (Losses Avoided):	
Potential Funding:	
Timeline:	
Project Priority:	

Worksheet completed by:	
Name and Title:	
Phone:	

San Rafael
Local Hazard Mitigation
Mitigation Strategy Meeting: Mitigation Actions v/1
February 22, 2017

Initial Goals

GOAL 1: Minimize risk and vulnerability of the City of San Rafael to the impacts of natural hazards, and protect lives and reduce damages and losses to property, public health, economy, and the environment.

Objectives:

- Protect life and reduce exposure and hazard losses to City residents, businesses, vulnerable populations, and visitors
- Increase community resiliency to the impacts of natural hazards and promote sustainable growth
- Protect and enhance quality of life in the City
- Assure long term protection and resiliency of existing and future redevelopment from natural hazards
- Protect critical facilities from natural hazards and minimize interruption of essential infrastructure, utilities, and services
- Plan for and prioritize measures to respond to and address potential short- and long- term hazard impacts associated with climate change

GOAL 2: Enhance public outreach, awareness, education, and preparedness for all hazards to minimize hazard related losses

Objectives:

- Engage the community in disaster awareness and prevention education to reduce the risk and vulnerability of natural hazard impacts on quality of life
- Improve the communities' understanding of natural hazards and how to effectively be prepared and take action to mitigate the impacts of hazard events
- Develop and target outreach and education for each hazard type and risk area
- Support and encourage public responsibility
- Enhance public outreach programs to target vulnerable populations, including multi-language communications

GOAL 3: Improve City's resiliency and capabilities to mitigate losses and to be prepared for, respond to, and recover from a disaster event

Objectives:

- Take a proactive approach to identifying and mitigating hazards
- Maintain current service levels
- Continued enhancements to community capabilities, leveraging new technologies to reduce losses and save lives
- Provide protection and increase safety for City employees and first responders from hazards

GOAL 4: Maintain FEMA Eligibility/Position Jurisdictions for Grant Funding

Objectives:

- Maintain good standing with FEMA and State hazard mitigation programs, regulations and requirements
- Develop an overall mitigation funding strategy to prioritize and pursue mitigation projects, including identification and tracking of Federal, state, and local grant programs and funding mechanisms

Initial Mitigation Action Ratings

Responsible Department/ Staff	Mitigation Action Title	Hazards Addressed	Points/ Worksheet Status
	Public awareness, education, and outreach program enhancements: Improve/Enhance public education, engagement, and preparedness, response, and recovery program for all hazards (simplify, multi-media, educate and clarify various emergency systems, messaging and training)	Multi-hazard	11
Planning/ Jenson (FM to complete worksheet)	Incorporate LHMP Update by reference through board adoption into the safety element of the General Plan Update	Multi-hazard	N/A*
OES	Develop funding strategy for mitigation action implementation and disaster recovery assistance	Multi-hazards	5
	Conduct Citywide evaluation of technology improvements for disaster preparedness, prevention, mitigation, response, and recovery (cloud storage, real time sensors, other)	Emergency Services/Multi-hazard	17
	Evaluate Cloud processing/storage of information	Emergency Services/Multi-hazard	2
	Evaluate and implement signal timing for first responders	Emergency Services/Multi-hazard	15
GIS/Brown	Update and maintain countywide Critical Facilities GIS layer	Emergency Services/Multi-hazard	N/A
OES	Build new EOC (upgrade technologies)	Emergency Services/Multi-hazard	30
OES	Mobile command unit expansion	Emergency Services/Multi-hazard	0
OES	Evaluate and update response and recovery capabilities, priorities, and procedures	Emergency Services/Multi-hazard	14
	Fill emergency manager position	Emergency Services/Multi-hazard	16

