San Mateo County

HAZARD MITIGATION PLAN

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VOLUME 1

TETRA TECH

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- David Pucci, Deputy Chief, Redwood City Fire Department

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Steering Committee members included:

- David Pucci, Chair, Redwood City and formerly assigned to Office of Emergency Services
- Bart Spencer, Co-Chair, Emergency Service Coordinator, Central County Fire Department
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LIST OF ACRONYMS

°F	Degrees Fahrenheit
ABAG	Association of Bay Area Governments
BACERP	Bay Area Climate and Energy Resilience Project
ADA	Americans with Disabilities Act
ASPA	Aboveground petroleum storage tank
API	Advanced Persistent Threat
ATC	(Federal) Air Traffic Controller
BART	Bay Area Rapid Transit System
BPR	Bottom pressure recorder
CAL FIRE	California Department of Forestry and Fire Protection
CAL OES	California Office of Emergency Services
CCR	California Code of Regulations
CDC	Centers for Disease Control and Prevention
CEQA	California Environmental Quality Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CGS	California Geological Society
CHP	California Highway Patrol
CIP	Capital Improvement Program
CPTED	Crime Prevention Through Environmental Design
CPUC	California Public Utilities Commission
CRS	Community Rating System
CSA	County Service Area

CWA	Clean Water Act
CZM	Coastal Zone Management
DART	Deep ocean Assessment and Reporting of Tsunamis
DEM	Digital Elevation Model
DFIRM	Digital Flood Insurance Rate Map
DMA	Disaster Mitigation Act
DOF	Department of Finance
DODS	Division of Dam Safety
DRIP	Drought Implementation Plan
DWR	Department of Water Resources
EA	Electronic Attack
EDD	Employment Development Department
EMA	Emergency Managers Association
EMP	Electromagnetic Pulse
EOP	Emergency operations plan
EPA	U.S. Environmental Protection Agency (also USEPA)
EPCRA	Emergency Planning and Community Right to Know Act
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FBI	Federal Bureau of Investigation
FEMA	Federal Emergency Management Agency
FMA	Flood Mitigation Insurance
FHSZ	Fire Hazard Severity Zone
FRA	Federal responsibility area
FRAP	Fire and Resource Assessment

g	Gravity (%g, percent acceleration force of gravity)
GIS	Geographic information system
gpcd	Gallons per capita per day
HAZUS-MH	Hazards U.S.-Multi-Hazard
HMI	Hazard Mitigation Insurance
HMGP	Hazard Mitigation Grant Program
HMP	Hazard Mitigation Plan
IBC	International Building Code
IPCC	Intergovernmental Panel on Climate Change
ISO	Insurance Services Office
IT	Information Technology
LEPC	Local emergency planning committee
LHMP	Local hazard mitigation plan
LiMWAN	Limit of Moderate Wave Action
LRA	Local responsibility area
m	Meter
MCE	Maximum credible earthquake
MCI	Mass casualty incident
MITM	Man in the middle
mm	Millimeter
MM	Modified Mercalli
mm/yr	Millimeters per year
mph	Miles per hour
mrp	Mean return period
N/A	Not applicable

NASA	National Aeronautics and Space Administration
NCDC	National Climatic Data Center
NCRIC	Northern California Regional Intelligence Center
NDSP	National Dam Safety Program
NEHRP	National Earthquake Hazard Reduction Program
NFIP	National Flood Insurance Program
NFPA	National Fire Protection Academy
NLD	National Levee Database
NMDC	National Drought Mitigation Center
NOAA	National Oceanic and Atmospheric Administration
NTSC	National Transportation Safety Board
NWS	National Weather Service
ONI	Ocean Niño Index
PCB	Polychlorinated biphenyls
PDM	Pre-disaster Mitigation Grant Program *or* Pre-disaster Mitigation
PDSI	Palmer Drought Severity Index
PGA	Peak Ground Acceleration
PG&E	Pacific Gas and Electric
ppm	Part per million
PTWC	Pacific Tsunami Warning Center
RCRA	Resource Conservation and Recovery Act
RCRA Info	RCRA Information
SB 37	Senate Bill 379
SCA	(Bay Area Water) Supply Conservation Agency
SCADA	Supervisory Control and Data Acquisition

SEMS	Standardized Emergency Management System
SERC	State Emergency Response Commission
SFO	San Francisco International Airport
SFPUC	San Francisco Public Utilities Commission
SMSO	San Mateo County Sherri's Office
SPCC	Spill Prevention Control and Countermeasures
SRA	State responsibility area
TSCA	Toxic Substances Control Act
UN	United Nations
URM	Unreinforced Masonry
USACE	U.S. Army Corps of Engineers
USDA	United States Department of Agriculture
USEPA	U.S. Environmental Protection Agency (also EPA)
USGS	U.S. Geological Survey
UST	Underground storage tank
VHFHSZ	Very High Fire Hazard Severity Zone
WC/ATWC	West Coast and Alaskan Tsunami Warning Center
WMD	Weapons of Mass Destruction
WUI	Wildland Urban Interface

EXECUTIVE SUMMARY

Executive Summary

Hazard mitigation is the use of long-term and short-term policies, programs, projects, and other activities to alleviate the death, injury, and property damage that can result from a disaster. San Mateo County has developed and maintained a multi-hazard mitigation plan (HMP) to reduce risks from natural disasters. The plan complies with requirements for hazard mitigation planning to maintain eligibility for funding under Federal Emergency Management Agency (FEMA) grant programs.

Previous Hazard Mitigation Planning In San Mateo County

Federal regulations require hazard mitigation plans to include a strategy for monitoring, evaluating, and updating the hazard mitigation plan. An update provides an opportunity to reevaluate recommendations, monitor the impacts of actions that have been accomplished, and determine if there is a need to change the focus of mitigation strategies. Disaster Mitigation Act of 2000 (DMA) compliance is contingent on meeting the plan update requirement. A jurisdiction covered by a plan that has expired is not able to pursue funding under the Robert T. Stafford Act, which requires a current hazard mitigation plan as a prerequisite.

Initial Response to DMA in San Mateo County

The Association of Bay Area Governments (ABAG) provides planning and research resources related to land use, housing, environmental and water resource protection, disaster resilience, energy efficiency, hazardous waste mitigation, risk management, financial services, and staff training to local cities, and towns.

In 2004, ABAG led a regional effort to address hazard mitigation planning for jurisdictions within its area of responsibility. This regional template was used by numerous counties and cities within the ABAG planning area to achieve initial compliance under the DMA. The ABAG process equipped local governments with tools to complete individual planning processes that met their needs, while pooling resources and eliminating redundant planning efforts. In 2010, ABAG conducted its second regional planning effort. During the 2010 update, 17 local governments in San Mateo County used the ABAG tools to achieve DMA compliance.

The San Mateo County Planning Effort

In 2015, the San Mateo County Office of Emergency Services (OES) and San Mateo County jurisdictions have teamed together to prepare an updated countywide hazard mitigation plan that would best suit the needs and capabilities of the County and its planning partners. With these factors in mind, San Mateo County committed to preparation of its 2016 plan by securing technical assistance to facilitate a planning process that would comply with all program requirements. The ensuing planning process developed a new plan for the County and its planning partners from scratch, using lessons learned from the prior planning effort. While this plan is an update for many of the planning partners, it is the initial plan for others. The updated plan differs from the initial plan for a variety of reasons:

- The plan has been totally re-structured as a countywide regional plan, focusing only on the geographic region of San Mateo County. The risk assessment is not a subset of a larger regional or

multi-county effort. Instead, it is isolated to San Mateo County and focuses on hazards of concern for the County and local jurisdictions.
- The plan was expanded to include special districts as planning partners.
- The risk assessment has been formatted to best support future grant applications by providing information on risk and vulnerability that will directly support measurement of "cost-effectiveness" required under FEMA mitigation grant programs.
- Newly available data and tools provide for a more detailed and accurate risk assessment through means such as FEMA's Hazards U.S. Multi-Hazard (HAZUS-MH) computer model or data such as FEMA's countywide Digital Flood Insurance Rate Maps (DFIRMs).
- The update gave the County and its planning partners an opportunity to engage local citizens and gauge their perception of risk and support for risk reduction through mitigation.

Plan Update Process

The plan update was carried out in the following phases:

- **Phase 1, Organize and Review**—A planning team was assembled for the plan update, consisting of the Steering Committee Chair and Co-Chair. The team conducted outreach to establish the planning partnership. A 10-member steering committee was assembled to oversee the plan update, consisting of County staff, citizens, and other stakeholders in the planning area. Coordination with other county, state, and federal agencies involved in hazard mitigation occurred throughout the plan update process. This phase included a review of the existing HMP, the California State Hazard Mitigation Plan, and existing programs that may support hazard mitigation actions.
- **Phase 2, Update the Risk Assessment**—Risk assessment is the process of measuring the potential loss of life as well as personal injury, economic injury, and property damage resulting from natural hazards. This process assesses the vulnerability of people, buildings, and infrastructure to natural hazards. Risk assessment models were enhanced with new data and technologies that have become available since 2010. The risk assessment included the following:
    - Hazard identification and profiling
    - Assessment of the impact of hazards on physical, social, and economic assets
    - Vulnerability identification
    - Estimates of the cost of potential damage.

  The Steering Committee used the risk assessment to rank risk and to gauge the potential impacts of each hazard of concern in the San Mateo County planning area.

- **Phase 3, Engage the Public**—The planning team implemented a public involvement strategy developed by the Steering Committee. The strategy included public meetings to present the risk assessment and the draft plan, a hazard mitigation survey, a County-sponsored website, and multiple media releases.
- **Phase 4, Assemble the Updated Plan**—The planning team and Steering Committee assembled a document to meet federal hazard mitigation planning requirements. A completed local mitigation

plan review crosswalk has been included in Appendix F of this volume. This completed crosswalk provides a comparative analysis between the content in the San Mateo County HMP and the federal hazard mitigation planning requirements.

- **Phase 5, Plan Adoption/Implementation**—The final adoption phase will begin once the State of California Governor's Office of Emergency Services and FEMA Region IX have granted pre-adoption approval. The plan maintenance process includes a schedule for monitoring and evaluating the plan's progress periodically and producing a revised plan every 5 years. This plan maintenance strategy also includes processes for continuing public involvement and integrating with other programs that can support or enhance hazard mitigation.

Risk Assessment Results

Based on the risk assessment, hazards were ranked as follows for the level of risk they pose to the overall planning area.

1. Earthquake
2. Severe Weather
3. Wildfire
4. Flood
5. Landslide
6. Tsunami
7. Dam Failure
8. Drought

Mitigation Guiding Principle, Goals, and Objectives

The Steering Committee and the planning partnership established the following goals for the plan update:

1. Protect life and property;
2. Provide information to residents to better understand the hazards of the region and ways to reduce their personal vulnerability to those hazards;
3. Promote hazard mitigation as an integrated public policy and as a standard business practice;
4. Increase resilience of infrastructure and critical facilities;
5. Protect the environment;
6. Develop and implement mitigation strategies that use public funds in an efficient and cost-effective way; and,
7. Improve community emergency management capability.

The following objectives were identified that meet multiple goals, helping to establish priorities for recommended mitigation actions:

1. Improve understanding of the locations, potential impacts, and linkages among threats hazards, vulnerability, and measures needed to protect life safety and health.

2. Establish and maintain partnerships among all levels of government, the private sector, community groups, and institutions of higher learning that improve and implement methods to protect life and property.
3. Develop and provide updated information about threats, hazards, vulnerabilities, and mitigation strategies to state, regional, and local agencies, as well as private-sector groups.
4. Encourage incorporation of mitigation measures into repairs, major alterations, new development, and redevelopment practices, especially in areas subject to substantial risk.
5. Promote and implement hazard mitigation plans and projects that are consistent with state, regional, and local climate action and adaptation goals, policies, and programs.
6. Advance community resilience through preparation, adoption, and implementation of state, regional, and local multi-hazard mitigation plans and projects.
7. Encourage life and property protection measures for all communities and structures located in hazard areas.
8. Actively promote effective coordination of regional and local hazard mitigation planning and action among state agencies, cities, counties, special districts, tribal organizations, councils of governments, metropolitan planning organizations, and regional transportation associations to create resilient and sustainable communities.
9. Improve systems that provide warning and emergency communications.
10. Promote dialogue between government representatives, private business, non-profit organizations, and the public regarding hazard mitigation.
11. Retrofit, purchase, or relocate structures in high hazard areas, especially those known to be repetitively damaged.

Mitigation Actions

Mitigation actions presented in this update are activities designed to reduce or eliminate losses resulting from natural hazards. The update process resulted in the identification of mitigation actions for implementation by a collective, regional effort, and by individual jurisdictions, as presented in Section 3 and Volume 2 of this plan.

Implementation

Full implementation of the recommendations of this plan will require time and resources. The measure of the plan's success will be its ability to adapt to changing conditions. San Mateo County and key plan stakeholders will assume responsibility for adopting the recommendations of this plan and committing resources toward implementation. The framework established by this plan commits San Mateo County and key plan stakeholders to pursue initiatives when the benefits of a project exceed its costs. San Mateo County and key plan stakeholders developed this plan with extensive public input, and public support of the actions identified in this plan will help ensure its success.

SECTION 1: PLANNING PROCESS AND COMMUNITY PROFILE

Chapter 1. Introduction to Hazard Mitigation Planning

1.1 The Big Picture

Hazard mitigation is defined as a method to reduce or alleviate the loss of life as well as personal injury, and property damage that can result from a disaster through long- and short-term strategies. Strategies include implementing planning approaches, policy changes, programs, projects, and other activities that can mitigate the impacts of hazards. The responsibility for hazard mitigation lies with many, including private property owners; business and industry stakeholders; and local, state, and federal government agencies.

The federal Disaster Mitigation Act (DMA) of 2000 (Public Law 106-390) requires state and local governments to develop hazard mitigation plans as a condition for federal disaster grant assistance. Before 2000, federal disaster funding focused on disaster relief and recovery, with only limited funding for hazard mitigation planning. The DMA increased the emphasis on planning for disasters before they occur.

DMA encourages state and local authorities to work together on pre-disaster planning and promotes sustainability for disaster resistance. "Sustainable hazard mitigation" includes sound management of natural resources and the recognition that hazards and mitigation must be understood in the largest possible social and economic context. The enhanced planning network called for by the DMA helps local governments articulate accurate needs for mitigation, resulting in faster allocation of funding and more cost-effective risk reduction projects.

1.2 Local Concerns

Natural and human-caused hazards affect citizens, property, the environment, and the economy of San Mateo County. Climate change, drought, earthquakes, floods, landslides, severe weather, tsunamis, wildfires, and dam failures have exposed San Mateo County residents and businesses to the financial and emotional costs of recovering after natural disasters. Additionally, human-caused hazards such as hazardous material releases, pipeline and tank leaks, terrorism, airline incidents, and cyber threats have the potential to further affect the county. The risk associated with both natural and human-caused hazards increases as more people move to or visit areas affected by those hazards.

The inevitability of hazards and the growing population and activity within San Mateo County create an urgent need to develop strategies, coordinate resources, and increase public awareness to reduce risk and prevent loss from future hazard events. Identifying risks posed by hazards and developing strategies to reduce the impact of a hazard event can assist in protecting life and property of citizens, communities, and visitors. Local residents and businesses can work together with the County to create a hazard mitigation plan (HMP) that addresses the potential impacts of hazard events.

1.3 Purposes for Planning

DMA compliance is only one of multiple objectives driving this planning effort. Elements and strategies in this plan were selected because they meet a program requirement as well as the needs of San Mateo County and its citizens. This HMP identifies resources, information, and strategies for reducing risk from natural hazards acknowledged as a concern in San Mateo County and will help guide and coordinate mitigation activities. The plan was developed to meet the following objectives:

- Meet or exceed program requirements specified under the DMA.
- Enable San Mateo County to continue using federal grant funding to reduce risk through mitigation.
- Meet the needs of San Mateo County as well as state and federal requirements.
- Create a risk assessment that focuses on San Mateo County hazards of concern.
- Coordinate existing plans and programs so that high-priority initiatives and projects to mitigate possible impacts of a disaster are funded and implemented.

1.4 Who Will Benefit from This Plan?

All residents, visitors, and businesses in San Mateo County are the ultimate beneficiaries of this HMP update. The plan identifies strategies and actions to reduce risk for those who live in, work in, go to school in, and visit San Mateo County. It provides a viable planning framework for all foreseeable natural hazards. Participation by Key stakeholders in developing the plan helped ensure that outcomes will be mutually beneficial. The plan's goals and recommendations can lay the groundwork for development and implementation of local mitigation activities and partnerships.

1.5 Contents of This Plan

This hazard mitigation plan is organized into three primary parts:

- SECTION 1—Planning Process and Community Profile
- SECTION 2—Risk Assessment
- SECTION 3—Mitigation Strategy.

Each part includes elements required under federal guidelines. DMA compliance requirements are cited at the beginning of subsections as appropriate to illustrate compliance.

The following appendices provided at the end of the volume include information or explanations to support the main content of the plan:

- Appendix A—References
- Appendix B—Steering Committee Ground Rules
- Appendix C—Steering Committee Agendas and Meeting Minutes
- Appendix D— Public Outreach
- Appendix E—San Mateo 2010 Action Items Status
- Appendix F— Federal Emergency Management Agency (FEMA) crosswalks
- Appendix G—Plan Adoption Resolutions.

Chapter 2.
Plan Update—What Has Changed

2.1 The Previous Plan

Seventeen jurisdictions in San Mateo County were covered under the 2010 Association of Bay Area Governments (ABAG) regional planning effort. The planning process used to develop the updated ABAG plan was as follows:

- Reevaluate the Functional Areas of the 2005 plan based on prioritizing mitigation for long-term recovery issues – This reevaluation was accomplished through a series of issue-oriented forums at meetings of its main policy standing committee, the Regional Planning Committee.
- Regional mitigation priority setting by cities, counties, and special districts with public involvement – This objective was met through a series of workshops where strategies were reviewed for relevance and clarity. Three regional workshops were held to review draft priorities, and the draft priorities were posted on line for public comment.
- Develop chapters to highlight functional areas – To make a better connection between the functional areas in the 2010 plan, chapters were developed to address mitigation strategies and how they achieved functionality.
- Raise public awareness – Public awareness was achieved through a series of campaigns, including an "op-ed" hazard mitigation piece on the anniversary of the Loma Prieta earthquake, securing an opportunity for free print ad and community service space, and public meetings focusing on specific aspects of the plan.
- Focused outreach in partnership with local jurisdictions – The 2010 planning process allowed for two opportunities for public comment.

2.2 Why Update?

2.2.1 Federal Eligibility

Title 44 of the Code of Federal Regulations (44 CFR) stipulates that hazard mitigation plans must present a schedule for monitoring, evaluating, and updating the plan. This schedule provides an opportunity to reevaluate recommendations, monitor the impacts of actions that have been accomplished, and determine if there is a need to change the focus of mitigation strategies. The Robert T. Stafford Act requires jurisdictions have current HMPs to pursue and receive federal funding.

2.2.2 Changes in Development

LHMP updates must be revised to reflect changes in development within the planning area during the previous performance period of the plan, as stated in 44 CFR Section 201.6(d)(3). The plan must describe changes in development in hazard-prone areas that increased or decreased vulnerability since the last plan was approved. If no changes in development altered the overall vulnerability, then plan updates may validate the information in the previously approved plan. The intent of this requirement is to ensure that the mitigation strategy continues to address the risk and vulnerability of existing and potential development and takes into consideration possible future conditions that could affect vulnerability.

The San Mateo County planning area experienced a 1.6 percent increase in population between 2000 and 2010, an average annual growth rate of 0.16 percent per year (U.S. Census 2000; U.S. Census 2015). Between 2010 and 2015, the California Department of Finance estimates that the total population of San Mateo County has grown an additional 4.8 percent to 753,123 (DOF 2015). Each jurisdiction in the planning area has a General Plan that guides future growth and policy making within each local jurisdiction. The General Plan is adopted by the local governing body of each jurisdiction. This HMP update assumes that some new development triggered by increased population occurred in hazard areas. It is assumed that hazard vulnerability did not increase, although it is possible that an increase in hazard exposure has occurred, because all such new development would have been regulated pursuant to local programs and codes.

2.2.3 New Analysis Capabilities

The risk assessment for the previous San Mateo County HMP used both quantitative and qualitative analyses. Building count data and annualized average loss estimates were provided for some, but not all, hazards of concern. These estimates were predominantly reported at the countywide scale. The updated risk assessment provides more detailed information on exposed population and building counts for each hazard of concern. This update also expands the level of detail in the loss estimate modeling for dam and reservoir failure, earthquake, and flood. Exposure and vulnerability estimates are presented at the community planning area level. This enhanced risk assessment allows for a more detailed understanding of the ways risk in the County is changing over time.

2.3 The Updated Plan—What Is Different?

Although San Mateo County's 2010 hazard mitigation plan update was prepared under the ABAG process, the County's stakeholders, including County agencies, municipalities, and special districts, determined that a new countywide hazard mitigation plan would better suit the needs and capabilities of the County and its planning partners. The plan update process included a greater focus on public involvement that concentrated on targeted public engagement instead of simply opening technical workshops to the public. A renewed effort was made to establish a plan maintenance and implementation protocol that clearly defines San Mateo County's commitment to the plan's ongoing success. Some of the major differences between the current and previous plans are as follows:

- The plan has been totally restructured as a countywide regional plan, focusing only on the geographic area of San Mateo County. The risk assessment is not a subset of a larger regional effort. Instead, it is isolated to San Mateo County and focuses on the hazards of concern for the County.

- The risk assessment has been prepared to best support future grant applications by providing information on risk and vulnerability that will directly support the measurement of "cost-effectiveness" required under FEMA mitigation grant programs
- Newly available data and tools provide for a more detailed and accurate risk assessment using means such as FEMA's Hazards U.S. Multi-Hazard (HAZUS-MH) computer model or new data such as FEMA's countywide Digital Flood Insurance Rate Maps (DFIRMs).
- The planning process creates the opportunity for all municipal planning partners to prepare to meet the requirements of California Senate Bill 379 (SB 379) during the next plan update. SB 379 state will require integration of quantitative climate change risk assessment in the development of climate change related initiatives as part of the safety element of general plans.
- The plan is more user-friendly because it is confined to one package.
- The update created an opportunity for the County, cities, and planning partners to engage citizens directly in a coordinated approach to gauge their perception of risk and support of the concept of risk reduction through mitigation.
- The plan identifies actions rather than strategies. Strategies provide direction, but actions are fundable under grant programs. This plan replaces strategies with a guiding principle, goals, and objectives. The actions identified meet multiple objectives that are measurable, so that each planning partner can measure the effectiveness of its mitigation actions.

Given the extent of changes in this update, reviewers should consider this document to be a new plan. When relevant, the update discusses correlations with the initial plan, especially when data or information is being carried over to this update. Table 2-1 indicates the major changes between the two plans as they relate to 44 CFR planning requirements.