Responsible Department/ Staff	Mitigation Action Title	Hazards Addressed	Points/ Worksheet Status
OES	Conduct evacuation and shelter planning for all communities and populations (to include all critical hazards, at risk populations, medical, ADA, animals, and an outreach component)	Emergency Services/Multi-hazard	7
OES	Develop and train volunteer resources	Emergency Services/Multi-hazard	4
OES	Update Emergency Operations Plan	Emergency Services/Multi-hazard	4
OES	Conduct preparedness, response, and recovery exercises	Emergency Services/Multi-hazard	3
	Evaluate and enhance conservation measures to reduce water consumption	Drought & Water Supply	1
	Evaluate use of reclaimed water/increase purple pipes	Drought & Water Supply	13
Public Works	Evaluate construction of water storage facilities under new ball fields	Drought & Water Supply	0
	MMWD exploration of desalination plants	Drought & Water Supply	0
Public Works	Leaky pip replacement program	Drought & Water Supply	0
Public Works	Retrofit/upgrade four remaining URMs on inventory list	Earthquake	1
Public Works	Study to further identify and evaluate earthquake prone areas and affected structures	Earthquake	1
Public Works	Inventory and evaluate options for vulnerable critical facilities and infrastructure (e.g., demolish, retrofit), including shelters	Earthquake	9
	Consider alternate EOC	Earthquake	14
	Develop energy storage plan	Earthquake	1
	Develop Climate Adaptation Plan and Implement resulting climate adaptation strategies	Climate Change/ Coastal Flooding/ Sea Level Rise	18
	Continued Involvement in BayWave Program (Phase I and Phase II); Implement resulting strategies from Phase II of the Program.	Climate Change/ Coastal Flooding/ Sea Level Rise	21
Planning	Expand wetland overlay district for adapting to SLR	Climate Change/ Coastal Flooding/ Sea Level Rise	3

Responsible Department/ Staff	Mitigation Action Title	Hazards Addressed	Points/ Worksheet Status
Sewer District	Relocate sewer facilities	Climate Change/ Coastal Flooding/ Sea Level Rise	5
Public Works	Elevate roads	Climate Change/ Coastal Flooding/ Sea Level Rise	1
Public Works	Elevate critical infrastructure	Climate Change/ Coastal Flooding/ Sea Level Rise	6
Public Works Flood Control District	Evaluate and identify improvements to existing berms, seawalls, etc. and implement resulting projects	Climate Change/ Coastal Flooding/ Sea Level Rise	0
Public Works	Consider joining CRS	Flood	10
	Modernize/upgrade sewer facilities	Flood	8
Sewer District	Elevate and floodproof pad and facilities in flood prone areas	Flood	13
Public Works	Beach Drive structural flood project (w/county)	Flood	6
Public Works	Evaluate new structural projects (floodwalls, levees) for flood protection	Flood	11
	Conduct flood insurance outreach	Flood	4
	Create/promote an Adopt a Drain program	Flood	14
Public Works	Modernizing existing (12) pump stations (new pumps, controls, backup generators, etc.)	Flood	20
Public Works	Add new pump stations in key areas	Flood	19
Public Works	Study to identify and map localized flooding areas	Flood	1
Public Works	Develop stormwater master plan	Flood	20
Public Works	Local Storm Drainage Improvements to accommodate 100-year storm	Flood	6
	Develop notification system for localized flooding (signs, detours, etc)	Flood	1
	Perform regular tree maintenance and removal	Heavy Rains and Storms	5
	Undergrounding of utilities	Heavy Rains and Storms	5
	Sewer pipe replacement program	Heavy Rains and Storms	0

Responsible Department/ Staff	Mitigation Action Title	Hazards Addressed	Points/ Worksheet Status
Public Works/ GIS/Brown	Identify and update mapping for all public and private levees	Levee Failure	20
Public Works/	Perform studies to determine levee improvements	Levee Failure	19
Public Works/	Develop funding strategy to support levee improvements	Levee Failure	0
Public Works/	Design, construct, inspect, and maintain levee improvements	Levee Failure	6
Public Works/	Update City study and mapping to identify potential landslides based on soil type and other factors	Landslide	20
Planning/ Jenson	Continue implementing hillside hazard overlay district to address slope stability hazards	Landslide	1
Public Works/	Develop strategy for monitoring, inspecting, and maintaining critical infrastructure for landslide susceptibility areas	Landslide	12
Public Works/	Develop funding strategy to support landslide projects	Landslide	0
Public Works/	Based on new studies and inspections, design and implement resulting projects	Landslide	5
City Fire/ Vegetation Management?	Identify, implement, and maintain defensible space projects	Wildfire	6
City Fire	Continue goat grazing project	Wildfire	6
City Fire	Continue Juniper and bamboo clearing programs	Wildfire	4
City Fire	Continue vegetation code enforcement program	Wildfire	0
City Fire City Open Space?	Identify, implement, and maintain fuels management projects (including collaboration with County fire on open space projects)	Wildfire	0
	Hire vegetation management specialist and identify other staffing support	Wildfire	13
	Develop Open Space Management Plan	Wildfire	7
City Fire	Develop City-specific Community Wildfire Protection Plan (CWPP) with enhanced wildfire mapping	Wildfire	3
	Dollar Hill Lookout/Fire Alert System	Wildfire	1
	Antennae redundancy with Fiber Connection	Wildfire	12
City Fire	Homeless Camp Removal	Wildfire	2