TABLE 2-1. PLAN CHANGES CROSSWALK

44 CFR Requirement	2010 Plan update	2016 Updated Plan
§201.6(b): 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 non-profit interests to be involved in the planning process; and (3) Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.	Appendix A of the ABAG Plan includes a description of the planning process. It includes detail of coordination with other agencies and review of the previous plan.	The plan development process deployed under this update was completely different from that of the ABAG plan. Volume 1 Chapters 3, 4, and 5 describe the planning process for the 2016 updated plan.
§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.	Appendix C of the ABAG plan includes a risk assessment for nine hazards (earthquake, tsunami, flood, landslide, wildfire, drought, climate change, dam failure, and delta levee failure) for the nine-county regional area.	Volume 1 Part 2 presents a risk assessment of nine hazards of concern: Climate change, dam failure, drought, earthquake, flood, landslide, severe weather, tsunami, and wildfire. These hazards are profiled as they impact San Mateo County. Additionally, human caused hazards were qualitatively assessed to develop a more complete picture of the hazards facing the county.

TABLE 2-1. PLAN CHANGES CROSSWALK

44 CFR Requirement	2010 Plan update	2016 Updated Plan
§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.	Appendix C of the ABAG plan includes a risk assessment for six hazards (earthquake, severe weather, flood, wildfire, landslide and tsunami) for the multi-county regional area.	Volume 1 Part 2 presents a risk assessment of each hazard of concern. Each chapter includes the following components: ▪ Hazard profile,-including maps of extent and location, historical occurrences, frequency, severity, and warning time. ▪ Secondary hazards ▪ Climate change impacts ▪ Exposure of people, property, critical facilities and environment. ▪ Vulnerability of people, property, critical facilities and environment. ▪ Future trends in development ▪ Scenarios ▪ Issues
§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). This description shall include an overall summary of each hazard and its impact on the community.	Utilizing existing studies and documents, the ABAG plan discussed vulnerability with an emphasis on exposure and land use. There was extensive discussion on the vulnerability to the earthquake hazard. The ABAG risk assessment attempts to estimate potential damage from future events. ABAG concluded that HAZUS was not an adequate tool for planning purposes.	Vulnerability was assessed for all hazards of concern. The HAZUS-MH computer model was used for the dam failure, earthquake, and flood hazards. These were Level 2 – user defined analyses using city and county data. Site-specific data on County-identified critical facilities were entered into the HAZUS model. HAZUS outputs were generated for other hazards by applying an estimated damage function to an asset inventory was extracted from HAZUS-MH.

TABLE 2-1. PLAN CHANGES CROSSWALK

44 CFR Requirement	2010 Plan update	2016 Updated Plan
§201.6(c)(2)(ii): [The risk assessment] must also address National Flood Insurance Program insured structures that have been repetitively damaged floods.	The ABAG plan includes summary information by county on identified repetitive losses. The plan includes a link to a website that includes more detailed information on repetitive losses which is no longer maintained. Within the plan itself, while there are inventories on the numbers and types of structures in repetitive loss areas, there is no description of the causes of repetitive flooding.	The plan includes a comprehensive analysis of repetitive loss areas that includes an inventory of the number and types of structures in the repetitive loss area. Repetitive loss areas are delineated, causes of repetitive flooding are cited, and these areas are reflected on maps.
§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 area.	The focus of the ABAG plan is on existing land use without detailed discussion on future land use. There is no consistent inventory of the number and types of structures exposed to each hazard of concern. The plan does provide an inventory of identified critical facilities.	A complete inventory of the numbers and types of buildings exposed was generated for each hazard of concern. The Steering Committee defined “critical facilities” for the planning area, and these facilities were inventoried by exposure. Each hazard chapter provides a discussion on future development trends.
§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) and a description of the methodology used to prepare the estimate.	The ABAG plan relied on creating regional correlations from past observed damage to create estimates of future losses from the hazards of concern. Appendix F assesses vulnerability by providing private building exposure estimates for earthquake, landslide, wildfire, dam failure, and 100-year flood.	Loss estimations in terms of dollar loss were generated for all hazards of concern. These estimates were generated by HAZUS-MH for the dam failure, earthquake, and flood hazards. For the other hazards, loss estimates were generated by applying a regionally relevant damage function to the exposed inventory. In all cases, a damage function was applied to an asset inventory. The asset inventory was the same for all hazards and was generated in HAZUS.
§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.	A strong component of the ABAG plan is its look at existing land use in hazard areas, especially for earthquake. Appendix E provides additional detail on existing land use, with a brief discussion of future land use (through 2030) by county.	There is a discussion on future development trends as they pertain to each hazard of concern. This discussion looks predominantly at the existing land use and the current regulatory environment that dictates this land use.

TABLE 2-1. PLAN CHANGES CROSSWALK

44 CFR Requirement	2010 Plan update	2016 Updated Plan
§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.	The ABAG plan has identified a comprehensive list of mitigation strategies for each planning partner to consider when creating annexes to the plan. These strategies were created via a facilitated process chronicled in the plan.	The plan contains a guiding principal, goals, objectives and actions. The guiding principal, planning partners. The actions are jurisdiction specific and strive to meet multiple objectives. The objectives of this plan are broad, similar to the strategies identified in the ABAG plan. All objectives meet multiple goals and stand alone as components of the plan. Each planning partner was asked to complete a capability assessment that looks at its regulatory, technical and financial capabilities.
§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.	The ABAG plan has identified one overall goal and basic "commitments" for the plan.	The Steering Committee identified a guiding principal, seven goals, and 11 objectives, as described in Volume I, Section 3. These goals and objectives targeted specifically for this hazard mitigation plan are completely new. They were identified based upon the capabilities of the planning partnership.
§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.+++	The ABAG plan contains a discussion on the process used to generate the mitigation strategies, but it does include an alternatives review.	Volume I, Section 3 includes a hazard mitigation catalog that was developed through a facilitated process. This catalog identifies actions that manipulate the hazard, reduce exposure to the hazard, reduce vulnerability, and increase mitigation capability. The catalog further segregates actions by scale of implementation. A table in the action plan section analyzes each action by mitigation type to illustrate the range of actions selected.

TABLE 2-1. PLAN CHANGES CROSSWALK

44 CFR Requirement	2010 Plan update	2016 Updated Plan
§201.6(c)(3)(ii): [The mitigation strategy] must also address the jurisdiction's participation in the National Flood Insurance Program, and continued compliance with the program's requirements, as appropriate.	Strategy GOVT-c-5 deals with maintaining compliance and good standing in the National Flood Insurance Program. Strategies HSNG-h-1, LAND-c-4, and ECON-f-1 encourage participation in the CRS program.	All municipal planning partners that participate in the National Flood Insurance Program have identified an action stating their commitment to maintain compliance and good standing under the National Flood Insurance Program. Communities that participate in the Community Rating System have identified actions to maintain or enhance their standing under the CRS program.
§201.6(c)(3)(iii): [The mitigation strategy shall describe] 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.	Under the ABAG plan, priorities are organized based on the following categories – ▪ Existing ▪ Existing/underfunded ▪ Very High ▪ High ▪ Moderate ▪ Under study ▪ Not applicable ▪ Not yet considered	Each of the recommended initiatives is prioritized using a qualitative methodology that looked at the objectives the project will meet, the timeline for completion, how the project will be funded, the impact of the project, the benefits of the project and the costs of the project. This prioritization scheme is detailed in Chapter 19.
§201.6(c)(4)(i): [The plan maintenance process shall include a] section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a 5-year cycle.	Appendix B of the ABAG plan contains a plan maintenance and update process.	Volume I, Section 3 details a plan maintenance strategy that contains additional detail addressing deficiencies observed during the 2010 update process. This update includes a more defined role and vehicle for facilitating the annual review of the plan

TABLE 2-1. PLAN CHANGES CROSSWALK

44 CFR Requirement	2010 Plan update	2016 Updated Plan
§201.6(c)(4)(ii): [The plan shall include a] process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate.	Appendix B of the ABAG plan contains a brief discussion on incorporation of the plan into other planning mechanisms.	Section 3 details recommendations for incorporating the plan into other planning mechanisms, such as: ▪ General Plan ▪ Emergency response plan ▪ Capital Improvement Programs ▪ Municipal code Specific current and future plan and program integration activities are detailed in each participating jurisdiction's annex located in Volume II.
§201.6(c)(4)(iii): [The plan maintenance process shall include a] discussion on how the community will continue public participation in the plan maintenance process.	The ABAG plan does not contain a process for how each jurisdiction will continue public participation in the plan maintenance process. Some of the local government annexes contain this discussion, however.	Section 3 details a comprehensive strategy for continuing public involvement.
§201.6(c)(5): [The local hazard mitigation plan shall include] documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval of the plan (e.g., City Council, County Commission, Tribal Council).	All agencies utilizing the ABAG tools submitted to the state and FEMA individually.	Volume I, Appendix G contains the resolutions of all planning partners that adopted this plan.

Chapter 3.
Plan Methodology

The process followed to develop this San Mateo County Hazard Mitigation Plan Update had the following primary objectives:

- Form a planning team
- Define the planning area
- Establish a steering committee
- Coordinate with other agencies
- Review existing programs
- Engage the public.

These objectives are discussed in the following sections.

3.1 Formation of the Planning Team

San Mateo County hired Tetra Tech, Inc. to assist with development and implementation of the plan. The Tetra Tech project manager and lead planner reported directly to the Steering Committee Chair and Vice Chair. A planning team was formed to lead the planning effort, consisting of the following members:

- David Pucci, Battalion Chief, Redwood City Fire Department
- Bart Spencer, Emergency Services Coordinator, Central County Fire Department
- Caitlin Kelly, Tetra Tech, Project Manager
- Rob Flaner, Tetra Tech, Principal in Charge
- Jason Geneau, Tetra Tech, Corporate Liaison
- Jessica Cerutti, Tetra Tech, Lead Planner.

3.2 Defining the Planning Area

The planning area was defined as the County of San Mateo, which consists of the mid-to southern land mass of the San Francisco Peninsula. The planning area includes San Mateo County's 20 incorporated jurisdictions, special districts, and unincorporated areas of the County.

3.3 The Steering Committee

Hazard mitigation planning enhances collaboration and support among diverse parties whose interests can be affected by hazard losses. A steering committee was formed to oversee all phases of the plan. The members of this committee included key San Mateo County staff, citizens, and other stakeholders from within the planning area. The planning team assembled a list of candidates representing interests within the planning area that could have recommendations for the plan or be affected by its recommendations. The team confirmed a committee of 10 members. Some members chose to designate alternates to attend on their behalf. Table 3-1 lists the committee members.

TABLE 3-1. STEERING COMMITTEE MEMBERS

Jurisdiction/Agency	Name	Title
Redwood City Fire Department	David Pucci	Deputy Chief
Central County Fire Department	Bart Spencer	Emergency Services Coordinator
San Mateo County Planning	Roberto Bartoli	Planner II
Pacifica Police Department	Joseph Spanheimer	Captain
Belmont Police Department	Patrick Halleran	Captain
Community College District	Tom Maloney	Emergency Preparedness Contractor
South San Francisco	Kenneth Anderson, Sr.	Disaster Preparedness Manager
Woodside Fire District	Daniel Ghiorso	Fire Chief
East Palo Alto	Daniel Berumen	Assistant Planner
San Mateo County OES	Bradley Hartzell	Battalion Chief – Fire Liaison

Leadership roles and ground rules were established during the Steering Committee's initial meeting on December 1, 2015. The Steering Committee agreed to meet monthly as needed throughout the course of the plan's development and more frequently during the mitigation initiative development phase. The planning team facilitated each Steering Committee meeting, which addressed a set of objectives based on the work plan established for the plan update. The Steering Committee met seven times from December 2015 through June 2016. Meeting agendas, notes, and attendance logs are available for review on request. All Steering Committee meetings were open to the public, and agendas and meeting notes were posted to the hazard mitigation plan website.

3.4 Coordination with Other Agencies

Opportunities for involvement in the planning process must be provided to neighboring communities; local and regional agencies involved in hazard mitigation; agencies with authority to regulate development; and to businesses, academia, and other private and nonprofit interests (44 CFR, Section 201.6(b)(2)). The planning team accomplished this task as follows:

- **Steering Committee Involvement**—The invitation to participate on the Steering Committee was presented during the project kickoff workshop, when all incorporated jurisdictions and multiple special districts were invited. The above participants from this group volunteered to serve as the finalized Steering Committee.
- **Public Outreach and Requested Data**—The following agencies assisted with public outreach efforts, provided data that supported the risk assessment portion of the plan, or reviewed the mitigation catalog used for development of the mitigation initiative action plan:
  - San Mateo County Manager's Office
  - San Mateo County Department of Planning and Building

  - San Mateo County Assessor's Office
  - Participating jurisdictions
- **Pre-Adoption Review**— The following agencies, as well as those listed above, were provided an opportunity to review and comment on this plan, primarily through the hazard mitigation plan website (see Section 3.6):
  - National Weather Service
  - Pacific Gas & Electric
  - City of San Mateo office of Emergency Services
  - City of Foster City Office of Emergency Services

Each agency was sent an e-mail informing them when draft portions of the plan became available for review. The Steering Committee received no comments from these organizations. The complete draft plan was sent to the California Governor's Office of Emergency Services (Cal OES) and the Federal Emergency Management Agency Region IX for pre-adoption reviews to ensure program compliance for DMA.

No other counties were invited to participate or invited to review the San Mateo County HMP.

3.5 Review of Existing Programs

Hazard mitigation planning must include review and incorporation, if appropriate, of existing plans, studies, reports, and technical information (44 CFR, Section 201.6(b)(3)). The following plans and programs can affect mitigation within the planning area:

- California Fire Code
- 2013 California Building Code
- California State Hazard Mitigation Forum
- Local Capital Improvement Programs
- Local Emergency Operations Plan
- Local General Plans
- Housing Element
- Safety Element
- Local Zoning Ordinances
- Local Coastal Program Policies.

Many of these relevant plans, studies, and regulations are cited in the capability assessment provided in Volume II of this plan for each participating jurisdiction.

3.6 Public Involvement

Broad public participation in the planning process helps ensure that diverse points of view about the planning area's needs are considered and addressed. The public must have opportunities to comment on disaster mitigation plans during the drafting stages and before the plan is approved (44 CFR, Section 201.6(b)(1)). The

Community Rating System (CRS) expands on these requirements by making CRS credits available for optional public involvement activities.

3.6.1 Strategy

The strategy for involving the public in this plan emphasized the following elements:

- Identify and involve planning area stakeholders.
- Open Steering Committee meetings to members of the public for on-going input.
- Use a survey to evaluate whether the public's perception of risk and support of hazard mitigation has changed since the initial planning process.
- Invite public participation at open-house public meetings.
- Attempt to reach as many planning area citizens as possible using multiple media, including social media.

Copies of materials used in the public outreach strategy are located in Appendix D of this volume.

Stakeholders and the Steering Committee

Stakeholders are the individuals, agencies, and jurisdictions that have a vested interest in the recommendations of the HMP. The effort to include stakeholders in this process included stakeholder participation on the Steering Committee. Stakeholders targeted for this process included the following:

- San Mateo County and local jurisdiction departments relevant for hazard mitigation planning
- Members of the academic community
- Community member representatives
- Local special-purpose districts and utilities
- Local business and visitor interests.

Survey

The planning team developed a 19-question hazard mitigation plan survey with guidance from the Steering Committee. The survey was used to gauge household and individual preparedness for natural hazards and the level of knowledge of tools and techniques that assist in reducing risk and loss from natural hazards. This survey was designed to help identify areas vulnerable to one or more natural hazards. Multiple methods were used to solicit survey responses:

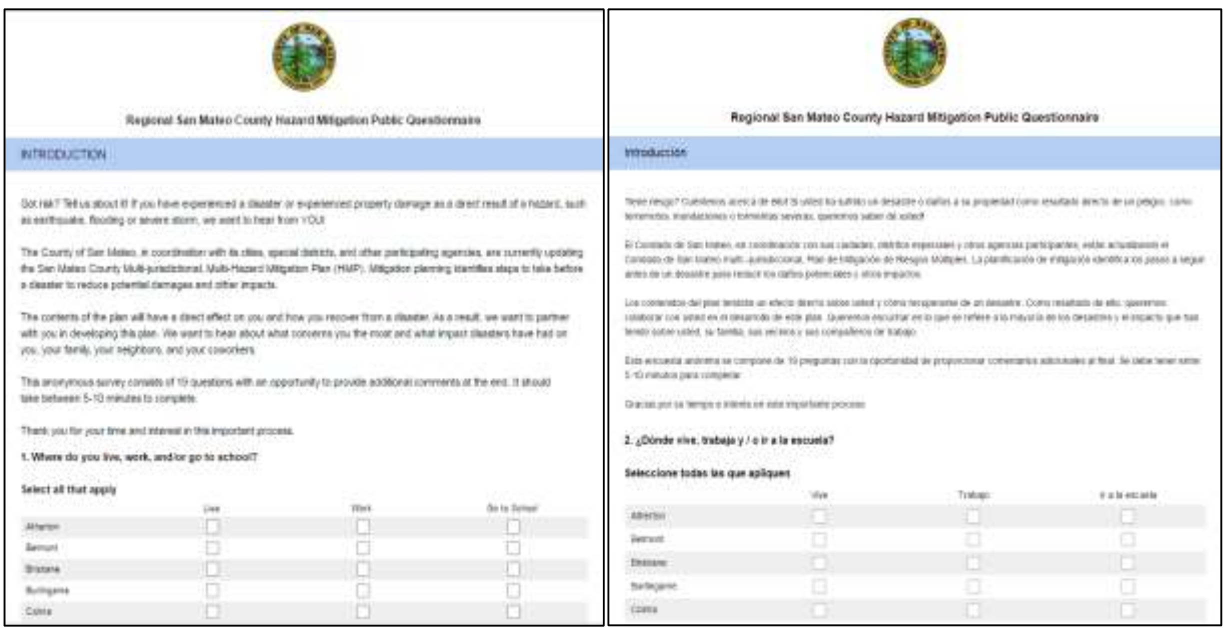
- A web-based version of the survey was made available on the plan website in both English and Spanish (see Figure 3-1).
- Attendees at the public meetings and open houses were asked to complete a survey.
- A press release was distributed to local media urging residents to participate.
- San Mateo County jurisdictions advertised the survey on social media.

Silver Dragon Exercise

Each year, Community Emergency Response Teams (CERT) participate in a door-to-door exercise called Silver Dragon. This exercise is designed to simulate door-to-door check in on residents in neighborhoods selected for the exercise. Each house received a reusable bag with various information regarding public health and general preparedness. The SC coordinated with county officials in order to include a mitigation message. As a result, over 10,000 homes received a flyer regarding hazard mitigation in their Silver Dragon bag which provided an overview of the project, an invitation to take the public survey, and a link to the project website.

Public Meetings

A public meeting was held in conjunction with an Emergency Services Council Meeting on April 21, 2016. The meeting format allowed both government officials and members of the public to understand the project and process, and subsequently ask questions (see Figure 3-2). Additionally, members of the Steering Committee participated in a hazard mitigation booth for San Mateo County Disaster Preparedness Day on June 11, 2016. This event served as the public review meeting in which attendees were given the opportunity to speak with members of the planning team about the HMP and to provide written or verbal feedback on the draft plan (Figure 3-3).



Regional San Mateo County Hazard Mitigation Public Questionnaire

INTRODUCTION

Got risk? Tell us about it! If you have experienced a disaster or experienced property damage as a direct result of a hazard, such as earthquake, flooding or severe storm, we want to hear from YOU!

The County of San Mateo, in coordination with its cities, special districts, and other participating agencies, are currently updating the San Mateo County Multi-jurisdictional Multi-Hazard Mitigation Plan (HMP). Mitigation planning identifies steps to take before a disaster to reduce potential damages and other impacts.

The contents of the plan will have a direct effect on you and how you recover from a disaster. As a result, we want to partner with you in developing this plan. We want to hear about what concerns you the most and what impact disasters have had on you, your family, your neighbors, and your coworkers.

This anonymous survey consists of 19 questions with an opportunity to provide additional comments at the end. It should take between 5-10 minutes to complete.

Thank you for your time and interest in this important process.

1. Where do you live, work, and/or go to school?

Select all that apply

	Live	Work	Go to School
Atherton	☐	☐	☐
Belmont	☐	☐	☐
Brisbane	☐	☐	☐
Burlingame	☐	☐	☐
Colma	☐	☐	☐

Regional San Mateo County Hazard Mitigation Public Questionnaire

Introducción

2. ¿Dónde vive, trabaja y / o ir a la escuela?

Seleccione todas las que apliquen

	Vive	Trabajo	Ir a la escuela
Atherton	☐	☐	☐
Belmont	☐	☐	☐
Brisbane	☐	☐	☐
Burlingame	☐	☐	☐
Colma	☐	☐	☐

FIGURE 3-1. SAMPLE PAGE FROM SURVEY DISTRIBUTED TO THE PUBLIC (ENGLISH AND SPANISH VERSIONS)

Jurisdiction-specific Outreach

Planning partners decided to take a proactive approach in engaging their local residents. Many participating jurisdictions linked their local government websites to the planning project website, such as Millbrae, Pacifica, San Carlos, and Portola Valley (Figure 3-2).

FIGURE 3-2. SAMPLE JURISDICTION-SPECIFIC OUTREACH

FIGURE 3-3. PUBLIC MEETING WITH THE SAN MATEO COUNTY EMERGENCY SERVICES COUNCIL

FIGURE 3-4. DISASTER PREPAREDNESS DAY – SAN MATEO, CA

Media Outreach

Press Releases

Press releases were distributed over the course of the plan's development as key milestones were achieved and before each public meeting. Each press release was supplemented by meeting announcements on the project website. The planning effort received the following press coverage:

- **April 18, 2016** – Announcement of public meeting at the San Mateo County Emergency Services Council
- **May 27, 2016** – Announcement of draft plan and mitigation booth for Disaster Preparedness Day

Copies of these press releases can be found in Appendix D of this volume.

Internet

At the beginning of the plan update process, the County established a hazard mitigation website (http://planning.smcgov.org/local-hazard-mitigation-plan) to include information about the update process (see Figure 3-5). Throughout the process, the website was used to keep the public informed on milestones and to solicit input:

FIGURE 3-5. SAMPLE PAGE FROM HAZARD MITIGATION PLAN WEBSITE

The site's address was publicized in all press releases, mailings, surveys and public meetings. Information on the plan development process, the Steering Committee, the survey, and phased drafts of the plan was made available to the public on the site throughout the process. San Mateo County intends to keep a website active after the plan is complete to keep the public informed about successful mitigation projects and future plan updates.

3.6.2 Public Involvement Results

Survey Outreach

A total of 1,056 respondents completed the on-line survey for this plan. Of these respondents, 91-percent indicated that they lived within San Mateo County, 54-percent work in San Mateo County, and 13-percent attend school within the county. The answers to its 19 questions helped guide the Steering Committee in affirming goals and objectives and in developing mitigation strategies. Additionally, survey results were shared with the planning partnership as part of both the Strengths, Weaknesses, Obstacles, and Opportunities session and as part of the jurisdictional annex workshop. Detailed survey results are provided in Appendix D of this volume. Key results are summarized as follows:

- Survey respondents ranked earthquake as the hazard of highest concern, followed by drought, and climate change.
- The majority of respondents received their information on disasters from local news, followed by friends/family, and San Mateo County Office of Emergency Services (OES).
- Approximately 60-percent of respondents are familiar with and subscribe to the county alert systems, SMC Alert.
- Approximately 20-percent of respondents indicated that they did not know if their home, workplace, or school is located in a hazard area.
- Nearly half of the respondents indicated that they do not have specialty insurance (earthquake, flood), because they believe it is too expensive.
- Respondents indicated that their top three recommended government actions for reducing damage from disasters are:
    1. Strengthen infrastructure (roads, water supply)
    2. Strengthen critical facilities
    3. Provide better public information about risks and vulnerable areas.

Public Meetings

By engaging the public through the public involvement strategy, the concept of mitigation was introduced to the public, and the Steering Committee received written feedback that was used in developing the components of the plan. The Steering Committee answered multiple technical questions regarding the plan during both meetings, however no verbal comments were received on the plan. Details of attendance and comments received are summarized in Table 3-2.

TABLE 3-2. SUMMARY OF PUBLIC MEETINGS

Date	Location	Number of Citizens in Attendance
4/21/2016	San Mateo County Emergency Services Council, 400 County Center, Redwood City, CA	27
6/10/2016	San Mateo County Event Center, 1346 Saratoga Drive, San Mateo, CA	3,000

Public Comments on the Draft Plan

The Steering Committee encouraged members of the public to review the plan, beginning on June 10, 2016. During the outreach event held at the Disaster Preparedness Fair, members of the public received a handout outlining the basic purpose of the plan and containing a link to view the plan. The handout also included a link to a form to provide plan comments. The Steering Committee received over 20 comments during the course of the public comment period, which ended on June 30, 2016. The majority of these comments included requested clarification on the model used for sea level rise and anticipated impacts of sea level rise as they relate to the coastal communities. Volume I, Section 2, Chapters 1 and 2 have been modified to address the public comments received by the Steering Committee. Additionally, members of the public provided information on jurisdictional previous hazard event history. These events were included in each respective jurisdictional annex in Volume II of this plan. Specific comments from the public and how they were addressed are available upon request.

3.7 Plan Development Chronology/Milestones

Table 3-3 summarizes important milestones in the development of the plan.

TABLE 3-3. PLAN DEVELOPMENT MILESTONES

Date	Event	Description	Attendance
2015			
12/01	Steering Committee Meeting #1	▪ Introduce potential Steering Committee members to planning process ▪ Discuss the role of the Steering Committee ▪ Review and discuss proposed charter for Steering Committee ▪ Review update process and schedule ▪ Introduce and discuss public involvement strategy	9 SC members, 1 Non-voting attendee (NVA)
2016			
1/05	Steering Committee Meeting #2	▪ Confirm Steering Committee charter ▪ Discuss previous plan review ▪ Discuss public involvement strategy ▪ Discuss results of vision statement and goal setting exercise ▪ Review and confirm critical facilities definition	9 SC Members, 3 NVA
2/02	Steering Committee Meeting #3	▪ Confirm minutes, charter and vision statement ▪ Discuss public involvement strategy ▪ Discuss plan sections, including maintenance and capability assessment	8 SC Members, 3 NVA

TABLE 3-3. PLAN DEVELOPMENT MILESTONES

Date	Event	Description	Attendance
3/01	Steering Committee Meeting #4	▪ Confirm meeting minutes ▪ Confirm objectives ▪ Introduce risk ranking strategy ▪ Discuss website and outreach meetings	8 SC Members, 1 NVA
4/05	Steering Committee Meeting #5	▪ Confirm minutes ▪ Public Involvement – Outreach meetings ▪ Plan review – maintenance, risk ranking, and adoption ▪ Strengths, Weaknesses, Obstacles, Opportunities (SWOO) Session	10 SC Members, 4 NVA SWOO Session: 24 Planning Partners
4/14	Silver Dragon Exercise	Outreach material was provided to residents throughout San Mateo County (excluding Foster City and the City of San Mateo).	Over 10,000 homes
4/21	Public Meeting #1	Public presentation of the project during the public San Mateo Emergency Services Council Meeting. Topics covered included: ▪ Mitigation overview ▪ Process overview ▪ Planning Partnership ▪ Hazards of concern ▪ Q&A	7 SC Members, 27 members of public
5/03	Steering Committee Meeting #6	▪ Confirm minutes ▪ Public Meeting #1 overview ▪ Public Meeting #2 prep ▪ Public Survey results ▪ SWOO results and mitigation catalog ▪ Action plan development	9 SC Members, 4 NVA
6/07	Steering Committee Meeting #7	▪ Confirm minutes ▪ Overview of jurisdictional participation ▪ Public involvement – June 11 ▪ CEQA exemption status ▪ Review comments on risk ranking and Section 2 ▪ Next steps	10 SC Members
6/11	Public Meeting #2	Hazard mitigation booth as part of San Mateo County's Disaster Preparedness Day. The booth included: ▪ NEHRP, floodplain, and wildfire display maps ▪ Mitigation subject matter experts for answering questions ▪ A HAZUS workstation, where San Mateo County citizens received a property-specific risk assessment for certain hazards ▪ Information on the draft plan, including a handout	Public contact with 225 people (based on number of handouts taken by public). 20 members of the public received a customized property risk assessment
7/01	Plan Submission	▪ Final draft plan submitted to the California Governor's Office of Emergency Services and FEMA Region IX for review and approval.	N/A
X/X	Adoption	▪ Plan adopted by San Mateo County	N/A
X/X	Final Plan Approval	▪ Final plan approved by FEMA	N/A

Chapter 4.
San Mateo County Profile

4.1 Geographic Overview

San Mateo County consist of approximately 530 square miles. The county is characterized by its varying geographic features, depending on region: North-County, South-County, Mid-County, and the Coast-side. The county is bounded to the north is San Francisco City and County, on the east by the San Francisco Bay, to the south is Santa Clara County, and on the west by the Pacific Ocean,. The dense urbanization of the Bay Area Corridor stands in marked contrast to the agricultural, parks and preserves, and undeveloped lands of the rural Coast-side regions (Figure 4-1) (SMCH 2010).

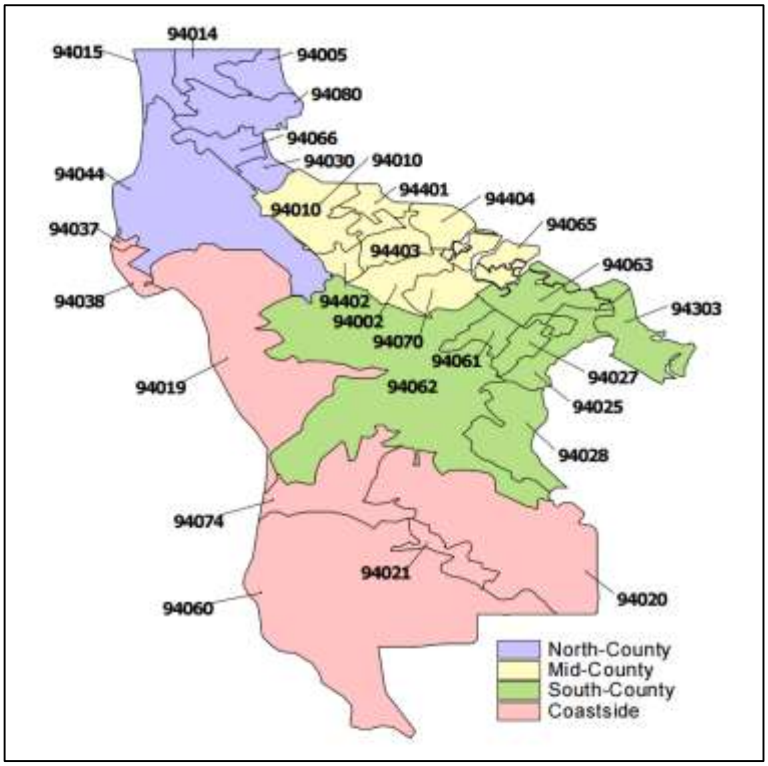


FIGURE 4-1. SAN MATEO COUNTY WITH COUNTY REGIONS AND ZIP CODES

Source: SMCH, 2010

4.2 Historical Overview

The area now known as San Mateo County was originally inhabited by the Ramaytush subdivision of the Ohlone people of the central and northern California coast. The tribal life of the Ohlone was well-structured and based on ancient tradition. The main responsibility of the leadership of the Ohlone people was to maintain the status quo and ensure that the traditions were followed and upheld while maintaining positive relationships and balance with other local tribes.

In 1822, Mexico seceded from Spain, and California became a territory of Mexico in 1824. Mexican governors of California granted the land encompassing current San Mateo County to soldiers and political allies. During Mexican times, foreigners from the United States and elsewhere began settling in the San Mateo area. Mexico ceded California to the United States through the Treaty of Guadalupe Hidalgo in 1848, and the discovery of gold in and around the Bay Area caused an influx of new settlers through 1852.

San Mateo County officially became a county in 1856. San Mateo County was split from San Francisco County as a political move to keep the established political clique in power by controlling the economic powerhouse at the northern tip of the peninsula.

The result halted development in San Mateo County, as all economic development was focused in the north. The isolation was particularly felt in the coastal areas of the county, where geological features made development difficult. Efforts to draw the coastal area out of isolation in the late 1800s and early 1900s through the Ocean Shore Railroad came to a halt during the 1906 San Francisco earthquake. The story on the Bayside, however, was different. The 1906 earthquake created a new middle class as earthquake survivors relocated to San Mateo County for more affordable housing and a stable commute via a newly established streetcar. Ten new towns were established between 1908 and 1927, and in 1928, the San Francisco Bureau of Governmental Research identified San Mateo County's bayside as an area for future industrial growth.

The San Francisco Peninsula experienced substantial growth during World War II and the post-war periods as the military invested in defense projects and military installations around the area. After World War II, many veterans previously stationed in the area decided to settle in San Mateo County. Most of the resulting population increase occurred on the Bayside. Between 1940 and 1950, the County's residents more than doubled in number, to 236,000. By 1960, the population nearly doubled again to 444,000, and the 1970 census listed the population at more than 557,000 (NPS 2010).

4.3 Major Past Hazard Events

Presidential disaster declarations are typically issued for hazard events that cause more damage than state and local governments can handle without assistance from the federal government, although no specific dollar loss threshold has been established for these declarations. A presidential disaster declaration puts federal recovery programs into motion to help disaster victims, businesses, and public entities. Some of the programs are matched by state programs. Presidential disaster, emergency, or fire management assistance declarations were issued for 21 events since 1954 in the planning area. These events are listed in Table 4-1.

TABLE 4-1. PRESIDENTIAL DISASTER, EMERGENCY, AND FIRE MANAGEMENT DECLARATIONS FOR HAZARD EVENTS IN PLANNING AREA

Type of Event	Disaster Declaration #	Date
Fire	FM-2856	9/10/2010
Severe Storm(s)	DR-1646	6/5/2006
Severe Storm(s)	DR-1628	2/3/2006
Severe Storm(s)	DR-1203	2/9/1998
Severe Storm(s)	DR-1155	1/4/1997
Severe Storm(s)	DR-1046	3/12/1995
Severe Storm(s)	DR-1044	1/10/1995
Freezing	DR-894	2/11/1991
Earthquake	DR-845	10/18/1989
Flood	DR-758	2/21/1986
Coastal Storm	DR-677	2/9/1983
Flood	DR-651	1/7/1982
Drought	EM-3023	1/20/1977
Flood[a]	DR-145	2/25/1963
Severe Storm(s)[a]	DR-138	10/24/1962
Flood[a]	DR-122	3/6/1962
Flood[a]	DR-82	4/4/1958
Fire[a]	DR-65	12/29/1956
Flood[a]	DR-47	12/23/1955
Flood[a]	DR-15	02/05/1954

a. Prior to 1964, federal disaster declaration were not issued specific to counties; pre-1964 declarations listed in this table are for the entire State of California, not San Mateo County specifically

Review of these events helps identify targets for risk reduction and ways to increase a community's capability to avoid large-scale events in the future. Still, many natural hazard events do not trigger federal disaster declaration protocol but still have significant impacts on San Mateo County. These events are also important to consider in establishing recurrence intervals for hazards of concern.

4.4 Physical Setting

This section discusses the physical area encompassing San Mateo County.

4.4.1 Geology and Topography

Because of the size and unique geographical location of San Mateo County, the topography and geology of the county varies based on location. Elevation ranges from sea level along the county coast lines and bay areas to 2,572 feet above sea level at the Santa Cruz Mountains. The Santa Cruz Mountain range bisects the county, essentially creating three separate regions: the Coast-side, Mountainside, and the Bayside.

The Bayside largely consist of mudflats, marshes, artificial fill, and broad, flat alluvial plains. The low-lying Bayside region gradually increases in slope toward the Santa Cruz Mountains, eventually becoming rolling foothills. The San Andreas Fault parallels the Santa Cruz Mountain range, delineating the threshold of the Bayside and beginning of the Santa Cruz mountainside.

The Santa Cruz Mountains are generally rugged with dense forest and steep grade, often exceeding 50 percent. This area is characterized by large amounts of open space, recreational, and trail areas, including Wunderlich Park, Huddart Park, and the Fifield-Cahill Ridge Trail.

The Coast-side of San Mateo County consists of sloping foothills of the Santa Cruz Mountains to nearly sea-level coastal terraces along the Pacific Ocean. The difference in topography along the coastline itself ranges from wide, sandy beaches to rocky coves. In some places, high, rocky cliffs have emerged from the gradual erosion of coastal terraces (SMP, 1986)

4.4.2 Natural Resources

San Mateo County's natural resources range from forested mountains to bayside marshlands and coastal ecosystems. These natural resources face pressure from development, invasive species, natural hazards, and climate change. Forty species in the Bay Area are protected under the Endangered Species Act (see Section 4.10.1; CBD, 2015).

These resources are an integral part of the economy, sense of place, and traditional culture of the island communities. They need to be considered in hazard mitigation planning, because they are affected by natural hazards and can influence the way that hazards alter the built environment.

4.4.3 Climate

Table 4-2 summarizes normal climate date from 1981 through 2010 at National Climatic Data Center (NCDC) weather station at San Francisco International Airport.

TABLE 4-2. NORMAL PRECIPITATION AND TEMPERATURES, 1981 – 2010

		Temperature (°F)		
	Precipitation (inches)	Minimum	Average	Maximum
Weather Station: San Francisco International Airport				
Annual	20.65	50.6	58.2	65.8
Winter	12.28	45.0	51.3	57.5
Summer	0.15	55.2	63.5	71.8
Spring	4.72	49.5	57.1	64.8
Autumn	3.5	52.6	60.8	69.0

Source: NCDC, 2015a.

4.5 Land Use

Table 4-3 summarizes the area of current land uses throughout San Mateo County by building function for each jurisdiction:

TABLE 4-3. AREA OF CURRENT LAND USES - SAN MATEO COUNTY BY BUILDING FUNCTION

Jurisdiction	Agriculture	Commercial	Education	Government	Industrial	Religion	Residential	Total
ATHERTON	1	22	16	0	0	0	2,479	**2,518**
BELMONT	0	215	22	1	36	9	7,426	**7,709**
BRISBANE	0	239	4	1	16	3	1,570	**1,833**
BURLINGAME	0	610	14	2	57	23	7,769	**8,475**
COLMA	2	129	0	0	7	0	314	**452**
DALY CITY	6	557	29	2	9	32	22,735	**23,370**
EAST PALO ALTO	9	118	16	1	24	33	4,535	**4,736**
FOSTER CITY	0	118	7	0	22	8	8,750	**8,905**
HALF MOON BAY	30	171	8	0	7	11	3,715	**3,942**
HILLSBOROUGH	0	38	5	0	0	0	3,879	**3,922**
MENLO PARK	3	471	18	2	72	27	9,234	**9,827**
MILLBRAE	0	221	15	1	5	8	6,505	**6,755**
PACIFICA	4	226	27	1	2	21	11,755	**12,036**
PORTOLA VALLEY	3	37	9	0	0	4	1,529	**1,582**
REDWOOD CITY	1	973	30	2	113	50	18,994	**20,163**
SAN BRUNO	0	447	20	0	27	25	12,104	**12,623**
SAN CARLOS	3	629	15	1	214	11	9,935	**10,808**
SAN MATEO	2	1,074	38	3	88	53	26,845	**28,103**
SOUTH SAN FRANCISCO	0	1,074	36	1	176	31	16,275	**17,593**
WOODSIDE	1	53	2	0	0	1	1,972	**2,029**
UNINCORPORATED	324	835	45	15	181	25	18,214	**19,639**
Total	**389**	**8,257**	**376**	**33**	**1,056**	**375**	**196,534**	**207,020**

4.6 Critical Facilities, Infrastructure, and Assets

Critical facilities and infrastructure are those that are essential to the health and welfare of the population. These features become especially important after a hazard event. Critical facilities typically include police and fire stations, schools, and emergency operations centers. Critical infrastructure can include the roads and bridges that provide ingress and egress and allow emergency vehicles access to those in need, and the utilities that provide water, electricity, and communication services to the community.

Critical facilities identified in this plan were selected, mapped, and included in geographic information system (GIS) databases based on information provided through the Steering Committee meetings, stakeholder information requests, and the State of California Multi-Hazard Mitigation Plan (2013). Although many facilities and assets of San Mateo County are important to the quality of life, this plan focuses on those whose loss would result in the greatest impacts on life and safety in the event of a natural hazard. These critical facilities and assets are considered imperative to the sustainability of San Mateo County. Additional information and detail will be incorporated as updates to this plan are pursued in the future. As defined for this hazard mitigation plan update, critical facilities are structures or other improvements, public or private, that, because of function, size, service area, or uniqueness, have the potential to cause serious bodily harm, extensive property damage, or disruption of vital socioeconomic activities if it is destroyed or damaged or if its functionality is impaired. Critical facilities may include but are not limited to health and safety facilities, utilities, government facilities, hazardous materials facilities, or vital community economic facilities.

Table 4-4 provides summaries of the general types of critical facilities. In light of the sensitivity of this information, a detailed list of facilities is not provided. The list is on file with San Mateo County. All critical facilities and point-based structures were analyzed in HAZUS-MH to help rank risk and identify mitigation actions. The risk assessment for each hazard qualitatively discusses critical facilities with regard to that hazard.

TABLE 4-4. CRITICAL FACILITIES AND ASSETS IN THE PLANNING AREA

	Medical and Health Services	Emergency Services	Government	Utilities	Transportation Infrastructure	Hazardous Materials	Community Economic Facilities	Other Assets	Total
Atherton	0	2	1	1	1	0	0	7	**12**
Belmont	0	3	1	25	6	2	2	13	**52**
Brisbane	0	2	1	0	4	1	1	2	**11**
Burlingame	1	4	1	5	11	5	7	12	**46**
Colma	0	1	5	0	3	0	26	0	**35**
Daly City	1	6	1	0	33	0	11	29	**81**
East Palo Alto	0	2	2	2	2	3	1	12	**24**
Foster City	0	2	1	1	10	2	2	10	**28**
Half Moon Bay	1	2	1	1	4	0	3	5	**17**
Hillsborough	0	3	1	2	4	0	0	6	**16**
Menlo Park	1	5	1	8	14	10	2	16	**57**
Millbrae	0	3	1	3	8	0	5	7	**27**
Pacifica	0	4	1	15	11	0	1	15	**47**
Portola Valley	0	1	3	0	5	0	0	3	**12**
Redwood City	2	7	11	37	34	10	9	24	**134**
San Bruno	0	4	2	0	30	2	3	17	**58**
San Carlos	0	3	7	18	8	16	6	10	**68**
San Mateo	2	7	2	19	57	1	8	32	**128**
South San Francisco	1	6	2	19	38	14	13	18	**111**
Woodside	0	1	1	0	12	0	1	4	**19**
Unincorporated	1	13	4	32	117	5	2	27	**201**
Total	**10**	**81**	**50**	**188**	**412**	**71**	**103**	**269**	**1,184**

4.7 Demographics

Some populations are at greater risk from hazard events because of decreased resources or physical abilities. Research has shown that people living near or below the poverty line, the elderly (especially older single men), individuals with disabilities, women, children, ethnic minorities, and renters all experience, to some degree, more severe effects from disasters than does the general population. These vulnerable populations may vary from the general population in risk perception, living conditions, access to information before, during, and after a hazard event, capabilities during an event, and access to resources for post-disaster recovery. Indicators of vulnerability—such as disability, age, poverty, and minority race and ethnicity—often overlap spatially and often in the geographically most vulnerable locations. Detailed spatial analysis to locate areas where there are higher concentrations of vulnerable community members would help to extend focused public outreach and education to these most vulnerable citizens.

4.7.1 Population Characteristics

Resident Population

Knowledge of the composition of the population, how it has changed in the past, and how it may change in the future is needed for making informed decisions about the future. Information about the population is a critical part of planning because it directly relates to land needs such as housing, industry, stores, public facilities and services, and transportation. The U.S. Census Bureau estimates the County's total resident population at 718,451 as of 2010. The California Department of Finance (DOF) estimates that the County's total resident population is 759, 155 as of January 1, 2016.

Population changes are useful socio-economic indicators. A growing population generally indicates a growing economy, while a decreasing population signifies economic decline. Table 4-5 shows the population in the planning area and the State of California from 1970 through 2015. The percentage population growth rate over that period, for San Mateo County and for the state, is shown on Figure 4-2. State of California and San Mateo County Population Growth per Decade. The planning area's population growth of about 25 percent through the 1970s dropped to 5.4 percent in the 1980s. After an increase between 1980 and 1990, population growth declined slightly in the 1990s and dropped sharply to 1.6 percent between 2000 and 2010. Based on current DOF estimates, however, 2010 through 2015 saw a steady increase in population of about 5 percent for San Mateo County while the State of California as a whole experienced approximately only 4 percent growth. The statewide population growth rate has been consistently higher than that of San Mateo County until 2015.