Appendix D Adoption Resolution

Note to Reviewers: When this plan has been reviewed and approved pending adoption by FEMA Region IX, the adoption resolutions will be signed by the participating jurisdictions and added to this appendix. A model resolution is provided below:

Resolution # _____

Adopting the San Rafael Local Hazard Mitigation Plan

Whereas, the City of San Rafael recognizes the threat that natural hazards pose to people and property within our community; and

Whereas, undertaking hazard mitigation actions will reduce the potential for harm to people and property from future hazard occurrences; and

Whereas, the U.S. Congress passed the Disaster Mitigation Act of 2000 ("Disaster Mitigation Act") emphasizing the need for pre-disaster mitigation of potential hazards;

Whereas, the Disaster Mitigation Act made available hazard mitigation grants to state and local governments;

Whereas, an adopted Local Hazard Mitigation Plan is required as a condition of future funding for mitigation projects under multiple FEMA pre- and post-disaster mitigation grant programs; and

Whereas, the City of San Rafael fully participated in the FEMA-prescribed mitigation planning process to prepare this local hazard mitigation plan; and

Whereas, the California Office of Emergency Services and Federal Emergency Management Agency, Region IX officials have reviewed the City of San Rafael Local Hazard Mitigation Plan and approved it contingent upon this official adoption of the participating governing body;

Whereas, the City of San Rafael desires to comply with the requirements of the Disaster Mitigation Act and to augment its emergency planning efforts by formally adopting the City of San Rafael Local Hazard Mitigation Plan;

Whereas, adoption by the governing body for the City of San Rafael, demonstrates the jurisdiction's commitment to fulfilling the mitigation goals and objectives outlined in this Local Hazard Mitigation Plan.

Whereas, adoption of this legitimacies the plan and authorizes responsible agencies to carry out their responsibilities under the plan.

Now, therefore, be it resolved, that the City of San Rafael adopts the City of San Rafael Local Hazard Mitigation Plan as an official plan; and

Be it resolved, that the City of San Rafael adopts the City of San Rafael Local Hazard Mitigation Plan by reference into the safety element of their general plan in accordance with the requirements of AB 2140, and

Be it further resolved, the City of San Rafael will submit this adoption resolution to the California Office of Emergency Services and FEMA Region IX officials to enable the plan's final approval in accordance with the requirements of the Disaster Mitigation Act of 2000 and to establish conformance with the requirements of AB 2140.

Passed:_____
(date)

_____
Certifying Official

Appendix E Critical Facilities

Table E-1 City of San Rafael Critical Facility Inventory

Name	Facility type	Address	Flood Zone	Landslide Area	Liquefaction Zone	Extreme Fire Zone	Average Fire Zone	Tsunami Zone	In WUI
Bahia Vista Elem. School	Community Space	125 Bahia Way	AE	surficial deposits	VH	N/A	N/A	No	No
Bahia Vista Elementary School	Community Space	125 Bahia Wy	AE	surficial deposits	VH	N/A	N/A	No	No
Big Rock Sudbury School	Community Space	1055 Las Ovejas Ave	X	surficial deposits	M	Moderate	Moderate	No	Yes
Boyd House	Community Space	1125 B St	X	mostly landslide	L	Moderate	Moderate	No	Yes
Bradford House	Community Space	333 G St	Shaded X	surficial deposits	H	N/A	N/A	No	Yes
Brandeis Hillel Day School	Community Space	180 N San Pedro Rd	X	few landslides	VL	Moderate	Moderate	No	No
Civic Center Library	Community Space	3501 Civic Center Dr	X	few landslides	VL	N/A	N/A	No	No
Civic Center Post office	Community Space	2 Civic Center Dr	X	surficial deposits	M	N/A	N/A	No	No
Coleman Elem. School	Community Space	140 Rafael Dr	Shaded X	surficial deposits	H	Moderate	High	No	Yes
Coleman Elementary School	Community Space	140 Rafael Dr	Shaded X	surficial deposits	H	Moderate	High	No	Yes