TABLE 4-5. POPULATION DATA BY DECADE 1970 - 2010

	Population	
	San Mateo County	**State of California**
1970	557,361	19,971,069
1980	587,329	23,667,764
1990	649,623	29,760,021
2000	707,161	33,871,653
2010	718,451	37,253,956

Source: CA DOF, 2013

Source: California Department of Finance, 2013 and 2015

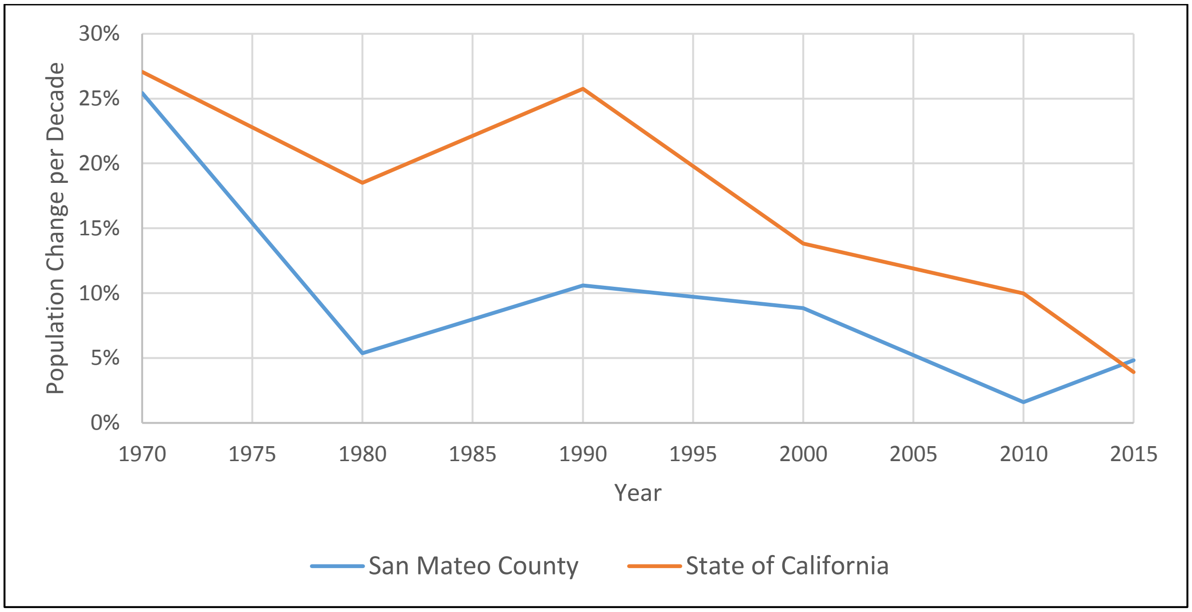


FIGURE 4-2. STATE OF CALIFORNIA AND SAN MATEO COUNTY POPULATION GROWTH PER DECADE

Note: 2015 included in analysis as current data point for 2010-2020 decade

Daily Commuting Population

According to the California Employment Development Department (EDD), in 2010, San Mateo County received an influx of approximately 150,000 daily commuters who lived in other locations, but worked in San Mateo County. The majority of commuters came from San Francisco, followed by Santa Clara County, and Alameda County. Some commuters travel to San Mateo County from as far as Sacramento and Tuolumne Counties. Conversely, approximately 146,000 residents of San Mateo County commute outside of the county on a daily basis. Figure 4-3 provides the County to County commuting estimates to San Mateo County from other counties.

Source: California Employment Development Department, 2015

FIGURE 4-3. COUNTY-TO-COUNTY COMMUTING ESTIMATES - 2010

In addition to those individuals whose commute terminates at a location within San Mateo County, San Francisco City and County receives the highest number of commuting workers in the nation. The highest number of commuters to San Francisco were from San Mateo County, followed by Alameda County. Santa Clara and Santa Cruz Counties also showed a high number of county-to-county commuters. Conversely, more than 100,000 workers leave San Francisco daily, with approximately 40,000 of these workers commuting to Santa Cruz, Santa Clara, or Alameda Counties. These trends indicate that while approximately 150,000 out-of-county commuters work in San Mateo County, more than 100,000 commuters pass through the county as part of their daily commute toward San Francisco and the North Bay Area or toward Alameda County and the South Bay Area.

This large commuter contingent has impacts on planning for the County's infrastructure and service needs, as well as on planning for hazard mitigation and emergency management. Commuters may be familiar with the area immediately surrounding their place of business or regular route to work, but may be less familiar with the services and resources provided to the population during a disaster event.

4.7.2 Age Distribution

As a group, the elderly are more apt to lack the physical and economic resources necessary for response to hazard events and are more likely to suffer health-related consequences, making recovery slower. They are more likely to be vision, hearing, or mobility impaired and more likely to experience mental impairment or dementia. Additionally, the elderly are more likely to live in assisted-living facilities where emergency preparedness occurs at the discretion of facility operators. Emergency managers typically identify these facilities as "critical facilities" because they require extra notice to evacuate. Elderly residents living in their own homes may have more difficulty evacuating their homes and could be stranded in dangerous situations. This population group is more likely to need special medical attention, which may not be readily available during natural disasters because of the isolation caused by the event. Specific planning attention for the elderly is an important consideration given the current aging of the American population.

Children under 14 are particularly vulnerable to disasters because of their young age and dependence on others for basic necessities. Very young children may additionally be vulnerable to injury or sickness; this vulnerability can be worsened during a natural disaster because they may not understand the measures that need to be taken to protect themselves from hazards.

The overall age distribution for the planning area is illustrated in Figure 4-4. Based on U.S. Census 2014 data estimates, 13.4 percent of the planning area's population is 65 or older, compared with the state average of 11.4 percent. According to U.S. Census data, 29.2 percent of the over-65 population has disabilities of some kind, and 6.5 percent have incomes below the poverty line. Children under the age of 18 account for 9.5 percent of individuals who are below the poverty line. It is also estimated that 19.9 percent of the population is 14 or younger, which varies slightly from the state's average of 20.5 percent.

4.7.3 Race, Ethnicity and Language

Research shows that minorities are less likely to be involved in pre-disaster planning and experience higher mortality rates during a disaster. Post-disaster recovery can be ineffective and is often characterized by assertions of cultural insensitivity. Since higher proportions of ethnic minorities may live below the poverty line than the majority population, poverty can compound vulnerability. According to the U.S. Census, the racial composition of the planning area is predominantly white, at about 56 percent. The largest minority populations are Asian at 26 percent, and other, non-identified races at approximately 8 percent. Figure 4-5 shows the racial distribution in the planning area. Based on the U.S. Census ethnicity definitions, San Mateo County consists of approximately 25-percent of individuals of Hispanic or Latino ethnicity (of any race) and approximately 75-percent of non-Hispanic or Latino ethnicity.

The planning area has a 34.4-percent foreign-born population. Other than English (46 percent), the most commonly spoken languages in the planning area are Spanish/Spanish Creole (20.2 percent) and Asian/Pacific Island languages (18.4 percent). The census estimates 18.9 percent of the residents speak English "less than very well."

Source: U.S. Census – American Community Survey 5-Year Estimates

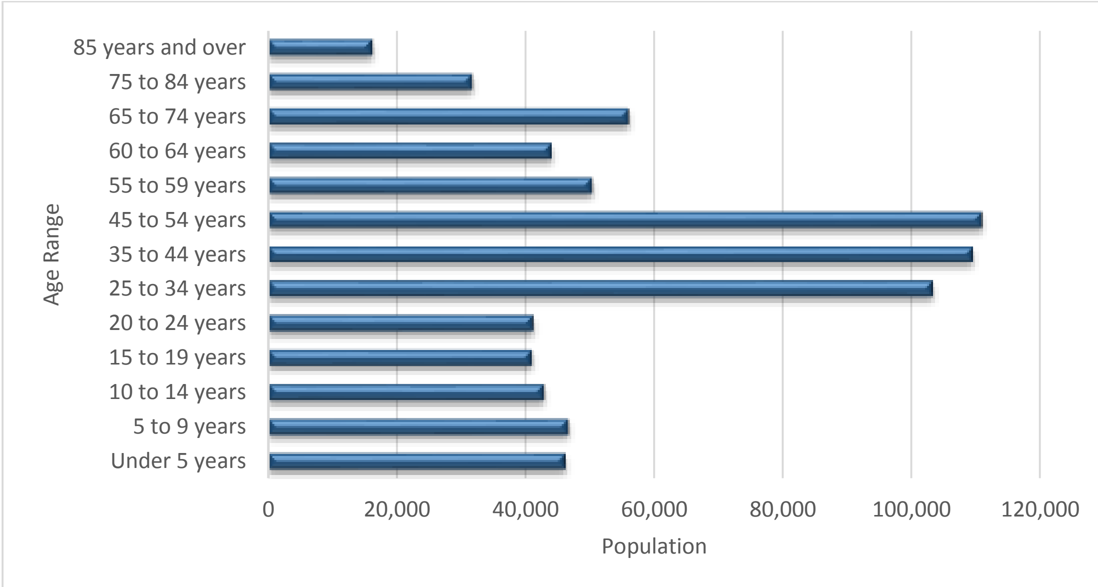


FIGURE 4-4. SAN MATEO COUNTY AGE DISTRIBUTION

Source: U.S. Census – American Community Survey 5-Year Estimates

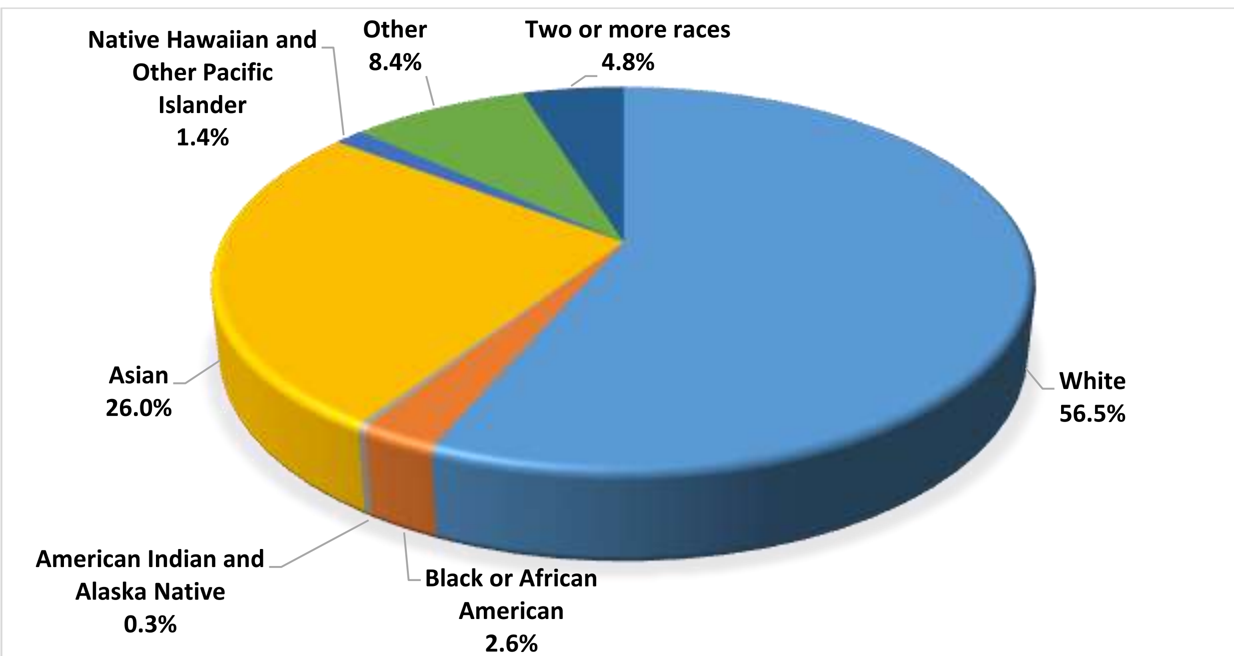


FIGURE 4-5. PLANNING AREA RACE DISTRIBUTION

4.7.4 Persons with Disabilities or with Access and Functional Needs

The 2010 U.S. Census estimates that 54 million non-institutionalized Americans with disabilities or with access and functional needs live in the U.S. This number equates to about one in five persons. This population is more likely to have difficulty responding to a hazard event than the general population. Local government is the first level of response to assist these individuals, and coordination of efforts to meet their access and functional needs is paramount to life safety efforts. It is important for emergency managers to distinguish between functional and medical needs to plan for incidents that require evacuation and sheltering. Knowing the percentage of population with a disability will allow emergency management personnel and first responders to have personnel available who can provide services needed by those with access and functional needs.

According to the U.S. Census 2014 estimates, persons with disabilities or others with access and functional needs make up 12.3 percent of the total civilian non-institutionalized population of San Mateo County.

4.8 Economy

As discussed in the Federal Emergency Management Agency (FEMA) Local Mitigation Handbook, economic resiliency drives recovery after a natural hazard event. An understanding of the major employers and economic sectors in the County whose losses or inoperability would affect the community and its ability to receive from a disaster is essential. The following provides information regarding multiple facets of the economy in San Mateo County.

4.8.1 Income

In the United States, individual households are expected to use private resources to prepare for, respond to, and recover from disasters to some extent. This expectation traditionally means that households living in poverty are automatically disadvantaged when they confront hazards. Additionally, the poor typically occupy more poorly built and inadequately maintained housing. Mobile or modular homes, for example, are more susceptible to damage in earthquakes and floods than are other types of housing. Furthermore, residents below the poverty level are less likely to have insurance to compensate for losses incurred from natural disasters. As a result, residents below the poverty level have a great deal to lose during an event and are the least prepared to deal with potential losses. The events following Hurricane Katrina in 2005 illustrated that personal household economics significantly influence people's decisions on evacuation. Individuals who cannot afford gas for their cars will likely decide not to evacuate, for example.

Based on U.S. Census Bureau estimates, estimated per capita income in the planning area in 2014 was $47,198, and the median household income was $91,421. It is estimated that about 18.5 percent of households receive an income between $100,000 and $149,999 per year and 10.1 percent of household incomes are above $150,000 annually. About 11 percent of the households in the planning area make less than $25,000 per year. According to the U.S. Census Bureau, 4.7 percent of households and 7.6 percent of individuals had income that fell below the poverty line. In 2004, Dr. Amy Glasmeier at the Massachusetts Institute of Technology (MIT) developed a preliminary living wage calculator that estimates the hourly living wage needed to support different types of families. These estimates take into consideration basic needs such as health, housing, transportation, and other necessities and interprets the living wage as a geographically specific hourly rate required to acquire basic minimum necessities cost. Table 4-6 presents summary information from the MIT Living Wage Calculator for 2014. Each hourly rate is adjusted per each working adult (MIT 2014). For the full analysis, including a breakdown of typical expenses and typical annual salary based on occupational area, please visit http://livingwage.mit.edu/counties/06081.

TABLE 4-6. HOURLY LIVING WAGE CALCULATION FOR SAN MATEO COUNTY, CALIFORNIA (2014)

	One Adult	One Adult + One Child	Two Adults	Two Adults + One Child
Living Wage	$14.37	$29.37	$11.30	$15.83
Poverty Wage	$5.00	$7.00	$3.00	$4.00
Minimum Wage	$9.00	$9.00	$9.00	$9.00

4.8.2 Industry, Businesses and Institutions

The technological boom of the mid-2000s continues to increase its presence within San Mateo County. Located just north of Santa Clara County, parts of San Mateo County are located in the area known as "Silicon Valley." Facebook, one of the largest social media companies today, is located in Menlo Park in southern San Mateo County. According to the January 2015 San Mateo County Economic and Industry Overview provided by the San Mateo County Economic Development Association:

- 22 of the top 100 fastest growing private companies headquartered in Silicon Valley are located in San Mateo County.
- 13 of the top 25 largest software companies in the Bay Area are headquartered in San Mateo County.
- 12 of the top 25 venture capital funded biotech companies (total venture capital funding disclosed) in the Bay Area have facilities in San Mateo County.
- 19 of the top 25 largest venture capital firms (ranked by revenue) in the Bay Area are located in San Mateo County.
- 15 of the top 25 biotech patent recipients in the Bay Area have facilities in San Mateo County.
- Seven of the top 25 largest digital entertainment companies in the Bay Area (based on number of Bay Area employees) are headquartered in San Mateo County (SAMCEDA 2015).

While the presence of tech companies and startups is anticipated to increase into the next decade, the planning area's economy as of the 2010 US Census is strongly based in the education/healthcare/social assistance services industry (21.6 percent), followed by the professional/scientific/management services and retail trade industries. Information and agriculture/fishing/hunting/mining make up the smallest source of the local economy, at less than 1 percent. Figure 4-6 shows the breakdown of industry types in the planning area.

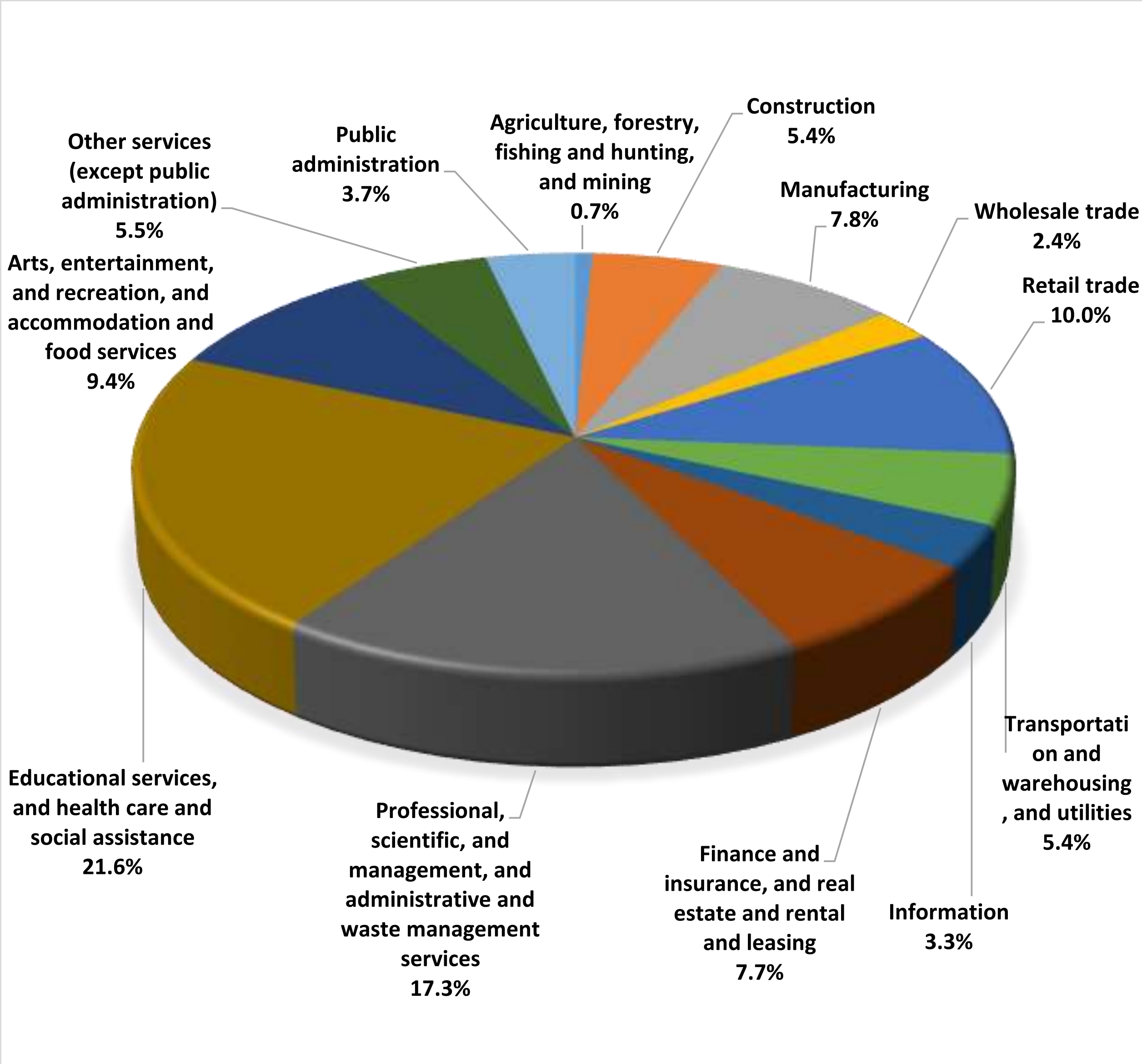


FIGURE 4-6. INDUSTRY IN THE PLANNING AREA

4.8.3 Employment Trends and Occupations

Management/business/science/arts occupations dominate the percentage of jobs in the planning area with 45 percent. Sales/office occupations make up 22.4 percent and service occupations represent 18.7 percent of the jobs in the planning area. Only about 7 percent of the employment in the planning area is in production/transportation/moving occupations (see Figure 4-7).

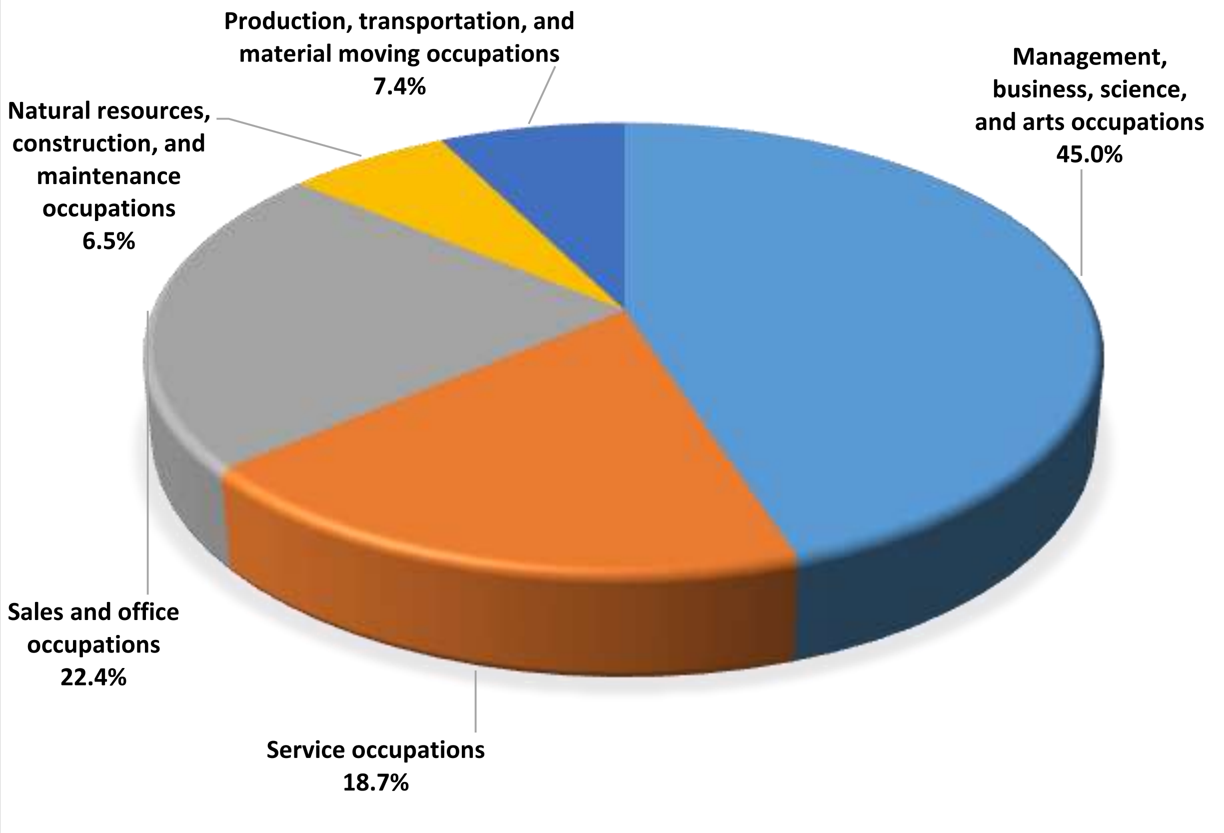


FIGURE 4-7. OCCUPATIONS IN THE PLANNING AREA (BASED ON U.S. CENSUS 5-YEAR ESTIMATES: 2010-2014)

California state data lists the following as the largest employers in San Mateo County (EDD 2016):

- Electric Charging Station
- Electronic Arts Inc.
- Forced Dump Debris Box Services
- Franklin Resources Inc.
- Franklin Templeton Investments
- Gate Gourmet
- Gilead Sciences Inc.
- Guckenheimer Inc.
- Hyatt Regency-San Francisco
- Kaiser Permanente Medical Center
- Kaiser Permanente South San Francisco
- Lucile Packard Children's Hospital
- Motif Inc.
- Oracle Corp.
- Peninsula Pathology Associates
- San Francisco International Airport
- San Mateo County Behavioral Health and Recovery Services
- San Mateo Medical Center
- Sciex LLC
- Seton Medical Center
- SRI International Inc.
- US Department of the Interior
- Visa Inc.
- Visa International Services Association
- Visa USA Inc.

According to the American Community Survey, about 69 percent of the planning area's population 16 and older is in the labor force. Figure 4-8 compares unemployment trends from the State of California and San Mateo County from 2004 through 2014. San Mateo County's unemployment rate was at its lowest in 2006, at 3.7 percent, rose to 8.4 percent in 2010, and has since fallen back, to 4.2 percent, in 2014. The state unemployment rate remained higher than the County's throughout this period.

Source: California Employment Development Department, 2015

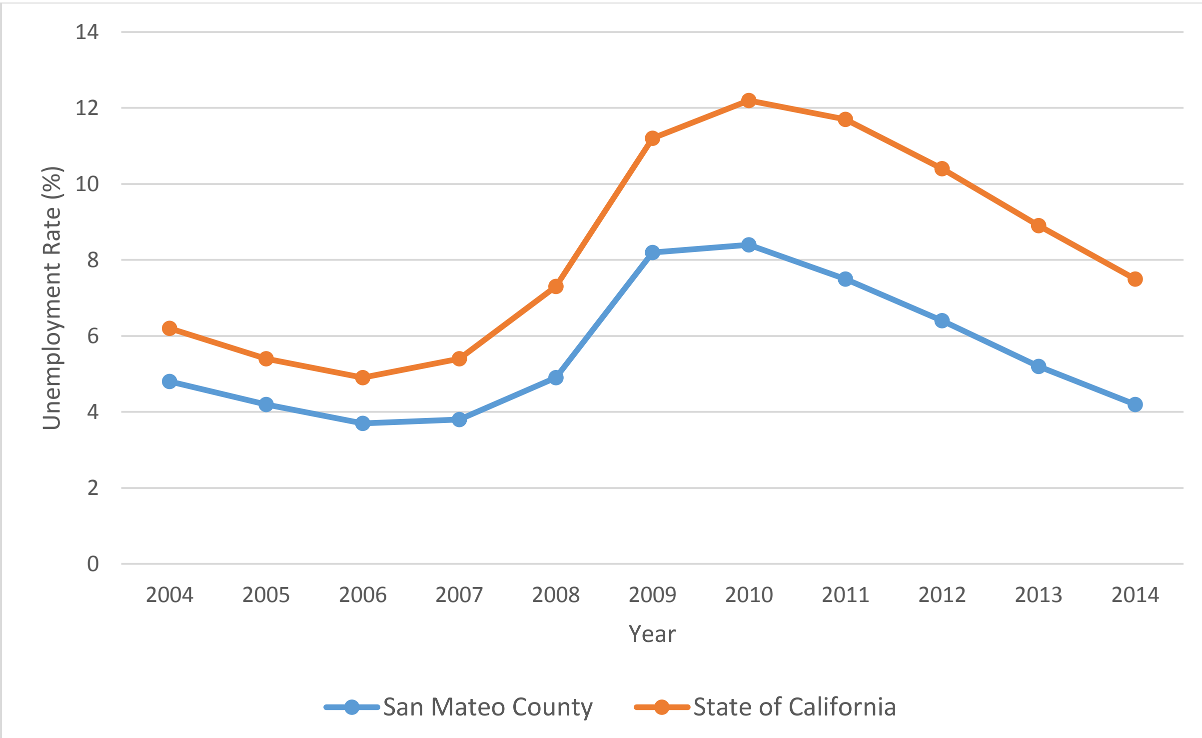


FIGURE 4-8. STATE OF CALIFORNIA AND SAN MATEO COUNTY UNEMPLOYMENT RATE

4.9 Future Trends in Development

An understanding of population and development trends can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place to protect human health and community infrastructure. The Disaster Mitigation Act (DMA) 2000 requires that communities consider land use trends, which can alter the need for, and priority of, mitigation options over time. Land use and development trends significantly affect exposure and vulnerability to various hazards. For example, significant development in a hazard area increases the building stock and population exposed to that hazard.

New development that has occurred in the last 5 years within the County and potential future development in the next 5 years, as identified by each jurisdiction, is addressed in the jurisdictional annexes located in Volume II of this plan.

4.10 Laws, Ordinances, and Programs

Existing laws, ordinances, and programs at the federal, state, and local levels can support or hinder hazard mitigation initiatives identified in this plan. Hazard mitigation plans are required to include a review and incorporation, if appropriate, of existing plans, studies, reports, and technical information as part of the planning process, as stated in 44 CFR, Section 201.6(b)(3). Pertinent federal, state, and local laws are described below.

4.10.1 Federal

Disaster Mitigation Act of 2000

The DMA 2000 is the current federal legislation addressing hazard mitigation planning. It emphasizes planning for disasters before they occur. It specifically addresses planning at the local level, requiring plans to be in place before Hazard Mitigation Grant Program funds can become available to communities. This plan is designed to meet the requirements of DMA, improving eligibility for future hazard mitigation funds.

Endangered Species Act

The federal Endangered Species Act (ESA) was enacted in 1973 to conserve species facing depletion or extinction and the ecosystems that support them. The act sets forth a process for determining which species are threatened and endangered and requires the conservation of the critical habitat where those species live. The ESA provides broad protection for species of fish, wildlife, and plants that are listed as threatened or endangered. Provisions are made for listing species, as well as for recovery plans and designation of critical habitat for listed species. The ESA outlines procedures for federal agencies to follow when they take actions that may jeopardize listed species and contains exceptions and exemptions. It is the enabling legislation for the Convention on International Trade in Endangered Species of Wild Fauna and Flora. Criminal and civil penalties are provided for violations of the ESA and the Convention.

Federal agencies must seek to conserve endangered and threatened species and use their authorities in furtherance of the ESA's purposes. The ESA defines three fundamental terms:

- **Endangered** means that a species of fish, animal, or plant is "in danger of extinction throughout all or a significant portion of its range." (For salmon and other vertebrate species, this category may include subspecies and distinct population segments.)
- **Threatened** means that a species "is likely to become endangered within the foreseeable future." Regulations may be less restrictive for threatened species than for endangered species.
- **Critical habitat** means "specific geographical areas that are essential for the conservation and management of a listed species, whether occupied by the species or not."

Five sections of the ESA are of critical importance to understanding it:

- **Section 4: Listing of a Species**—The National Oceanic and Atmospheric Administration Fisheries Service (NOAA Fisheries) is responsible for listing marine species; the U.S. Fish and Wildlife Service is responsible for listing terrestrial and freshwater aquatic species. The agencies may initiate reviews for listings, or citizens may petition for them. A listing must be made "solely on the basis of the best scientific and commercial data available." After a listing has been proposed, agencies receive comment and conduct further scientific reviews for 12 to 18 months, after which they must decide if the listing is warranted. Economic impacts cannot be considered in this decision, but it may include an evaluation of the adequacy of local and state protections. Critical habitat for the species may be designated at the time of listing.

- **Section 7: Consultation**—Federal agencies must ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed or proposed species or adversely modify its critical habitat. This limitation includes private and public actions that require a federal permit. Once a final listing is made, non-federal actions are subject to the same review, termed a "consultation." If the listing agency finds that an action will "take" a species, it must propose mitigations or "reasonable and prudent" alternatives to the action; if the proponent rejects these, the action cannot proceed.
- **Section 9: Prohibition of Take**—It is unlawful to "take" an endangered species, including killing or injuring it or modifying its habitat in a way that interferes with essential behavioral patterns, including breeding, feeding, or sheltering.
- **Section 10: Permitted Take**—Through voluntary agreements with the federal government that provide protections to an endangered species, a non-federal applicant may commit a take that would otherwise be prohibited as long as it is incidental to an otherwise lawful activity (such as developing land or building a road). These agreements often take the form of a "Habitat Conservation Plan."
- **Section 11: Citizen Lawsuits**—Civil actions initiated by any citizen can require the listing agency to enforce the ESA's prohibition of taking or to meet the requirements of the consultation process.

The Clean Water Act

The federal Clean Water Act (CWA) employs regulatory and non-regulatory tools to reduce direct pollutant discharges into waterways, finance municipal wastewater treatment facilities, and manage polluted runoff. These tools are employed to achieve the broader goal of restoring and maintaining the chemical, physical, and biological integrity of the nation's surface waters so that they can support "the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water."

Evolution of CWA programs over the last decade has included a shift from a program-by-program, source-by-source, and pollutant-by-pollutant approach to more holistic watershed-based strategies. Under the watershed approach, equal emphasis is placed on protecting healthy waters and restoring impaired ones. A full array of issues are addressed, not just those subject to CWA regulatory authority. Involvement of stakeholder groups in development and implementation of strategies for achieving and maintaining water quality and other environmental goals is a hallmark of this approach.

National Flood Insurance Program

The National Flood Insurance Program (NFIP) provides federally backed flood insurance in exchange for communities enacting floodplain regulations. Participation and good standing under NFIP are prerequisites to grant funding eligibility under the Robert T. Stafford Act. San Mateo County and multiple jurisdictions participate in the NFIP and has adopted regulations that meet the NFIP requirements. At the time of the preparation of this plan, all participating jurisdictions within San Mateo County were in good standing with NFIP requirements.

Coastal Zone Management Act

The national Coastal Zone Management Act requires federal agencies to conduct their planning, management, development, and regulatory activities in a manner consistent to the maximum extent practicable with the policies of state Coastal Zone Management (CZM) programs. State CZM lead agencies have the authority to review federal actions for consistency with their federally approved CZM programs. In California, the California Coastal Commission, the Bay Conservation and Development Commission, and the California Coastal Conservancy are the three CZM agencies empowered to conduct federal consistency reviews. The informational and procedural requirements for CZM federal consistency reviews are prescribed by federal regulations (15 CFR 930).

National Incident Management System

The National Incident Management System (NIMS) is a systematic approach for government, nongovernmental organizations, and the private sector to work together to manage incidents involving hazards. The NIMS provides a flexible but standardized set of incident management practices. Incidents typically begin and end locally, and they are managed at the lowest possible geographical, organizational, and jurisdictional level. In other instances, success depends on the involvement of multiple jurisdictions, levels of government, functional agencies, and emergency-responder disciplines. These instances necessitate coordination across this spectrum of organizations. Communities using NIMS follow a comprehensive national approach that improves the effectiveness of emergency management and response personnel across the full spectrum of potential hazards (including natural hazards, terrorist activities, and other human-caused disasters) regardless of size or complexity.

Americans with Disabilities Act and Amendments

The Americans with Disabilities Act (ADA) seeks to prevent discrimination against people with disabilities in employment, transportation, public accommodation, communications, and government activities. The most recent amendments became effective in January 2009 (P.L. 110-325). Title II of the ADA deals with compliance with the act in emergency management and disaster-related programs, services, and activities. It applies to state and local governments as well as third parties, including religious entities and private nonprofit organizations.

The ADA has implications for sheltering requirements and public notifications. During an emergency alert, officials must use a combination of warning methods to ensure that all residents have any necessary information. Those with hearing impairments may not hear radio, television, sirens, or other audible alerts, while those with visual impairments may not see flashing lights or visual alerts. Two stand-alone technical documents have been issued for shelter operators to meet the needs of people with disabilities. These documents address physical accessibility as well as medical needs and service animals.

The ADA also intersects with disaster preparedness programs in regards to transportation, social services, temporary housing, and rebuilding. Persons with disabilities may require additional assistance in evacuation and transit (such as vehicles with wheelchair lifts or paratransit buses). Evacuation and other response plans should address the unique needs of residents. Local governments may be interested in implementing a special-needs registry to identify the home addresses, contact information, and needs for residents who may require more assistance.

4.10.2 State

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act was enacted in 1972 to mitigate the hazard of surface faulting to structures for human occupancy. The Alquist-Priolo Earthquake Fault Zoning Act's main purpose is to prevent construction of buildings used for human occupancy on the surface trace of active faults. Before a new project is permitted, cities and counties require a geologic investigation to demonstrate that proposed buildings will not be constructed on active faults. The act addresses only the hazard of surface fault rupture and is not directed toward other earthquake hazards, such as liquefaction or seismically induced landslides. The law requires the State of California Geologist to establish regulatory zones around the surface traces of active faults and to issue appropriate maps. The maps are distributed to all affected cities, counties, and state agencies for their use in planning and controlling new or renewed construction. Local agencies must regulate most development projects within the zones. Projects include all land divisions and most structures for human occupancy.

California General Planning Law

California state law requires that every county and city prepare and adopt a comprehensive long-range plan to serve as a guide for community development. The general plan expresses the community’s goals, visions, and policies relative to future land uses, both public and private. The general plan is mandated and prescribed by state law (Cal. Gov. Code §65300 et seq.), and forms the basis for most local government land use decision-making.

The plan must consist of an integrated and internally consistent set of goals, policies, and implementation measures. In addition, the plan must focus on issues of the greatest concern to the community and be written in a clear and concise manner. City and county actions, such as those relating to land use allocations, annexations, zoning, subdivision and design review, redevelopment, and capital improvements, must be consistent with the plan.

California Environmental Quality Act

The California Environmental Quality Act (CEQA) was passed in 1970, shortly after the federal government enacted the National Environmental Policy Act, to institute a statewide policy of environmental protection.

CEQA requires state and local agencies in California to follow a protocol of analysis and public disclosure of the potential environmental impacts of development projects. CEQA makes environmental protection a mandatory part of every California state and local agency's decision making process.

CEQA establishes a statewide environmental policy and mandates actions all state and local agencies must take to advance the policy. Jurisdictions conduct analysis of the project to determine if there are potentially significant environmental impacts, identify mitigation measures, and possible project alternatives by preparing environmental reports for projects that requires CEQA review. This environmental review is required before an agency takes action on any policy, program, or project.

The County and the unincorporated areas have sought exemption from CEQA for the Hazard Mitigation Plan based on four different sections of the CEQA Guidelines:

- **Section 15183(d):** "The project is consistent with…a general plan of a local agency, and an EIR was certified by the lead agency for the...general plan."
- **Section 15262:** "A project involving only feasibility or planning studies for possible future actions which the agency, board or commission has not approved, adopted, or funded does not require the preparation of an EIR or negative declaration but does require consideration of environmental factors. This section does not apply to the adoption of a plan that will have a legally binding effect on later activities."
- **Section 15306:** "(Categorical Exemption) Class 6 consists of basic data collection, research, experimental management, and resource evaluation activities which do not result in a serious or major disturbance to an environmental resource. These may be strictly for information gathering purposes, or as part of a study leading to an action which a public agency has not yet approved, adopted or funded."
- **Section 15601(b)(3):** "...CEQA applies only to projects which have the potential for causing a significant effect on the environment. Where it can be seen with certainty that there is no possibility that the activity in question may have a significant effect on the environment, the activity is not subject to CEQA."

Planning partners may seek exemption at their discretion.

California Coastal Act of 1976

The California Coastal Act of 1976 recognized California's coasts as an important natural resource that required permanent protection. The act permanently established the California Coastal Commission and included specific polies that address such issues and shoreline public access and development design. The act also allowed for the development of Local Coastal Programs by coastal communities regarding coastal development and regulatory oversight. . These programs delineate the rules, regulations, and permitting processes for development along coastal areas for each jurisdiction. Each Local Coastal Program is reviewed and certified by the California Coastal Commission.

AB 162: Flood Planning, Chapter 369, Statutes of 2007

This California State Assembly Bill passed in 2007 requires cities and counties to address flood-related matters in the land use, conservation, and safety and housing elements of their general plans. The land use element must identify and annually review the areas covered by the general plan that are subject to flooding as identified in floodplain mapping by either FEMA or the Department of Water Resources (DWR). During the next revision of the housing element on or after January 1, 2009, the conservation element of the general plan must identify rivers, creeks, streams, flood corridors, riparian habitat, and land that may accommodate floodwater for groundwater recharge and stormwater management. The safety element must identify information regarding flood hazards, including:

- Flood hazard zones
- Maps published by FEMA, DWR, the U.S. Army Corps of Engineers, the Central Valley Flood Protection Board, and the Governor's Office of Emergency Services (OES)
- Historical data on flooding
- Existing and planned development in flood hazard zones.

The general plan must establish goals, policies and objectives to protect from unreasonable flooding risks, including:

- Avoiding or minimizing the risks of flooding new development
- Evaluating whether new development should be located in flood hazard zones
- Identifying construction methods to minimize damage.

AB 162 establishes goals, policies and objectives to protect from unreasonable flooding risks. It establishes procedures for the determination of available land suitable for urban development, which may exclude lands where FEMA or DWR has concluded that the flood management infrastructure is not adequate to avoid the risk of flooding.

AB 2140: General Plans: Safety Element, Chapter 739, Statutes of 2006

This bill provides that the state may allow for more than 75 percent of public assistance funding under the California Disaster Assistance Act only if the local agency is in a jurisdiction that has adopted a local hazard mitigation plan (LHMP) as part of the safety element of its General Plan. The LHMP needs to include elements specified in this legislation. In addition, this bill requires CAL OES to give preference for federal mitigation funding to cities and counties that have adopted LHMPs. The intent of the bill is to encourage cities and counties to create and adopt hazard mitigation plans.

AB 70: Flood Liability, Chapter Number 367, Statutes of 2007

This bill provides that a city or county may be required to contribute a fair and reasonable share to compensate for property damage caused by a flood to the extent that it has increased the state's exposure to liability for property damage by unreasonably approving new development in a previously undeveloped area that is protected by a state flood control project, unless the city or county meets specified requirements.

AB 32: The California Global Warming Solutions Act

This bill addresses greenhouse gas emissions. It identifies the following potential adverse impacts of global warming:

> *"… the exacerbation of air quality problems, a reduction in the quality and supply of water to the state from the Sierra snowpack, a rise in sea levels resulting in the displacement of thousands of coastal businesses and residences, damage to marine ecosystems and the natural environment, and an increase in the incidences of infectious diseases, asthma, and other human health-related problems."*

AB 32 establishes a state goal of reducing greenhouse gas emissions to 1990 levels by 2020 (a reduction of approximately 25 percent from forecast emission levels), with further reductions to follow. The law requires the state Air Resources Board to do the following:

- Establish a program to track and report greenhouse gas emissions.
- Approve a scoping plan for achieving the maximum technologically feasible and cost-effective reductions from sources of greenhouse gas emissions.
- Adopt early reduction measures to begin moving forward.
- Adopt, implement and enforce regulations—including market mechanisms such as "cap and-trade" programs—to ensure that the required reductions occur.

The Air Resources Board recently adopted a statewide greenhouse gas emissions limit and an emissions inventory, along with requirements to measure, track, and report greenhouse gas emissions by the industries it determined to be significant sources of greenhouse gas emissions.

Senate Bill 97

Senate Bill 97, enacted in 2007, amends CEQA to clearly establish that greenhouse gas emissions and the effects of greenhouse gas emissions are appropriate subjects for CEQA analysis. It directs the Governor's Office of Planning and Research to develop draft CEQA guidelines for the mitigation of greenhouse gas emissions or their effects by July 1, 2009, and directs the California Natural Resources Agency to certify and adopt the CEQA Guidelines by January 1, 2010.

Senate Bill 1241: General Plans: Safety Element – Fire Hazard Impacts

In 2012, Senate Bill 1241 was enacted, requiring that all future General Plans address fire risk in state responsibility areas and very high fire hazard severity zones in their safety element. In addition, the bill requires cities and counties to make certain findings regarding available fire protection and suppression services before approving a tentative map or parcel map.

Senate Bill 379: General Plans: Safety Element – Climate Adaptation

Senate Bill 379 builds on the flood planning inclusions into the safety and housing elements and the hazard mitigation planning safety element inclusions in General Plans outlined in AB 162 and AB 2140. SB 379 specifically focuses on a new requirement that cities and counties include climate adaptation and resiliency strategies in the safety element of their General Plans beginning January 1, 2017. In addition, this bill requires general plans to include a set of goals, policies, and objectives, and specified implementation measures based on the conclusions drawn from climate adaptation research and recommendations.

California State Building Code

California Code of Regulations Title 24 (CCR Title 24), also known as the California Building Standards Code, is a compilation of building standards from three sources:

- Building standards that have been adopted by state agencies without change from building standards contained in national model codes
- Building standards that have been adopted and adapted from the national model code standards to meet California conditions
- Building standards authorized by the California legislature that constitute extensive additions not covered by the model codes adopted to address particular California concerns.

The state Building Standards Commission is authorized by California Building Standards Law (Health and Safety Code Sections 18901 through 18949.6) to administer the processes related to the adoption, approval, publication, and implementation of California's building codes. These building codes serve as the basis for the design and construction of buildings in California. The national model code standards adopted into Title 24 apply to all occupancies in California, except for modifications adopted by state agencies and local governing bodies. Since 1989, the Building Standards Commission has published new editions of Title 24 every 3 years.

Standardized Emergency Management System

CCR Title 19 establishes the Standardized Emergency Management System (SEMS) to standardize the response to emergencies involving multiple jurisdictions. SEMS is intended to be flexible and adaptable to the needs of all emergency responders in California. It requires emergency response agencies to use basic principles and components of emergency management. Local governments must use SEMS by December 1, 1996, to be eligible for state funding of response-related personnel costs under CCR Title 19 (Sections 2920, 2925 and 2930).The roles and responsibilities of Individual agencies contained in existing laws or the state emergency plan are not superseded by these regulations.

California State Hazard Mitigation Plan

Under the DMA, California must adopt a federally approved state multi-hazard mitigation plan to be eligible for certain disaster assistance and mitigation funding. The intent of the California State Hazard Mitigation Plan is to reduce or prevent injury and damage from hazards in the state through the following:

- Documenting statewide hazard mitigation planning in California
- Describing strategies and priorities for future mitigation activities
- Facilitating the integration of local and tribal hazard mitigation planning activities into statewide efforts
- Meeting state and federal statutory and regulatory requirements.

The plan is an annex to the State Emergency Plan, and it identifies past and present mitigation activities, current policies and programs, and mitigation strategies for the future. It also establishes hazard mitigation goals and objectives. The plan will be reviewed and updated annually to reflect changing conditions and new information, especially information on local planning activities.

Governor's Executive Order S-13-08

Governor's Executive Order S-13-08 enhances the state's management of climate impacts from sea level rise, increased temperatures, shifting precipitation and extreme weather events. There are four key actions in the executive order:

- Initiate California's first statewide climate change adaptation strategy to assess expected climate change impacts, identify where California is most vulnerable, and recommend adaptation policies by early 2009. This effort will improve coordination within state government so that better planning can more effectively address climate impacts on human health, the environment, the state's water supply and the economy.
- Request that the National Academy of Science establish an expert panel to report on sea level rise impacts in California, to inform state planning and development efforts.
- Issue interim guidance to state agencies for how to plan for sea level rise in designated coastal and floodplain areas for new projects.
- Initiate a report on critical infrastructure projects vulnerable to sea level rise.

4.10.3 Local

Plans, reports, and other technical information were identified and provided directly by the County, participating jurisdictions, and numerous stakeholders involved in the planning effort, as well as through independent research by the planning consultant. Relevant documents, including plans, reports, and ordinances were reviewed to identify:

- Existing jurisdictional capabilities;
- Needs and opportunities to develop or enhance capabilities, which may be identified within the local mitigation strategies;
- Mitigation-related goals or objectives, considered during the development of the overall Goals and Objectives;
- Proposed, in-progress, or potential mitigation projects, actions and initiatives to be incorporated into the updated jurisdictional mitigation strategies.