Name	Facility type	Address	Flood Zone	Landslide Area	Liquefaction Zone	Extreme Fire Zone	Average Fire Zone	Tsunami Zone	In WUI
County Community School	Community Space	160b N San Pedro Rd	X	surficial deposits	M	Moderate	Moderate	No	No
Davidson Middle School	Community Space	280 Woodland Ave	AE	surficial deposits	VH	N/A	N/A	No	No
Davidson Middle School	Community Space	280 Woodland Ave	Shaded X	surficial deposits	VH	N/A	N/A	No	No
Dixie Elem. School	Community Space	1175 Idylberry Rd	X	surficial deposits	H	N/A	N/A	No	No
Dixie School	Community Space	1175 Idylberry Rd	X	surficial deposits	H	N/A	N/A	No	No
Dominican University	Community Space	50 Acacia Dr	Shaded X	surficial deposits	H	Moderate	High	No	Yes
Erskine B. Mcnear House	Community Space	123 Knightdr	X	surficial deposits	H	N/A	N/A	No	Yes
Gallinas Elem. School	Community Space	177 N San Pedro Rd	X	surficial deposits	VL	Moderate	Moderate	No	No
Glenwood Elem. School	Community Space	25 W Castlewood Dr	X	surficial deposits	M	N/A	N/A	No	No
Glenwood Elementary School	Community Space	25 W Castlewood Dr	X	surficial deposits	M	N/A	N/A	No	No
Jewish Community Center	Community Space	200 N San Pedro Rd	X	few landslides	VL	Moderate	Moderate	No	No
Laurel Dell Elem. School	Community Space	225 Woodland Ave	Shaded X	few landslides	H	Moderate	Moderate	No	No
Lucas Valley Homeowners Community Center	Community Space	1201 Idylberry Rd	X	few landslides	VL	Moderate	Moderate	No	Yes

Name	Facility type	Address	Flood Zone	Landslide Area	Liquefaction Zone	Extreme Fire Zone	Average Fire Zone	Tsunami Zone	In WUI
Madrone Continuation High School	Community Space	310 Nova Albion Way	X	surficial deposits	M	Moderate	Moderate	No	No
Marin Academy	Community Space	1600 Mission Ave	X	surficial deposits	L	Moderate	Moderate	No	Yes
Marin Civic Center Exhibit Hall	Community Space	10 Avenue of The Flags	Shaded X	surficial deposits	VH	N/A	N/A	No	No
Marin County Civic Center	Community Space	3501 Civic Center Dr	X	few landslides	VL	N/A	N/A	No	No
Marin Waldorf School	Community Space	755 Idylberry Rd	X	surficial deposits	H	N/A	N/A	No	No
Marin Ymca	Community Space	1500 Los Gamos Dr	X	few landslides	L	Moderate	Moderate	No	No
Marinwood Community Center	Community Space	775 Miller Creek Rd	X	surficial deposits	H	N/A	N/A	No	No
Mary E Silveira Elem. School	Community Space	375 Blackstone Dr	X	surficial deposits	M	N/A	N/A	No	No
Mary E. Silveira School	Community Space	375 Blacksone Dr	X	surficial deposits	M	N/A	N/A	No	No
Miller Creek Middle School	Community Space	2255 Las Gallinas Ave	X	surficial deposits	H	N/A	N/A	No	No
Mission Rafael Station Post office	Community Space	910 D St	Shaded X	surficial deposits	H	N/A	N/A	No	No
Mission San Rafael Arcangel	Community Space	1102 5th AVE	Shaded X	surficial deposits	H	N/A	N/A	No	No
Montessori De Terra Linda	Community Space	620 Del Ganado Rd	X	surficial deposits	M	Moderate	Moderate	No	No

Name	Facility type	Address	Flood Zone	Landslide Area	Liquefaction Zone	Extreme Fire Zone	Average Fire Zone	Tsunami Zone	In WUI
National Guard Armory	Community Space	153 Madison Ave	X	surficial deposits	M	Moderate	Moderate	No	No
Peacock Gap Country Club	Community Space	33 Biscayne Dr	X	few landslides	VL	N/A	N/A	No	No
Phoenix Academy	Community Space	160b N San Pedro Rd	X	surficial deposits	M	Moderate	Moderate	No	No
Pickleweed Community Center	Community Space	50 Canal St	AE	surficial deposits	VH	N/A	N/A	Yes	No
Pickleweed Library	Community Space	50 Canal St	AE	surficial deposits	H	N/A	N/A	No	No
Robert Dollar Estate	Community Space	1408 Missionave	X	surficial deposits	L	Moderate	Moderate	No	Yes
Robert Dollar House	Community Space	115 J St	Shaded X	surficial deposits	H	N/A	N/A	No	No
Saint Isabella	Community Space	1 Trinity Way	X	surficial deposits	M	Moderate	Moderate	No	No
Saint Marks School	Community Space	39 Trellis Dr	X	surficial deposits	M	Moderate	Moderate	No	No
Saint Raphael School	Community Space	1100 Fifth Ave	X	surficial deposits	H	N/A	N/A	No	No
San Pedro Elem. School	Community Space	498 Point San Pedro Rd	X	surficial deposits	VL	N/A	N/A	No	No
San Pedro School	Community Space	480 Pt San Pedro Rd	X	surficial deposits	VL	N/A	N/A	No	No
San Rafael Adult Education	Community Space	125 Bahia Way	AE	surficial deposits	VH	N/A	N/A	No	No
San Rafael City Hall	Community Space	1400 5th AVE	X	surficial deposits	L	N/A	N/A	No	No

Name	Facility type	Address	Flood Zone	Landslide Area	Liquefaction Zone	Extreme Fire Zone	Average Fire Zone	Tsunami Zone	In WUI
San Rafael Community Center	Community Space	618 B St	AH	surficial deposits	VH	N/A	N/A	No	No
San Rafael High School	Community Space	185 Mission Ave	Shaded X	surficial deposits	VH	N/A	N/A	No	No
San Rafael Improvement Club	Community Space	1801 5thave	Shaded X	surficial deposits	VL	Moderate	Moderate	No	No
San Rafael Library	Community Space	1100 E St	X	surficial deposits	L	Moderate	Moderate	No	No
San Rafael Main Post office	Community Space	40 Bellam Blvd	X	surficial deposits	VL	N/A	N/A	No	No
Short Elem. School	Community Space	35 Marin St	Shaded X	surficial deposits	H	Moderate	High	No	No
St. Vincents School	Community Space	4900 Highway101	X	few landslides	VL	N/A	N/A	No	No
Sun Valley Elem. School	Community Space	75 Happy Ln	X	surficial deposits	H	Moderate	Moderate	No	Yes
Sun Valley Elementary School	Community Space	75 Happy Ln	X	surficial deposits	H	Moderate	Moderate	No	Yes
Terra Linda High School	Community Space	320 Nova Albion Way	X	surficial deposits	M	Moderate	Moderate	No	No
Terra Linda Recreation Center	Community Space	670 Del Ganado Rd	X	surficial deposits	M	Moderate	Moderate	No	No
Vallecito Elem. School	Community Space	50 Nova Albion Wy	X	surficial deposits	M	Moderate	Moderate	No	No
Vallecito Elementary School	Community Space	50 Nova Albion Wy	X	surficial deposits	M	Moderate	Moderate	No	No