The following local regulations, codes, ordinances and plans were reviewed during this plan process in an effort to develop mitigation planning goals, objectives, and mitigation strategies that are consistent across local and regional planning and regulatory mechanisms; and thus develop complementary and mutually supportive plans, including:

- General Plans

  - Housing Element
  - Safety Element
- Building Codes
- Zoning and Subdivision Ordinances
- NFIP Flood Damage Prevention Ordinances
- Stormwater Management Plans
- Emergency Management and Response Plans
- Land Use and Open Space Plans
- Climate Action Plans

Capability Assessment

All participating jurisdictions — including San Mateo County on behalf of the unincorporated areas, incorporated municipalities, and special districts — compiled an inventory and analysis of existing authorities and capabilities called a "capability assessment." A capability assessment creates an inventory of an agency's mission, programs, and policies, and evaluates its capacity to carry them out. These evaluations include assessments on legal and regulatory capabilities, fiscal capabilities, and administrative and technical capabilities. Additionally, information on NFIP compliance, classifications under various community mitigation programs, and information about public education and outreach capabilities were collected in order to develop a more complete picture of overall capability throughout the planning area. Specific capability assessments for each participating jurisdiction are available in the individual jurisdictional annexes located in Volume II of this plan.

Legal and Regulatory Capabilities

Jurisdictions have the ability to develop policies and programs and to implement rules and regulations to protect and serve residents. Local policies are typically identified in a variety of community plans, implemented via a local ordinance, and enforced through a governmental body.

Jurisdictions regulate land use through the adoption and enforcement of zoning, subdivision and land development ordinances, building codes, building permit ordinances, floodplain, and stormwater management ordinances. When effectively prepared and administered, these regulations can lead to hazard mitigation.

Fiscal Capabilities

Assessing a jurisdiction's fiscal capability provides local governance with an understanding of the ability to fulfill the financial needs associated with hazard mitigation projects. This assessment identifies both outside resources, such as grant-funding eligibility, and local jurisdictional authority to generate internal financial capability, such as through impact fees.

Administrative and Technical Capabilities

Legal, regulatory, and fiscal capabilities are needed to provide the backbone for successfully developing a mitigation strategy, however, without appropriate personnel, the strategy may not be implemented. The Administrative and Technical Capability focuses on the availability of personnel resources responsible for implementing multiple facets of hazard mitigation. These personnel resources include technical experts, such as engineers and scientists, as well as personnel capabilities that may be found in multiple departments, such as grant writers.

NFIP Compliance

Flooding is the #1 natural hazard in the United States and, with the promulgation of recent federal regulation, homeowners throughout the country are experiencing increasingly high flood insurance premiums. In addition, community participation in the NFIP opens up additional opportunity for grant funding associated specifically with flooding issues. Assessment of the jurisdiction's current NFIP status and compliance provides planners with a greater understanding of the successful implementation of local flood management program and opportunities for improvement that directly affect residents and available grant funding opportunities for hazard mitigation.

Public Outreach Capability

As part of a whole community approach, regular engagement with the public on issues regarding hazard mitigation provides a jurisdiction with the opportunity to directly interface with community members. Assessing this outreach and education capability illustrates the connection between the government and community members which opens a two-way dialogue that will ideally result in a more resilient community based on education and public engagement.

Other Programs

Other programs, such as the Community Rating System, Storm Ready, and Firewise, enhance a jurisdiction's ability to mitigate, prepare, and respond to natural hazards. These programs indicate a jurisdiction's desire to go beyond minimum requirements set forth by local, state, and federal regulations for the purpose of creating a more resilient community. These programs complement each other by focusing on communication, mitigation, and community preparedness to save lives and minimize the impact of natural hazards on a community.

SECTION 2:
HAZARD PROFILES

Chapter 1. Identified Hazards of Concern and Risk Assessment Methodology

Risk assessment is the process of measuring the potential loss of life, personal injury, economic injury, and property damage resulting from identified hazards. It allows emergency management personnel to establish early response priorities by identifying potential hazards and vulnerable assets. The process focuses on the following elements:

- **Hazard identification**—Use all available information to determine what types of hazards may affect a jurisdiction, how often they can occur, and their potential severity.
- **Vulnerability identification**—Assess the impact of hazard events on the people, property, environment, economy and lands of the region.
- **Cost evaluation**—Estimate the cost of potential damage or cost that can be avoided by mitigation.

The risk assessment for this hazard mitigation plan update evaluates the risk of natural hazards prevalent in the planning area and meets requirements of the Disaster Mitigation Act (DMA) (44 Code of Federal Regulations [CFR], Section 201.6(c)(2)).

Specific information regarding the location and individual analysis on personal, governmental, and critical infrastructure analyzed during the risk assessment process is provided in aggregate to protect individual privacy and the safety of critical facilities.

1.1 Identified Hazards of Concern

The Steering Committee considered the full range of natural hazards that could affect the planning area and then listed hazards that present the greatest concern. The process incorporated a review of state and local hazard planning documents as well as information on the frequency of, magnitude of, and costs associated with hazards that have strike or could affect the planning area. Anecdotal information regarding natural hazards and the perceived vulnerability of the planning area's assets to them was also used. Based on the review, this plan addresses the following hazards of concern. (Hazards were profiled in alphabetical order; therefore, the listing of the hazard has no relevance to the hazard's severity or level of concern.)

- Climate Change
- Dam failure
- Drought
- Earthquake
- Flood
- Landslide
- Severe Weather

- Tsunami
- Wildfire

In addition to the natural hazards listed above, San Mateo County decided to address additional human-caused hazards to develop a comprehensive and regional approach to hazard mitigation in the County. These human-caused hazards, with the exception of dam failure, are presented in **Section 2, Chapter 11.** These human-caused hazards are further categorized into man-made and technological hazards. Human-caused hazards are characterized by intentional acts for the purpose of disruption, whether fiscal, social, or other. Human-caused hazards addressed in this plan include the following:

- Terrorism
- Cyber Threats

Technological hazards are characterized by an assumed unintentional failure of a human-made mechanism or structure. Technological hazards addressed in this plan include the following:

- Hazardous Materials Release
- Pipeline and Tank Failure
- Aircraft incidents

As lessons learned from the 2016 process, the Steering Committee recommended additional hazards for consideration in future planning efforts. These include a standalone chapter for Coastal Hazards (included in the Severe Weather chapter of this plan) and health hazards.

1.2 Risk Assessment Tools

1.2.1 Mapping

National, state, and county databases were reviewed to locate available spatially based data relevant to this planning effort. Maps were produced using geographic information system (GIS) software to show the spatial extent and location of hazards identified when such datasets were available. These maps are included in the hazard profile chapters of this document.

1.2.2 HAZUS-MH

Overview

In 1997, the Federal Emergency Management Agency (FEMA) developed the standardized Hazards U.S. (HAZUS) model to estimate losses caused by earthquakes and identify areas that face the highest risk and potential for loss. HAZUS was later expanded into a multi-hazard methodology, HAZUS-MH, with new models for estimating potential losses from hurricanes and floods.

HAZUS-MH is a GIS-based software program used to support risk assessments, mitigation planning, and emergency planning and response. It provides a wide range of inventory data, such as demographics, building stock, critical facility, transportation and utility lifeline, and multiple models to estimate potential losses from natural disasters. The program maps and displays hazard data and the results of damage and economic loss estimates for buildings and infrastructure. Its advantages include the following:

- Provides a consistent methodology for assessing risk across geographic and political entities.
- Provides a way to save data so that they can readily be updated as population, inventory, and other factors change and as mitigation planning efforts evolve.
- Facilitates review of mitigation plans because it helps to ensure that FEMA methodologies are incorporated.
- Supports grant applications by calculating benefits using FEMA definitions and terminology.
- Produces hazard data and loss estimates that can be used in communication with local stakeholders.
- Is administered by the local government and can be used to manage and update a hazard mitigation plan throughout its implementation.

Levels of Detail for Evaluation

HAZUS-MH provides default data for inventory, vulnerability, and hazards; these default data can be supplemented with local data to provide a more refined analysis. The model can carry out three levels of analysis, depending on the format and level of detail of information about the planning area:

- **Level 1**—All of the information needed to produce an estimate of losses is included in the software's default data. These data are derived from national databases and describe in general terms the characteristic parameters of the planning area.
- **Level 2**—More accurate estimates of losses require more detailed information about the planning area. To produce Level 2 estimates of losses, detailed information is required about local geology, hydrology, hydraulics, and building inventory, as well as data about utilities and critical facilities. This information is needed in a GIS format.
- **Level 3**—This level of analysis generates the most accurate estimate of losses. It requires detailed engineering and geotechnical information to customize it for the planning area.

1.3 Overall Risk Assessment Approach

The risk assessments in Section 2, Chapters 2 through 11 describe the risks associated with each hazard of concern identified. Each chapter describes the hazard, the planning area's vulnerabilities, and probable event scenarios. The following steps were used to define the risk of each hazard:

- **Identify and profile each hazard**—The following information is given for each hazard:
  - Geographic areas most affected by the hazard
  - Event frequency estimates
  - Severity estimates
  - Warning time likely to be available for response.

- **Determine exposure to each hazard**—Exposure was assessed by overlaying hazard maps with an inventory of structures, facilities, and systems to decide which of them would be exposed to each hazard.
- **Assess the vulnerability of exposed facilities**—Vulnerability of exposed structures and infrastructure was evaluated by interpreting the probability of occurrence of each event and assessing structures, facilities, and systems that are exposed to each hazard. Tools such as GIS and FEMA's hazard-modeling program HAZUS-MH were used for this assessment for the flood, earthquake, and tsunami hazards. Outputs similar to those from HAZUS-MH were generated for other hazards, using maps generated through GIS.

1.3.1 Dam Failure, Earthquake, and Flood

The following hazards were evaluated using HAZUS-MH:

- **Flood**—A Level 2 user-defined analysis was performed for general building stock in flood zones and for critical facilities and infrastructure. Current flood mapping for the planning area was used to delineate flood hazard areas and estimate potential losses from the 100- and 10-year flood events. To estimate damage that would result from a flood, HAZUS-MH uses pre-defined relationships between flood depth at a structure and resulting damage, with damage given as a percent of total replacement value. Curves defining these relationships have been developed for damage to structures and for damage to typical contents within a structure. By inputting flood depth data and known property replacement cost values, dollar-value estimates of damage were generated.
- **Tsunami**—A Level 2 analysis was run using the flood methodology described above.
- **Earthquake**—A Level 2 analysis was performed to assess earthquake exposure and vulnerability for two scenario events and two probabilistic events:
  - A Magnitude-7.8 event on the San Andreas Fault with an epicenter approximately 138 miles northwest of the City of San Mateo.
  - A Magnitude-7.5 event on the San Gregorio Fault with an epicenter approximately 85 miles south southeast of the City of San Mateo.
  - The standard HAZUS-MH 100- and 500-year probabilistic events

1.3.2 Dam Failure, Landslide, Sea Level Rise, Severe Weather, and Wildfire

Historical datasets were not adequate to model future losses for most of the hazards of concern. However, areas and inventory susceptible to some of the hazards of concern were mapped by other means and exposure was evaluated. A qualitative analysis was conducted for other hazards using the best available data and professional judgment.

1.3.3 Drought

The risk assessment methodologies used for this plan focus on damage to structures. The risk assessment for drought was more limited and qualitative than the assessment for the other hazards of concern because drought does not affect structures.

1.4 Sources of Data Used in HAZUS-MH Modeling

1.4.1 Building and Cost Data

Replacement cost values and detailed structure information derived from parcel and tax assessor data provided by San Mateo County were loaded into HAZUS-MH. When available, an updated inventory was used in place of the HAZUS-MH defaults for critical facilities and infrastructure.

Replacement cost is the cost to replace the entire structure with one of equal quality and utility. Replacement cost is based on industry-standard cost-estimation models published in *RS Means Square Foot Costs* (RS Means, 2015). It is calculated using the RS Means square foot cost for a structure, which is based on the HAZUS-MH occupancy class (multi-family residential or commercial retail trade), multiplied by the square footage of the structure from the tax assessor data. The construction class and number of stories for single-family residential also factor into determining the square foot costs.

1.4.2 HAZUS-MH Data Inputs

The following hazard datasets were used for the HAZUS-MH Level 2 analysis conducted for the risk assessment:

- **Flood**—The effective Digital Flood Insurance Rate Map (DFIRM) for the planning area was used to delineate flood hazard areas and estimate potential losses from the 100-year and 10-year flood events. Using the DFIRM floodplain boundaries and base flood elevation information, and the County's 5-foot digital elevation model (DEM) data, flood depth grids were generated and integrated into the HAZUS-MH model.
- **Tsunami**—Tsunami area data, provided by the Association of Bay Area Governments (ABAG), and the County's 5-foot DEM were used to develop depth grids that were integrated into the HAZUS-MH model.
- **Earthquake**—Earthquake shake maps and probabilistic data prepared by the U.S. Geological Survey (USGS) were used for the analysis of this hazard. A National Earthquake Hazard Reduction Program (NEHRP) soils map from the California Department of Conservation and ABAG's liquefaction susceptibility data were also integrated into the HAZUS-MH model.

1.4.3 Other Local Hazard Data

Locally relevant information on hazards was gathered from a variety of sources. Frequency and severity indicators include past events and the expert opinions of geologists, emergency management specialists, and others. Data sources for specific hazards were as follows:

- **Dam Failure**—Dam inundation area data for Bear Gulch, Emerald Lake, Felt Lake, Laurel Creek, Lower Crystal Spring, Pilarcitos, Ricky Dam, San Andreas, and Searsville provided by the County.
- **Landslide**—USGS rainfall induced landslides data were provided by ABAG. Areas categorized as "mostly a landslide area" were used in the exposure analysis.
- **Sea Level Rise**—Sea level rise data were provided by ABAG and NOAA through the County of San Mateo. The 6 feet above current Mean Higher High Water level of sea rise was used for the exposure analysis.
- **Severe Storm**—No GIS format severe storm area datasets were identified for San Mateo County.
- **Wildfire**—Fire severity data was acquired from California Department of Forestry and Fire Protection (CAL FIRE).

1.4.4 Data Source Summary

Table 1-1 summarizes the data sources used for the risk assessment for this project.

TABLE 1-1. HAZUS-MH MODEL DATA DOCUMENTATION

Data	Source	Date	Format
Property parcel data	San Mateo County	2015	Digital (GIS) format
Building information such as area, occupancy, date of construction, and stories	San Mateo County	2016	Digital (tabular) format
Building replacement cost	RS Means	2015	Paper format. Updated RS Means values
Population data	HAZUS-MH	2010	Digital (GIS and tabular) format
Flood hazard data	FEMA	2015	Digital (GIS) format
Tsunami	ABAG (State of California)	2009	Digital (GIS) format
Earthquake shake maps	USGS Earthquake Hazards Program website	2012	Digital (GIS) format
Liquefaction susceptibility	ABAG (USGS)	2006	
NEHRP Soils	California Department of Conservation	2008	Digital (GIS) format
Dam inundation areas	San Mateo County	Unknown	Digital (GIS) format
Landslide	ABAG (USGS)	1997	Digital (GIS) format
Seal Level Rise	ABAG (NOAA)	2012	Digital (GIS) format
Wildfire	CAL FIRE	2008	Digital (GIS) format
Digital Elevation Model	San Mateo County	2006	Digital (GIS) format
Critical Facilities and Assets			
EOCs, police stations, airports, bus facilities, port facilities, communications facilities, electric power facilities	FEMA Hazus-MH version 2.2 Default Critical Facilities Data	2015	Digital (GIS) format

TABLE 1-1. HAZUS-MH MODEL DATA DOCUMENTATION

Data	Source	Date	Format
Landmarks (includes fire stations, medical care facilities, police stations, schools, military facilities, ferry facilities, public facilities, government facilities)	San Mateo County	2015	Digital (GIS) format
San Mateo County critical facilities information (includes fire stations, schools, potable water facilities, wastewater facilities)	San Mateo County	2016	Digital (spreadsheet) format
Dams	San Mateo County	TBD	Digital (GIS) format
Toxic Release Inventory facilities (includes hazardous material facilities)	Environmental Protection Agency (EPA)	2016	Digital (GIS) format
State and local bridges (includes highway bridges, light rail bridges, rail bridges)	California Department of Transportation (Caltrans)	2015	Digital (GIS) format
BART stations	San Mateo County	2015	Digital (GIS) format
Rail stations	California Department of Transportation (Caltrans)	2013	Digital (GIS) format
San Mateo County GIS data (includes electric power facilities, potable water facilities, wastewater facilities)	ArcGIS Online	2016	Digital (GIS) format
Critical facilities information provided by Colma, San Carlos, and Redwood City	Colma, San Carlos, Redwood City	2016	Digital (spreadsheet) format

1.5 Limitations

Loss estimates, exposure assessments, and hazard-specific vulnerability evaluations rely on the best available data and methodologies. Uncertainties are inherent in any loss estimation methodology and arise in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from the following:

- Approximations and simplifications necessary to conduct a study
- Incomplete or outdated inventory, demographic or economic parameter data
- The unique nature, geographic extent, and severity of each hazard
- Mitigation measures already employed
- The amount of advance notice residents have to prepare for a specific hazard event.
- Specific to sea level rise, there currently exists no standardized model for assessing sea level rise impacts. Different models will provide different results. Additionally, most sea level rise models do not take into account factors such as storm surge and tides. Future sea level rise models may include these additional factors, however, such modelling exceeds the purpose and scope as well as modeling capabilities of this plan.

These factors can affect loss estimates by a factor of two or more. Therefore, potential exposure and loss estimates are approximate and should be used only to understand relative risk. Over the long term, San Mateo County will collect additional data to assist in estimating potential losses associated with other hazards.

Chapter 2.
Climate Change

2.1 California Senate Bill No. 379

Senate Bill 379, enacted October 8, 2015, requires that local hazard mitigation plans adopted on or after January 1, 2017, consider advice provided in the Office of Planning and Research's General Plan Guidelines and include all of the following:

- A vulnerability assessment that identifies the risks that climate change poses to the local jurisdiction and the geographic areas at risk from climate change impacts, including but not limited to flood and fire hazards. Information available from federal, state, regional, and local agencies should be used in development of this assessment, including:
- The Internet-based Cal-Adapt tool.
- The most recent version of the California Adaptation Planning Guide.
- Local agencies on the types of assets, resources, and populations that will be sensitive to various climate change exposures.
- Local agencies on their current ability to deal with the impacts of climate change.
- Historical data on natural events and hazards, including locally prepared maps of areas subject to previous risk, areas that are vulnerable, and sites that have been repeatedly damaged.
- Existing and planned development in identified at-risk areas, including structures, roads, utilities, and essential public facilities.
- Federal, state, regional, and local agencies with responsibility for the protection of public health and safety and the environment, including special districts and local offices of emergency services.
- A set of adaptation and resilience goals, policies, and objectives based on the available information.
- A set of feasible implementation measures designed to carry out the goals, policies, and objectives including, but not limited to, all of the following:
- Feasible methods to avoid or minimize climate change impacts associated with new uses of land.
- The location, when feasible, of new essential public facilities outside of at-risk areas, including, but not limited to, hospitals and health care facilities, emergency shelters, emergency command centers, and emergency communications facilities, or identifying construction methods or other methods to minimize damage if these facilities are located in at-risk areas.
- The designation of adequate and feasible infrastructure located in an at-risk area.
- Guidelines for working cooperatively with relevant local, regional, state, and federal agencies.
- The identification of natural infrastructure that may be used in adaptation projects, where feasible. Where feasible, the plan should use existing natural features and ecosystem processes, or restoration of natural features and ecosystem processes, in developing alternatives for consideration.

At the time this hazard mitigation plan was drafted, guidelines and resources are still being developed to assist local governments in meeting the intent of Senate Bill No. 379. The information in the following chapter addresses the issues presented and the intent of the requirements using the best available information at the time this plan was developed.

2.2 What is Climate Change?

Climate — consisting of patterns of temperature, precipitation, humidity, wind and seasons — plays a fundamental role in shaping natural ecosystems and the human economies and cultures that depend on them. "Climate change" refers to changes over a long period of time. Worldwide, average temperatures have increased 1.4ºF since 1880 (NASA 2015). Although this increase may seem small, it can lead to large changes in climate and weather.

The warming trend and its related impacts are caused by increasing concentrations of carbon dioxide and other greenhouse gases in the earth's atmosphere. Greenhouse gases are gases that trap heat in the atmosphere, resulting in a warming effect. Carbon dioxide is the most commonly known greenhouse gas; however, methane, nitrous oxide and fluorinated gases also contribute to warming. Emissions of these gases come from a variety of sources, such as the combustion of fossil fuels, agricultural production, changes in land use, and volcanic eruptions. According to the U.S. Environmental Protection Agency (EPA), carbon dioxide concentrations measured about 280 parts per million (ppm) before the industrial era began in the late 1700s and have risen 43 percent since then, reaching 399 ppm in 2014 (see Figure 2-1). Furthermore, scientists are able to place this rise in carbon dioxide in a longer historical context by measuring carbon dioxide in ice cores. According to these records, carbon dioxide concentrations in the atmosphere are the highest that they have been in 650,000 years (NASA 2016). According to NASA, this trend is of particular significance "because most of it is very likely human-induced and [it is] proceeding at a rate that is unprecedented in the past 1,300 years" (NASA 2016). There is broad scientific consensus (97 percent of scientists) that climate-warming trends are very likely the result of human activities (NASA 2016). Unless emissions of greenhouse gases are substantially reduced, this warming trend and its associated impacts are expected to continue.

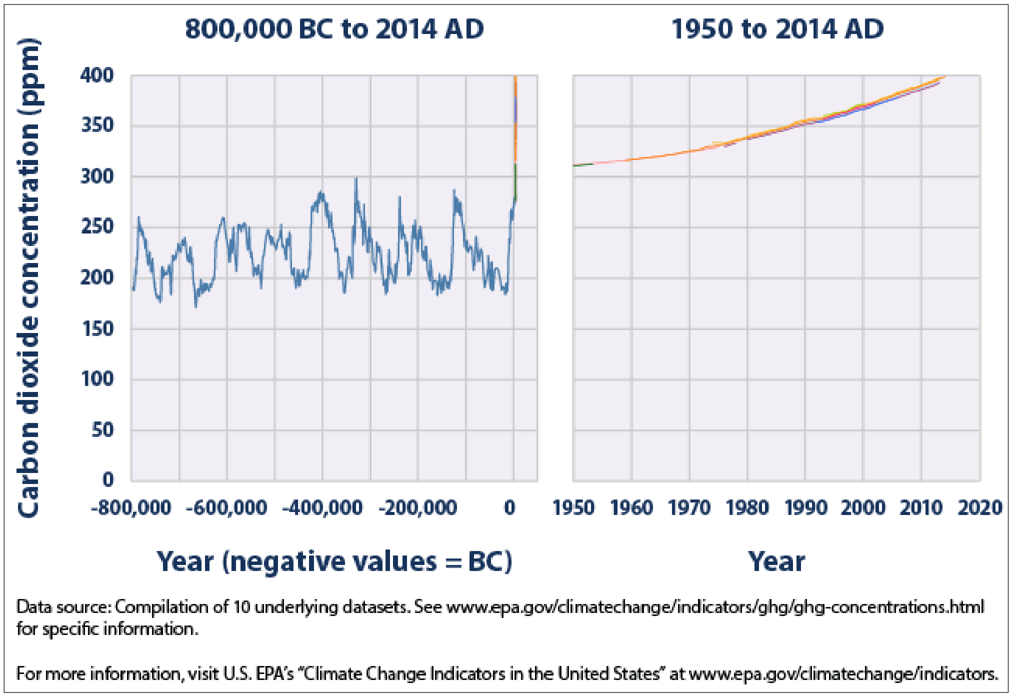


FIGURE 2-1. GLOBAL CARBON DIOXIDE CONCENTRATIONS OVER TIME

Climate change will affect the people, property, economy, and ecosystems of San Mateo County in a variety of ways. Climate change impacts are most frequently associated with negative consequences, such as increased vulnerability to flood or increased heat-related illnesses and public health concerns; however, other changes may present opportunities. The most important effect for development of this plan is that climate change will have a measurable impact on the occurrence and severity of natural hazards.

2.3 How Climate Change Affects Hazard Mitigation

An essential aspect of hazard mitigation is predicting the likelihood of hazard events in a planning area. Typically, predictions are based on statistical projections from records of past events. This approach assumes that the likelihood of hazard events remains essentially unchanged over time. Thus, averages based on the past frequencies of, for example, floods are used to estimate future frequencies: if a river has flooded an average of once every 5 years for the past 100 years, then it can be expected to continue to flood an average of once every 5 years.

The assumption that future behavior will be equivalent to past behavior for hazards that are affected by climate conditions is not valid if climate conditions are changing. As flooding is generally associated with the frequency and quantity of precipitation, for example, the frequency of flooding will not remain constant if broad precipitation patterns change over time. Specifically, as hydrology changes, storms currently considered to be a 1-percent-annual-chance event (100-year flood) might strike more often, leaving many communities at greater risk. The risks of, landslide, severe storms, extreme heat, and wildfire are all affected by climate patterns as well. For this reason, an understanding of climate change is pertinent to efforts to mitigate natural hazards. Information about how climate patterns are changing provides insight on the reliability of future hazard projections used in mitigation analysis. This chapter summarizes current understandings about climate change to provide a context for the recommendation and implementation of hazard mitigation measures.

2.4 Current Indications of Climate Change

The major scientific agencies of the United States and the world — including the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA) and the Intergovernmental Panel on Climate Change (IPCC) — agree that climate change is occurring. Multiple temperature records from all over the world have shown a warming trend, and IPCC has stated that the warming of the climate system is unequivocal (IPCC 2014). Of the 10 warmest years in the 134-year record, all but one (1998) occurred since 2000, and 2015 was the warmest year on record (NASA 2016). Worldwide, average temperatures have increased 1.4ºF since 1880 (NASA 2016).

Rising global temperatures have been accompanied by other changes in weather and climate. Many places have experienced changes in rainfall resulting in more intense rain, as well as more frequent and severe heat waves (IPCC 2014). The planet's oceans and glaciers have also experienced changes: oceans are warming and becoming more acidic, ice caps are melting, and sea levels are rising (NASA 2016). Global sea level has risen approximately 6.7 inches, on average, in the last 100 years (NASA 2016). This rise has already put some coastal homes, beaches, roads, bridges, and wildlife at risk (USGCRP 2009).

NASA currently maintains information on the vital signs of the planet. At the time this plan was developed, the following trends and status of these signs are as follows (NASA 2016):

- **Carbon Dioxide**—Increasing trend, currently at 403.28 parts per million
- **Global Temperature**—Increasing trend,, increase of 1.4 degrees Fahrenheit since 1880
- **Arctic Ice Minimum**—Decreasing trend, 13.4 percent per decade
- **Land Ice**—Decreasing trend, 287.0 billion metric tons per year
- **Sea Level**—Increasing trend, 3.4 millimeters (mm) per year.

2.5 Projected Future Impacts

The Third National Climate Assessment Report for the United States indicates that impacts from climate change will continue through the 21st century and beyond. Not all changes are understood at this time and the impacts of those changes will depend on global emissions of greenhouse gases and sensitivity in human and natural systems. Still, the following impacts are expected in the United States (NASA 2016):

- Temperatures will continue to rise
- Growing seasons will lengthen
- Precipitation patterns will change
- Droughts and heat waves will increase
- Hurricanes will become stronger and more intense
- Sea level will rise 1 to 4 feet by 2100

- The Arctic may become ice free.

The California Climate Adaptation Planning Guide outlines the following climate change impact concerns for Bay Area Communities (Cal EMA et al. 2012):

- Increased temperature
- Reduced precipitation
- Sea level rise – coastal inundation and erosion
- Public health – heat and air pollution
- Reduced agricultural productivity
- Inland flooding
- Reduced tourism.

Cal-Adapt, a publicly available resource that offers information on how climate change might affect local communities, provides visualization tools that present the most current data available whenever possible. While best available data are used, it is important to remember that climate change projections involve inherent uncertainty. This uncertainty is largely derived from the fact that climate projections depend on future greenhouse gas emission scenarios and that different climate change models result in differing outcomes or impacts. Generally, the uncertainty in greenhouse gas emissions is addressed by the presentation of differing climate pathways: low or high emissions scenarios. In low emission scenarios, greenhouse gas emissions are reduced substantially from current levels. In high emissions scenarios, greenhouse gas emissions generally increase or continue at current levels. Uncertainty in outcomes is generally addressed by averaging a variety of model outcomes. Despite this uncertainty, climate change projections present valuable information to help guide decision-making for possible future conditions. Information presented by Cal-Adapt for San Mateo's local climate snapshot is as follows:

2.5.1 Precipitation

According to Cal-Adapt, precipitation projections for California remain uncertain. Models show differing impacts, from slightly wetter winters to slightly drier winters, with the potential for a 10 to 20 percent decrease in total annual precipitation (Cal-Adapt 2016). Changes in precipitation patterns coupled with warmer temperatures may lead to significant changes in hydrology. In the high emission scenario, more precipitation may fall as rain rather than snow and this snow may melt earlier in the season, thus altering the timing of changes in stream flow and flood events (Cal-Adapt 2016).

2.5.2 Temperature

The historical average (1961-1990) temperature in San Mateo County is 56.4ºF. The average temperature in the County is expected to increase above this baseline by 3.2ºF in the low emissions scenario and 5.4ºF in the high emissions scenario by 2090 (Figure 2-2).

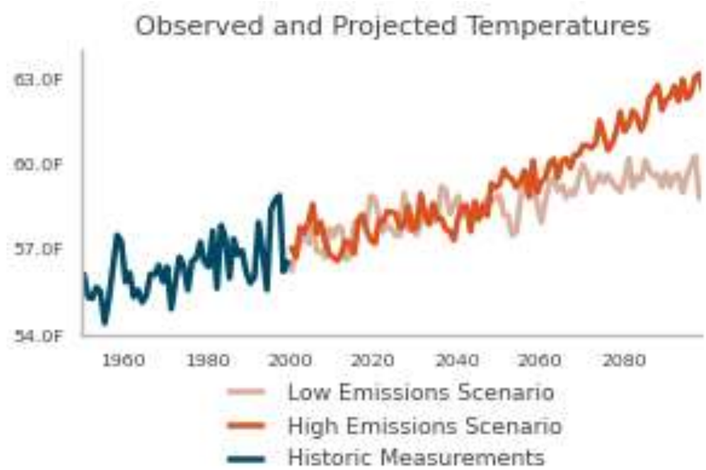


FIGURE 2-2. OBSERVED AND PROJECTED AVERAGE TEMPERATURES IN SAN MATEO COUNTY

2.5.3 Snow Pack

While there are no snow water equivalency measurements for San Mateo County, Cal-Adapt indicates that some parts of California should expect snow pack levels to be reduced by up to 25 inches from the baseline (1961-1990) by 2090.

2.5.4 Sea Level Rise

As sea levels rise, more areas will be vulnerable to a 1 percent annual chance or 100 year flood event. In San Mateo County, it is estimated that the land area vulnerable may increase by 22 percent in the Bay Area and by 19 percent on the coast if 55.12 inches (140 centimeters or 4.59 feet) of sea level rise occurs (Figure 2-3).

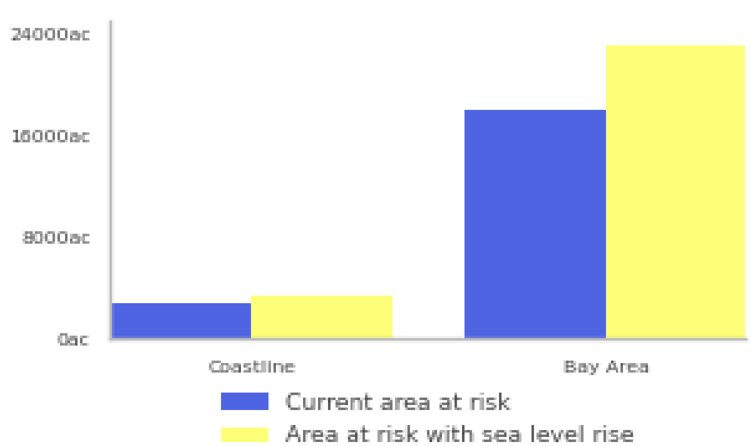


FIGURE 2-3. LAND VULNERABLE TO A 100-YEAR FLOOD EVENT IN SAN MATEO COUNTY

2.5.5 Wildfire

Wildfire risk is expected to change in the coming decades. Under high emission scenarios, the fire risk in San Mateo County may increase by 1.14 times the current risk by 2085, while the risk may be 0.98 the current risk in low emission scenarios (Figure 2-4).

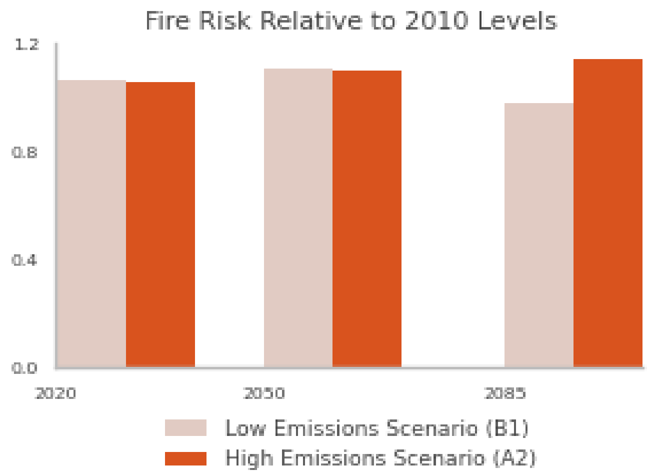


FIGURE 2-4. PROJECTED CHANGED IN FIRE RISK IN SAN MATEO COUNTY

2.6 Responses to Climate Change

Communities and governments worldwide are working to address, evaluate, and prepare for climate changes that are likely to affect communities in coming decades. Generally, climate change discussions encompass two separate but inter-related considerations: mitigation and adaptation. The term "mitigation" can be confusing, because its meaning changes across disciplines:

- Mitigation in restoration ecology and related fields generally refers to policies, programs, or actions that are intended to reduce or to offset the negative impacts of human activities on natural systems. Generally, mitigation can be understood as avoiding, minimizing, rectifying, reducing or eliminating, or compensating for known impacts (CEQ 1978).
- Mitigation in climate change discussions is defined as "a human intervention to reduce the impact on the climate system." It includes strategies to reduce greenhouse gas sources and emissions and enhance greenhouse gas sinks (EPA 2013c).
- Mitigation in emergency management is typically defined as the effort to reduce loss of life and property by lessening the impact of disasters (FEMA 2013).

Mitigation is used as defined by the climate change community in this chapter. Mitigation in the other chapters of this plan is primarily used in an emergency management context.

Adaptation is defined by the IPCC as "the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities, In some natural systems, human intervention may facilitate adjustment to expected climate and its effects" (IPCC 2014).

Mitigation and adaptation are related, as the world's ability to reduce greenhouse gas emissions will affect the degree of adaptation that will be necessary. Some initiatives and actions can both reduce greenhouse gas emissions and support adaptation to likely future conditions. According to a 2014 document compiled by the Bay Area Climate and Energy Resilience Project, nine communities within San Mateo County have developed greenhouse gas emission reduction goals, and at least seven communities had begun work to compile information on or to develop adaptation strategies (BACERP 2014).

Societies across the world are facing the need to adapt to changing conditions associated with natural disasters and climate change. Farmers are altering crops and agricultural methods to deal with changing rainfall and rising temperature; architects and engineers are redesigning buildings; and planners are looking at managing water supplies to deal with droughts or flooding.

Most ecosystems show a remarkable ability to adapt to change and to buffer surrounding areas from the impacts of change. Forests can bind soils and hold large volumes of water during times of plenty, releasing it through the year; floodplains can absorb vast volumes of water during peak flows; and coastal ecosystems can hold out against storms, attenuating waves and reducing erosion. Other ecosystem services — such as food provision, timber, materials, medicines, and recreation — can provide a buffer to societies in the face of changing conditions.

Ecosystem-based adaptation is the use of biodiversity and ecosystem services as part of an overall strategy to help people adapt to the adverse effects of climate change. It includes the sustainable management, conservation, and restoration of specific ecosystems that provide key services.

2.7 Climate Change Impacts on Hazards

The following sections provide information on how each hazard of concern identified for this planning process may be altered by climate change and how these impacts may alter current exposure and vulnerability for the people, property, critical facilities, and the environment in San Mateo County to these hazards. For detailed hazard profiles and risk assessment information on each hazard, please see **Chapters 3** through **11**.

2.7.1 Dam Failure

Impacts to Hazard

On average, changes in California's annual precipitation levels are not expected to be dramatic; however, small changes may have significant impacts for water resource systems, including dams. Dams are designed partly based on assumptions about a river's flow behavior, expressed as hydrographs. Changes in weather patterns can have significant effects on the hydrograph used for the design of a dam. If the hygrograph changes, it is conceivable that the dam can lose some or all of its designed margin of safety, also known as freeboard. If freeboard is reduced, dam operators may be forced to release increased volumes earlier in a storm cycle to maintain the required margins of safety. Such early releases of increased volumes can increase the potential for flood downstream. According to the California Department of Water Resources (DWR), since the 1950s, flood flows on many California rivers have been record setting. As a result, water infrastructure, such as dams, have been forced to manage flows they were not designed to address (DWR 2007). The California Division of Dam Safety (DODS) has indicated that climate change may result in the need for increased safety precautions to address higher winter runoff, frequent fluctuations of water levels, and increased potential for sedimentation and debris accumulation from changing erosion patterns and increases in wildfires. Furthermore, DODS indicates that climate change "will impact the ability of dam operators to estimate extreme flood events" (DWR 2008).

Dams are constructed with safety features known as "spillways." Spillways are put in place on dams as a safety measure in the event the reservoir fills too quickly. Spillway overflow events, often referred to as "design failures," result in increased discharges downstream and increased flooding potential. Although climate change will not increase the probability of catastrophic dam failure, it may increase the probability of design failures.

Population

Population exposure and vulnerability to the dam failure hazard is unlikely to change as a result of climate change.

Property

Property exposure and vulnerability to the dam failure hazard is unlikely to change as a result of climate change.

Critical Facilities

The exposure and vulnerability of critical facilities are unlikely to change as result of climate change. Dam owners and operators may need to alter maintenance and operations to account for changes in the hydrograph and increased sedimentation.

Environment

The exposure and vulnerability of the environment to dam failure is unlikely to change as a result of climate change. Ecosystem services may be used to mitigate some of the factors that may increase the aforementioned risk of design failures, such as increasing the natural water storage capacity in watersheds above dams.

2.7.2 Drought

Impacts to Hazard

The long-term effects of climate change on regional water resources are unknown, but global water resources are already experiencing the following stresses without climate change:

- Growing populations
- Increased competition for available water
- Poor water quality
- Environmental claims
- Uncertain reserved water rights

- Groundwater overdraft
- Aging urban water infrastructure,

With a warmer climate, droughts could become more frequent, more severe, and longer-lasting. According to the National Climate Assessment, "higher surface temperatures brought about by global warming increase the potential for drought. Evaporation and the higher rate at which plants lose moisture through their leaves both increase with temperature. Unless higher evapotranspiration rates are matched by increases in precipitation, environments will tend to dry, promoting drought conditions (Globalchange.gov 2014). The potential impacts and likelihood of drought are uncertain because expected changes in precipitation patterns are still uncertain. That being said, DWR has already noted the impact of climate change on statewide water resources by charting changes in snowpack, sea level, and river flow. As temperatures rise and more precipitation comes in the form of rain instead of snow, these changes will likely continue or grow even more significant. DWR estimates that the Sierra Nevada snowpack, which supplies water for San Mateo County and other parts of the state, will experience a 48-65 percent loss by the end of the century, based off historic April 1st averages (CA DWR 2016). Increasing temperatures may also increase net evaporation from reservoirs from between 15 and 37 percent (CA DWR 2013).

By addressing current stresses on water supplies and by building a flexible, robust program, the County will be able to more adeptly respond to changing conditions and to survive dry years.

Population

Population exposure and vulnerability to drought is unlikely to increase as a result of climate change. While greater numbers of people may need to engage in behavior change, such as water saving efforts, significant life or health impacts are unlikely.

Property

Property exposure and vulnerability may increase as a result of increased drought resulting from climate change, although this would most likely occur in non-structural property such as crops and landscaping. It is unlikely that structure exposure and vulnerability would increase as a direct result of drought, although secondary impacts of drought, such as wildfire, may increase and threaten structures.

Critical Facilities

Critical facility exposure and vulnerability is unlikely to increase as a result of increased drought resulting from climate change; however, critical facility operators may need to alter standard management practices and actively manage resources, particularly in water-related service sectors.

Environment

The vulnerability of the environment may increase as a result of increased drought resulting from climate change. Prolonged or more frequent drought resulting from climate change may further stress the ecosystems in the region, which include many special status species (Cal EMA et al. 2012).

2.8 Earthquake

Impacts to Hazard

The impacts of global climate change on earthquake probability are unknown. Some scientists say that melting glaciers could induce tectonic activity. As ice melts and water runs off, tremendous amounts of weight are shifted on the earth's crust. As newly freed crust returns to its original, pre-glacier shape, it could cause seismic plates to slip and stimulate volcanic activity, according to research into prehistoric earthquakes and volcanic activity. NASA and U.S. Geological Survey (USGS) scientists found that retreating glaciers in southern Alaska may be opening the way for future earthquakes (NASA, 2004).

Secondary impacts of earthquakes could be magnified by climate change. Soils saturated by repetitive storms or heavy precipitation could experience liquefaction or an increased propensity for slides during seismic activity caused by the increased saturation. Dams storing increased volumes of water as a result of changes in the hydrograph could fail during seismic events.

Population, Property, Critical Facilities, and the Environment

Increases in exposure and vulnerability of the local resources are not able to be determined because impacts on the earthquake hazard are not well understood.

2.9 Flood

Impacts to Hazard

Global climate change could trigger an increase in flood activity in two ways: flooding associated with sea level rise, and atmospheric changes that alter the frequency, duration, and intensity of storms that cause flooding.

Changes in Hydrology

Use of historical hydrologic data has long been the standard of practice for designing and operating water supply and flood protection projects. For example, historical data are used for flood forecasting models and to forecast snowmelt runoff for water supply. This method of forecasting assumes that the climate of the future will be similar to that of the period of historical record. However, the hydrologic record cannot be used to predict changes in the frequency and severity of extreme climate events such as floods. Going forward, models must be calibrated or statistical relations developed more frequently, new forecast-based tools must be developed, and a standard of practice that explicitly considers climate change must be adopted. Climate change is already altering water resources, and resource managers have observed the following:

- Historical hydrologic patterns can no longer be solely relied on to forecast the water future.
- Precipitation and runoff patterns are changing, increasing the uncertainty for water supply and quality, flood management, and ecosystem functions.
- Extreme climatic events will become more frequent, necessitating improvement in flood protection, drought preparedness, and emergency response.

The amount of snow is critical for water supply and environmental needs, but so is the timing of snowmelt runoff into rivers and streams. Rising snowlines caused by climate change will allow more mountain areas, such as the Sierra Nevada watersheds, to contribute to peak storm runoff. (See the Drought section for how snowpack changes are affecting water supply.) High frequency flood events (such as 10-year floods) in particular will likely increase with a changing climate. Along with reductions in the amount of the snowpack and accelerated snowmelt, scientists project greater storm intensity, resulting in more direct runoff and flooding. Changes in watershed vegetation and soil moisture conditions will likewise change runoff and recharge patterns. As stream flows and velocities change, erosion patterns will also change, altering channel shapes and depths, possibly increasing sedimentation behind dams, and affecting habitat and water quality. With potential increases in the frequency and intensity of wildfires caused by climate change, there is potential for more floods after a fire, which increase sediment loads and water quality impacts.

As hydrology changes, what is currently considered a 1-percent-annual-chance (100-year flood) may strike more often, leaving many communities at greater risk. Planners will need to factor a new level of safety into the design, operation, and regulation of flood protection facilities such as dams, bypass channels, and levees, as well as the design of local sewers and storm drains.

Sea Level Rise

There is evidence that the global sea is rising at an increased rate and will continue rising over the next century. The two major causes of sea level rise are thermal expansion caused by the warming of the oceans and the loss of land-based ice (glaciers and polar ice caps) through increased melting. Thermal expansion can account for 50 percent of sea level rise and is a result of warming atmospheric temperatures and subsequent warming of ocean waters, causing the expansion. Since 1900, records and research have shown that the sea level has been steadily rising at a rate of 0.04 to 0.1 inch per year (NOAA 2013). Although that rise may seem like a small amount, such increases add up over time. In fact, water levels in San Francisco Bay have risen 7 inches in the past century. Significant enough sea level rise could affect up to 330 square miles of low-lying land around the San Francisco Bay area (including but not limited to San Mateo County). Additionally, sea level rise will also increase the risk of erosion and the adverse impacts of storm surge and high waves (DWR 2013).

There are two types of sea level: global and relative. Global sea level rise refers to the increase currently observed in the average global sea level trend (primarily attributed to changes in ocean volume caused by ice melt and thermal expansion). The melting of glaciers and continental ice masses can contribute significant amounts of freshwater input to the earth's oceans. In addition, a steady increase in global atmospheric temperature creates an expansion of salt water molecules, increasing ocean volume.

Local sea level refers to the height of the water as measuring along the coast relative to a specific point on land. Water level measurements at tide stations are referenced to stable vertical points on the land and a known relationship is established. Measurements at any given tide station include both global sea level rise and vertical land motion (subsidence, glacial rebound, or large-scale tectonic motion). The heights of both the land and water are changing; therefore, the land-water interface can vary spatially and temporally and must be defined over time. Relative sea level trends reflect changes in local sea level over time and are typically the most critical sea level trend for many coastal applications (coastal mapping, marine boundary delineation, coastal zone management, coastal engineering, and sustainable habitat restoration) (NOAA 2013).