Name	Facility type	Address	Flood Zone	Landslide Area	Liquefaction Zone	Extreme Fire Zone	Average Fire Zone	Tsunami Zone	In WUI
Venetia Valley School	Community Space	177 N San Pedro Rd	X	surficial deposits	VL	Moderate	Moderate	No	No
Victor Talking Machine Exhibit	Community Space	1801 5thave	Shaded X	surficial deposits	VL	Moderate	Moderate	No	No
Marin Household Hazardous Waste Facility	Hazardous	565 Jacobyst	X	surficial deposits	VL	N/A	N/A	No	No
Biomarin	Medical	770 Lindaro St	AH	surficial deposits	VH	N/A	N/A	No	No
Huckleberry Teen Health	Medical	361 3rd St	Shaded X	surficial deposits	VH	N/A	N/A	Yes	No
Kaiser Foundation Hospital	Medical	99 Montecillo Rd	X	few landslides	VL	Moderate	Moderate	No	No
Kaiser Medical office	Medical	1033 3rd St	Shaded X	surficial deposits	H	N/A	N/A	No	No
Kaiser Medical office	Medical	1540 5th St	Shaded X	surficial deposits	H	N/A	N/A	No	No
Marin Community Clinic	Medical	3110 Kerner Blvd	AE	surficial deposits	VH	N/A	N/A	No	No
Marin County Health	Medical	3240 Kerner Blvd	AE	surficial deposits	VH	N/A	N/A	No	No
Marin County Special	Medical	161 Mitchell Blvd #200	Shaded X	surficial deposits	W	N/A	N/A	No	No
Marin Ophthalmic Surgery	Medical	901 E St	X	surficial deposits	L	N/A	N/A	No	No

Name	Facility type	Address	Flood Zone	Landslide Area	Liquefaction Zone	Extreme Fire Zone	Average Fire Zone	Tsunami Zone	In WUI
Marin Treatment Center	Medical	1466 Lincoln Ave	Shaded X	surficial deposits	VL	N/A	N/A	No	No
Ritter Health Center	Medical	16 Ritter St	AH	surficial deposits	VH	N/A	N/A	No	No
Rotacare	Medical	1033 3rd St	Shaded X	surficial deposits	H	N/A	N/A	No	No
Fire Station 51	Public Safety	1039 C St	X	surficial deposits	L	N/A	N/A	No	No
Fire Station 52	Public Safety	210 3rd St	Shaded X	surficial deposits	VH	N/A	N/A	No	No
Fire Station 53	Public Safety	30 Joseph Ct	X	few landslides	VL	Moderate	Moderate	No	Yes
Fire Station 54	Public Safety	46 Castro Ave	AE	surficial deposits	VH	N/A	N/A	No	No
Fire Station 55	Public Safety	955 Point San Pedro Rd	AE	surficial deposits	VH	N/A	N/A	No	No
Fire Station 56	Public Safety	650 Del Ganado Rd	X	surficial deposits	M	Moderate	Moderate	No	No
Marin County Sheriff's office	Public Safety	1600 Los Gamos Dr	X	surficial deposits	L	Moderate	Moderate	No	No
San Rafael Department of Public Works	Public Safety	111 Morphew St	X	surficial deposits	VH	N/A	N/A	No	No
San Rafael Police Department	Public Safety	1400 5th Ave	X	surficial deposits	L	Moderate	Moderate	No	No
Downtown SMART Station	Transportation	680 3rdst	Shaded X	surficial deposits	H	N/A	N/A	No	No

Name	Facility type	Address	Flood Zone	Landslide Area	Liquefaction Zone	Extreme Fire Zone	Average Fire Zone	Tsunami Zone	In WUI
Marin Civic Center SMART Station	Transportation	Under Hwy 101 At Civic Center Dr And Mcinnis Pkwy	Shaded X	surficial deposits	VH	N/A	N/A	No	No
400 Canal	Utility	390 Canal Street	AE	water	VH	N/A	N/A	Yes	No
400 Canal Storm Water Pump Station	Utility	390 Canal Street	AE	water	VH	N/A	N/A	Yes	No
Cayes	Utility	17 Narragansett Cove	AE	surficial deposits	VH	N/A	N/A	No	No
Cayes Storm Water Pump Station	Utility	17 Narragansett Cove	AE	surficial deposits	VH	N/A	N/A	No	No
Corporate Center	Utility	752 Lincoln Ave	AE	surficial deposits	VH	N/A	N/A	No	No
Corporate Center Storm Water Pump Station	Utility	752 Lincoln Ave	AE	surficial deposits	VH	N/A	N/A	No	No
Glenwood	Utility	915 San Pedro Rd	AE	surficial deposits	VH	N/A	N/A	No	No
Glenwood Storm Water Pump Station	Utility	915 San Pedro Rd	AE	surficial deposits	VH	N/A	N/A	No	No
Kerner	Utility	3780 Kerner Blvd	AE	surficial deposits	VH	N/A	N/A	No	No
Kerner Storm Water Pump Station	Utility	3780 Kerner Blvd	AE	surficial deposits	VH	N/A	N/A	No	No

Name	Facility type	Address	Flood Zone	Landslide Area	Liquefaction Zone	Extreme Fire Zone	Average Fire Zone	Tsunami Zone	In WUI
Lindaro	Utility	740 Lindaro St	AH	surficial deposits	VH	N/A	N/A	No	No
Lindaro Storm Water Pump Station	Utility	740 Lindaro St	AH	surficial deposits	VH	N/A	N/A	No	No
Montecito	Utility	199 3rd St	AE	surficial deposits	W	N/A	N/A	Yes	No
Montecito Storm Water Pump Station	Utility	199 3rd St	AE	surficial deposits	W	N/A	N/A	Yes	No
North Francisco	Utility	325 Francisco Blvd E	AE	surficial deposits	VH	N/A	N/A	Yes	No
North Francisco Storm Water Pump Station	Utility	325 Francisco Blvd E	AE	surficial deposits	VH	N/A	N/A	Yes	No
Peacock	Utility	34 Lagoon Rd	AE	surficial deposits	VH	N/A	N/A	Yes	No
Peacock Storm Water Pump Station	Utility	34 Lagoon Rd	AE	surficial deposits	VH	N/A	N/A	Yes	No
Piombo	Utility	5 Piombo Pl	AE	surficial deposits	VH	N/A	N/A	No	No
Piombo Storm Water Pump Station	Utility	5 Piombo Pl	AE	surficial deposits	VH	N/A	N/A	No	No
Rossi	Utility	569 Francisco Blvd E	AE	surficial deposits	VH	N/A	N/A	Yes	No
Rossi Storm Water Pump Station	Utility	569 Francisco Blvd E	AE	surficial deposits	VH	N/A	N/A	Yes	No

Name	Facility type	Address	Flood Zone	Landslide Area	Liquefaction Zone	Extreme Fire Zone	Average Fire Zone	Tsunami Zone	In WUI
San Quentin	Utility	2650 Kerner Blvd	AE	water	W	N/A	N/A	Yes	No
San Quentin Storm Water Pump Station	Utility	2650 Kerner Blvd	AE	water	W	N/A	N/A	Yes	No
Sanitary Sewer Pump Station 01--Andersen A	Utility	1001 Andersen Dr	AE	surficial deposits	VH	N/A	N/A	No	No
Sanitary Sewer Pump Station 02--Andersen B	Utility	1271 Andersen Dr	AE	surficial deposits	VH	N/A	N/A	No	No
Sanitary Sewer Pump Station 03--Kerner A	Utility	3098 Kerner Blvd	AE	surficial deposits	VH	N/A	N/A	No	No
Sanitary Sewer Pump Station 04--Mooring	Utility	2 Point San Pedro Rd	X	surficial deposits	VH	N/A	N/A	No	No
Sanitary Sewer Pump Station 05--West Francisco	Utility	852 West Franisco Blvd	AE	surficial deposits	VH	N/A	N/A	No	No
Sanitary Sewer Pump Station 06--Third Street	Utility	119 3rd St	AE	surficial deposits	VH	N/A	N/A	Yes	No
Sanitary Sewer Pump Station 07--North Francisco	Utility	201 East Francisco Blvd	AE	surficial deposits	VH	N/A	N/A	Yes	No
Sanitary Sewer Pump Station 08--Mcphail's	Utility	540 West Francisco Blvd	AE	surficial deposits	VH	N/A	N/A	No	No

Name	Facility type	Address	Flood Zone	Landslide Area	Liquefaction Zone	Extreme Fire Zone	Average Fire Zone	Tsunami Zone	In WUI
Sanitary Sewer Pump Station 09--Bret Harte	Utility	86 Woodland Ave	AE	surficial deposits	VH	N/A	N/A	No	No
Sanitary Sewer Pump Station 10--Simms	Utility	40 Simms St	AE	surficial deposits	VH	N/A	N/A	No	No
Sanitary Sewer Pump Station 11--South Francisco	Utility	1601 East Francisco Blvd	AE	surficial deposits	VH	N/A	N/A	No	No
Sanitary Sewer Pump Station 12--West Railroad	Utility	47 Castro Ave	AE	surficial deposits	VH	N/A	N/A	No	No
Sanitary Sewer Pump Station 13--Cayes Main	Utility	19 Gloucester Cv	AE	surficial deposits	VH	N/A	N/A	No	No
Sanitary Sewer Pump Station 14--Newport	Utility	11 Newport Way	AE	surficial deposits	VH	N/A	N/A	No	No
Sanitary Sewer Pump Station 15--San Pedro	Utility	48 Marina Blvd	X	surficial deposits	H	Moderate	High	Yes	No
Sanitary Sewer Pump Station 16--Loch Lomond	Utility	575 Point San Pedro	X	surficial deposits	H	N/A	N/A	Yes	No
Sanitary Sewer Pump Station 17--Glenwood	Utility	905 Point San Pedro	AE	surficial deposits	VH	N/A	N/A	Yes	No
Sanitary Sewer Pump Station 18--Sea Way	Utility	50 Sea Way	AE	surficial deposits	VH	N/A	N/A	Yes	No

Name	Facility type	Address	Flood Zone	Landslide Area	Liquefaction Zone	Extreme Fire Zone	Average Fire Zone	Tsunami Zone	In WUI
Sanitary Sewer Pump Station 19--Fiberglass	Utility	11 Beach Way	AE	surficial deposits	VH	Moderate	Moderate	Yes	No
Sanitary Sewer Pump Station 20--Beach	Utility	35 Beach Way	AE	few landslides	VL	N/A	N/A	No	No
Sanitary Sewer Pump Station 21--Riviera	Utility	301 Riviera Dr	AE	surficial deposits	VH	N/A	N/A	No	No
Sanitary Sewer Pump Station 22--Peacock	Utility	140 Peacock Dr	AE	surficial deposits	VH	N/A	N/A	No	No
Sanitary Sewer Pump Station 23--Peackock Lagoon	Utility	44 Lagoon Rd	AE	surficial deposits	VH	N/A	N/A	Yes	No
Sanitary Sewer Pump Station 24--Main Drive	Utility	850 Point San Pedro Rd	AE	water	VL	Moderate	Moderate	Yes	No
Sanitary Sewer Pump Station 25--Mcnear's Beach	Utility	210 Cantera Way	X	surficial deposits	VL	N/A	N/A	No	Yes
Sanitary Sewer Pump Station 26--Biscayne	Utility	403 Biscayne Dr	X	surficial deposits	VH	N/A	N/A	No	Yes
Sanitary Sewer Pump Station 27--Kerner B	Utility	2599 Kerner Blvd	AE	surficial deposits	VH	N/A	N/A	No	No
Sanitary Sewer Pump Station 28--Kerner C	Utility	2450 Kerner Blvd	AE	water	VH	N/A	N/A	No	No

Name	Facility type	Address	Flood Zone	Landslide Area	Liquefaction Zone	Extreme Fire Zone	Average Fire Zone	Tsunami Zone	In WUI
Sanitary Sewer Pump Station 29--Bedford	Utility	47 Bedford Way	AE	surficial deposits	VH	N/A	N/A	No	No
Sanitary Sewer Pump Station 30--Baypoint	Utility	30 Baypoint Dr	AE	surficial deposits	VH	N/A	N/A	No	No
Sanitary Sewer Pump Station 31--Marin Bay Park	Utility	1 Cantera Way	X	few landslides	VL	N/A	N/A	No	Yes
Sanitary Sewer Pump Station 32--Baypoint Lagoon	Utility	147 Baypoint Dr	AE	surficial deposits	VH	N/A	N/A	No	No

Source: San Rafael GIS, Marin Map

Appendix F Public Survey

WILL BE INPUT AT END OF SURVEY PERIOD