Short-term variations in the sea level typically occur on a daily basis and include waves, tides, or specific flood events. Long-term variations in the sea level occur over various time scales, from monthly to yearly, and may be repeatable cycles, gradual trends, or intermittent differences. Seasonal weather patterns (changes in the Earth's declination), changes in coastal and ocean circulation, anthropogenic influences, vertical land motion, and other factors may influence changes in the sea level over time. When sea level trends are estimated, a minimum of 30 years of data are used to account for long-term sea level variations and reduce errors in computing sea level trends based on the monthly mean sea level (NOAA 2013).

Sea Level Rise Exposure Estimates

The NOAA Coastal Services Center has developed a dataset to show potential sea level rise inundation ranging from 1 to 6 feet above current levels. The purpose of these data is to provide a preliminary look at sea level rise and coastal flooding impacts. According to NOAA, the data illustrate the scale of potential flooding, not the exact location, and do not account for erosion, subsidence, or future construction. Water levels are shown as they would appear during the highest high tides, excluding wind driven tides (NOAA 2015).

An exposure analysis was performed using the 6-foot sea level rise data to estimate the potential impacts to resources within the planning area. It is important to note that this assessment assumes that these impacts occur in present-day San Mateo County, rather than gradually over years or decades. Figure 2-5 provides the inundation area for the six foot sea level rise analysis. Alternate models for sea level rise are readily available for public viewing. These alternate models are provided for informational purposes only and do not supersede the analysis conducted on the selected best available data for this plan. These alternate models may be viewed at the following websites:

- Our Coast, Our Future - http://data.prbo.org/apps/ocof/
- NOAA[1] - https://coast.noaa.gov/slr/

[1] The NOAA interactive map uses is a similar dataset to that analyzed in this plan's assessment. The interactive map expands the dataset to denote low-lying areas.

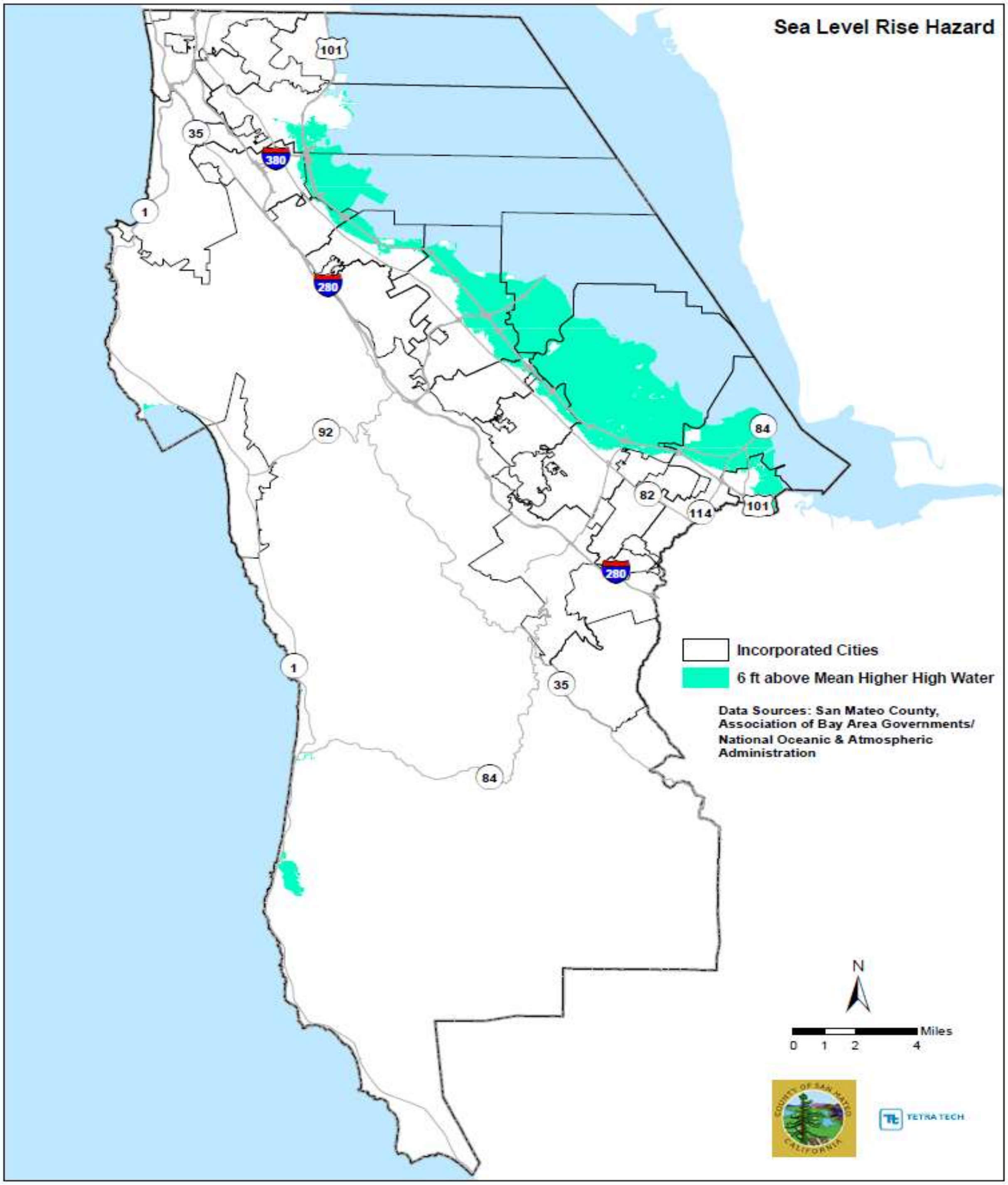


FIGURE 2-5. SAN MATEO COUNTY 6 FOOT SEA LEVEL RISE INUNDATION AREAS[2]

[2] Figure 2-5 provides a regional overview of sea-level rise. Jurisdiction-specific sea level rise maps are available, where applicable, in the jurisdictional annexes located in Volume II.

Population

All populations currently residing in sea level rise inundation areas would be exposed to the sea level rise hazard. It is unlikely that exposure would result in death or injury because sea level rise is expected to occur gradually over years and decades; however, residents in these areas would need to relocate. Table 2-1 shows the estimated population for each jurisdiction currently residing in potential sea level rise inundation areas.

Table 2-1. Population within 6 Foot Sea Level Rise Inundation Areas

	Population Exposed[a]	% of Total Population
Atherton	0	0.0%
Belmont	1,902	7.1%
Brisbane	0	0.0%
Burlingame	846	2.8%
Colma	0	0.0%
Daly City	0	0.0%
East Palo Alto	11,725	40.2%
Foster City	32,390	100.0%
Half Moon Bay	0	0.0%
Hillsborough	0	0.0%
Menlo Park	1,964	5.9%
Millbrae	739	3.2%
Pacifica	20	0.0%
Portola Valley	0	0.0%
Redwood City	24,167	29.5%
San Bruno	1,603	3.6%
San Carlos	534	1.8%
San Mateo	39,899	39.3%
South San Francisco	28	0.0%
Woodside	0	0.0%
Unincorporated	103	0.2%
Total	**115,904**	**15.4%**

a. The population exposed is established by the percent of total residential buildings that are exposed multiplied by the estimated 2015 population.

Property

All property located within the sea level rise inundation areas would be exposed to the hazard; however, gradual sea level rise may allow for a managed retreat from areas likely to be inundated. In addition to properties located within the inundation area, properties at the edge of the inundation area may be exposed to storm surge or other coastal hazards. Table 2-2 summarizes the value of planning area buildings in the inundation area.

More than 16 percent of the total replacement value of the planning area is exposed to sea level rise. Table 2-3 lists the structure type of buildings in the inundation areas. Residential properties make up 93 percent of this exposure. The current distribution of land uses in sea level rise inundation areas is shown in Table 2-4.

TABLE 2-2. VALUE OF STRUCTURES WITHIN 6 FOOT SEA LEVEL RISE INUNDATION AREAS

	Value Exposed			% of Total
	Building	Contents	Total	Replacement Value[a]
Atherton	$0	$0	$0	0.0%
Belmont	$395,204,419	$329,674,930	$724,879,349	7.0%
Brisbane	$17,328,240	$17,328,240	$34,656,480	0.8%
Burlingame	$2,714,669,560	$2,566,247,168	$5,280,916,728	24.7%
Colma	$0	$0	$0	0.0%
Daly City	$0	$0	$0	0.0%
East Palo Alto	$1,043,061,421	$881,113,700	$1,924,175,121	32.8%
Foster City	$4,843,529,380	$3,342,664,716	$8,186,194,096	99.6%
Half Moon Bay	$0	$0	$0	0.0%
Hillsborough	$0	$0	$0	0.0%
Menlo Park	$1,195,475,133	$1,280,368,711	$2,475,843,845	13.4%
Millbrae	$271,002,459	$203,639,591	$474,642,050	4.9%
Pacifica	$1,600,830	$800,415	$2,401,245	0.0%
Portola Valley	$0	$0	$0	0.0%
Redwood City	$7,477,738,926	$6,801,246,307	$14,278,985,232	39.6%
San Bruno	$271,833,972	$224,496,562	$496,330,534	2.9%
San Carlos	$1,622,747,334	$1,813,902,740	$3,436,650,074	17.0%
San Mateo	$7,101,978,923	$5,479,532,674	$12,581,511,596	29.0%
South San Francisco	$1,704,503,151	$1,798,466,620	$3,502,969,771	10.9%
Woodside	$0	$0	$0	0.0%
Unincorporated	$210,449,394	$233,675,248	$444,124,642	1.4%
Total	**$28,869,789,115.81**	**$24,972,490,609.12**	**$53,842,279,725**	**16.8%**

a. Percentages are based on the total replacement value for individual jurisdictions, not for the planning area as a whole. The "total" percentage shown is based on the sum of replacement values for jurisdictions in this table.

Note: Values shown are accurate only for comparison among results in this plan.

TABLE 2-3. PRESENT LAND USE/STRUCTURE TYPE WITHIN 6 FOOT SEA LEVEL RISE INUNDATION AREAS

	Number of Structures[a]							
	Residential	Commercial	Industrial	Agriculture / Forestry	Religion	Government	Education	Total
Atherton	0	0	0	0	0	0	0	0
Belmont	528	14	3	0	1	0	0	546
Brisbane	0	1	0	0	0	0	0	1
Burlingame	220	237	52	0	0	0	1	510
Colma	0	0	0	0	0	0	0	0
Daly City	0	0	0	0	0	0	0	0
East Palo Alto	1,825	26	19	6	7	0	11	1,894
Foster City	8,750	117	22	0	8	0	7	8,904

TABLE 2-3. PRESENT LAND USE/STRUCTURE TYPE WITHIN 6 FOOT SEA LEVEL RISE INUNDATION AREAS

	Number of Structures[a]							
	Residential	Commercial	Industrial	Agriculture / Forestry	Religion	Government	Education	Total
Half Moon Bay	0	0	0	0	0	0	0	0
Hillsborough	0	0	0	0	0	0	0	0
Menlo Park	545	69	64	3	7	0	4	692
Millbrae	210	14	2	0	0	0	0	226
Pacifica	6	0	0	0	0	0	0	6
Portola Valley	0	0	0	0	0	0	0	0
Redwood City	5,609	437	86	1	1	2	3	6,139
San Bruno	437	13	1	0	0	0	1	452
San Carlos	180	174	121	0	0	0	1	476
San Mateo	10,560	278	46	0	8	2	11	10,905
South San Francisco	7	217	43	0	0	0	0	267
Woodside	0	0	0	0	0	0	0	0
Unincorporated	29	19	10	0	0	0	0	58
Total	**28,901**	**1,616**	**469**	**10**	**32**	**4**	**39**	**31,071**

a. Structure type assigned to best fit HAZUS occupancy classes based on present use classifications provided by San Mateo County assessor's data. Where conflicting information was present in the available data, parcels were assumed to be improved.

Future Land Use

While coastal communities will experience some degree of future exposure based on anticipated land use, the majority of future impact will revolve around the bayside communities. Redwood City can expect to experience the largest exposure in terms of acreage with over 18,000 acres exposed to a 6 ft. sea level rise.

Table 2-4 provides a detailed analysis of future land use exposure to sea level rise.

Critical Facilities

Table 2-5 shows the critical facilities located in the sea level rise inundation areas. All facilities located in these areas are exposed and potentially vulnerable to impacts from sea level rise. 296 of the planning area's critical facilities (25 percent) are in the inundation areas. In addition, the following major roads may be at least partially inundated as a result of sea level rise:

- State Highway 1
- State Highway 92
- US Highway 101
- State Highway 82
- State Highway 109
- Interstate 380

- State Highway 84
- State Highway 114

Environment

The exposure and vulnerability of the environment may increase as a result of climate change impacts on the flood hazard. Changes in the timing and frequency of flood events may have broader ecosystem impacts that alter the ability of already stressed species to survive.

TABLE 2-4. FUTURE LAND USE IN THE 6 FOOT SEA LEVEL RISE INUNDATION AREA.

Jurisdiction	Agriculture/ Resource		Commercial		Education		Industrial		Mixed Use		Water/Other	
	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total
ATHERTON	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%
BELMONT	0.0	0.00%	4.1	1.73%	1.2	0.51%	30.5	12.81%	45.8	19.24%	57.3	24.07%
BRISBANE	0.0	0.00%	12.2	0.11%	0.0	0.00%	0.0	0.00%	0.0	0.00%	10,928.9	99.52%
BURLINGAME	0.0	0.00%	186.5	11.70%	0.0	0.00%	0.0	0.00%	281.7	17.67%	1,021.4	64.07%
COLMA	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%
DALY CITY	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	10.4	27.25%
EAST PALO ALTO	0.7	0.08%	3.3	0.40%	0.1	0.02%	101.4	12.28%	0.0	0.00%	124.7	15.10%
FOSTER CITY	0.0	0.00%	432.8	3.42%	87.6	0.69%	54.8	0.43%	13.1	0.10%	10,233.6	80.83%
HALF MOON BAY	0.0	0.00%	6.7	10.99%	0.0	0.00%	0.0	0.00%	0.0	0.00%	22.4	36.77%
HILLSBOROUGH	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%
MENLO PARK	1,914.3	24.22%	2.8	0.03%	43.3	0.55%	537.2	6.80%	0.0	0.00%	5,011.9	63.41%
MILLBRAE	0.0	0.00%	14.6	6.28%	0.0	0.00%	24.1	10.38%	0.6	0.25%	104.0	44.86%
PACIFICA	0.0	0.00%	4.6	3.36%	0.1	0.07%	0.0	0.00%	0.0	0.00%	124.4	90.60%
PORTOLA VALLEY	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%
REDWOOD CITY	0.0	0.00%	470.3	2.60%	70.0	0.39%	530.7	2.94%	63.0	0.35%	12,466.0	69.03%
SAN BRUNO	0.0	0.00%	4.0	3.94%	1.0	0.95%	29.2	28.46%	0.0	0.00%	5.5	5.33%
SAN CARLOS	0.0	0.00%	42.0	8.34%	9.4	1.87%	229.0	45.44%	0.0	0.00%	183.1	36.34%
SAN MATEO	0.0	0.00%	379.8	7.26%	205.1	3.92%	9.8	0.19%	77.1	1.47%	2,316.6	44.25%
SOUTH SAN FRANCISCO	0.0	0.00%	253.1	1.83%	0.0	0.00%	376.7	2.72%	1.1	0.01%	13,154.5	95.04%
WOODSIDE	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%
UNINCORPORATED	54.8	0.33%	12.7	0.08%	0.0	0.00%	27.6	0.16%	0.0	0.00%	16,184.1	96.57%
Total	**1,969.7**	**2.21%**	**1,829.6**	**2.05%**	**417.8**	**0.47%**	**1,951.1**	**2.19%**	**482.3**	**0.54%**	**71,723.5**	**80.42%**

Jurisdiction	Parks/ Open Space		Residential		Total
	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)
ATHERTON	0.0	0.00%	0.0	0.00%	0.0
BELMONT	22.5	9.45%	76.6	32.19%	237.9
BRISBANE	41.0	0.37%	0.0	0.00%	10,982.1
BURLINGAME	75.4	4.73%	29.3	1.84%	1,594.3
COLMA	0.0	0.00%	0.0	0.00%	0.0
DALY CITY	27.8	72.75%	0.0	0.00%	38.2
EAST PALO ALTO	254.5	30.80%	341.4	41.32%	826.1
FOSTER CITY	285.1	2.25%	1,553.9	12.27%	12,667.8
HALF MOON BAY	31.8	52.24%	0.0	0.00%	60.9
HILLSBOROUGH	0.0	0.00%	0.0	0.00%	0.0
MENLO PARK	272.6	3.45%	122.0	1.54%	7,904.1
MILLBRAE	50.4	21.75%	38.2	16.47%	231.8
PACIFICA	3.7	2.69%	4.5	3.28%	137.3
PORTOLA VALLEY	0.0	0.00%	0.0	0.00%	0.0
REDWOOD CITY	3,707.9	20.53%	751.6	4.16%	18,059.6
SAN BRUNO	3.5	3.44%	59.4	57.88%	102.6
SAN CARLOS	4.0	0.80%	36.3	7.21%	503.9
SAN MATEO	581.7	11.11%	1,665.4	31.81%	5,235.5
SOUTH SAN FRANCISCO	51.9	0.37%	3.3	0.02%	13,840.6
WOODSIDE	0.0	0.00%	0.0	0.00%	0.0
UNINCORPORATED	465.5	2.78%	13.8	0.08%	16,758.4
Total	**5,879.0**	**6.59%**	**4,695.7**	**5.27%**	**89,181.1**

TABLE 2-5. CRITICAL FACILITIES WITHIN 6 FOOT SEA LEVEL RISE INUNDATION AREAS

	Medical and Health Services	Emergency Services	Government	Utilities	Hazardous Materials	Community Economic Facilities	Other Assets	Total
Atherton	0	0	0	0	0	0	0	**0**
Belmont	0	0	0	1	4	1	0	**0**
Brisbane	0	0	0	0	0	0	0	**0**
Burlingame	0	1	0	4	3	5	0	**1**
Colma	0	0	0	0	0	0	0	**0**
Daly City	0	0	0	0	0	0	0	**0**
East Palo Alto	0	0	1	1	0	3	0	**8**
Foster City	0	2	1	1	10	2	2	**10**
Half Moon Bay	0	0	0	0	0	0	0	**0**
Hillsborough	0	0	0	0	0	0	0	**0**
Menlo Park	0	1	0	4	4	10	0	**3**
Millbrae	0	0	0	2	2	0	0	**0**
Pacifica	0	0	0	0	0	0	0	**0**
Portola Valley	0	0	0	0	0	0	0	**0**
Redwood City	1	5	6	35	16	9	4	**6**
San Bruno	0	0	0	0	1	0	0	**1**
San Carlos	0	0	1	4	4	10	0	**0**
San Mateo	0	2	1	13	23	1	0	**8**
South San Francisco	0	1	0	8	11	4	1	**0**
Woodside	0	0	0	0	0	0	0	**0**
Unincorporated	0	0	0	0	33	0	0	**0**
Total	**1**	**12**	**10**	**73**	**111**	**45**	**7**	**37**

2.9.1 Landslide

Impacts to Hazard

Climate change may alter storm patterns, increasing the probability of more frequent, intense storms with varying duration. Increase in global temperature is likely to affect the snowpack and its ability to hold and store water. Warming temperatures also could increase the occurrence and duration of droughts, which would increase the probability of wildfire, reducing the vegetation that helps to support steep slopes. All of these factors would increase the probability for landslides.

Population and Property

Population and property exposure and vulnerability would be unlikely to increase as a result of climate change impacts to the landslide hazard. Landslide events may occur more frequently, but the extent and location should be contained within mapped hazard areas.

Critical Facilities

Critical facility exposure and vulnerability would be unlikely to increase as a result of climate change impacts to the landslide hazard; however, critical facility owners and operators may experience more frequent disruption to service provision as a result of landslide hazards. For example, transportation systems may experience more frequent delays if slides blocking these systems occur more frequently.

Environment

Exposure and vulnerability of the environment would be unlikely to increase as a result of climate change, but more frequent slides in riverine systems may impair water quality and have negative impacts on already stressed species.

2.9.2 Severe Weather

Impacts to Hazard

Climate change presents a challenge for risk management associated with severe weather. The frequency of severe weather events has increased steadily over the last century. The number of weather-related disasters during the 1990s was four times that of the 1950s and cost 14 times as much in economic losses. Historical data show that the probability for severe weather events increases in a warmer climate.

This increase in average surface temperatures can also lead to more intense heat waves that can be exacerbated in urbanized areas by what is known as urban heat island effect. The evidence suggests that heat waves are already increasing, especially in western states. According to information on Cal-Adapt, extreme heat days are likely to increase from a historical average for 4 days annually in San Mateo County. This increase would be coupled with an increase in heat waves and warm nights.

Population and Property

Population and property exposure and vulnerability would be unlikely to increase as a direct result of climate change impacts to the severe weather hazard. Severe weather events may occur more frequently and intensely, but exposure and vulnerability will remain the same. Secondary impacts, such as the extent of localized flooding, may increase, thus affecting greater numbers of people and structures.

Critical Facilities

Critical facility exposure and vulnerability would be unlikely to increase as a result of climate change impacts to the severe weather hazard; however, critical facility owners and operators may experience more frequent disruption to service provision. For example, more frequent and intense storms may cause more frequent disruptions in power service.

Environment

Exposure and vulnerability of the environment would be unlikely to increase as a result of climate change impacts on the severe weather hazard; however, more frequent storms and heat events and more intense rainfall may place additional stressors on already stressed systems.

2.9.3 Tsunami

Impacts to Hazard

Impacts to the frequency of tsunami events resulting from climate change are unknown. Triggering events for tsunamis such as earthquakes or landslides may increase, and therefore the frequency of tsunamis may increase. Some researchers have also indicated that rapid sea level rise may stress faults, leading to underwater landslides that trigger tsunamis (Geology 2013).

Even if the frequency of tsunami events does not increase, tsunami impacts may reach farther into communities than previous events and modelling have indicated because of sea level rise.

Population, Property, and Critical Facility

Population, property, and critical facility exposure and vulnerability to the tsunami hazard may increase as a result of climate change related sea level rise. As sea levels rise, tsunami impact areas may reach into parts of the community that were previously believed to be outside of the tsunami risk area. This reach will depend on the size of the tsunami, the local topography, and the extent of sea level rise.

Environment

Exposure and vulnerability of the environment to tsunamis may be impacted by the effects of climate change. In particular, sea level rise could alter the shape of existing shoreline, putting different structures and ecosystems closer to the shoreline and potential tsunami impacts. These assets would not have the same protection to tsunamis due to a shorter time period to adapt. Additionally, ice crust melt could lead to a rise of the earth's crust, especially at higher latitudes, causing more submarine landslides and a greater vulnerability to tsunamis.

2.9.4 Wildfire

Impacts to Hazard

Wildfire is controlled by climate variability, local topography, and human intervention. Climate change has the potential to affect multiple elements of the wildfire system: fire behavior, ignitions, fire management, and vegetation fuels. Hot dry spells create the highest fire risk. Increased temperatures may intensify wildfire danger by warming and drying out vegetation. Additionally, changes in climate patterns may affect the distribution and perseverance of insect outbreaks that create dead trees (increase fuel). Forest susceptibility to wildfires changes when climate alters fuel loads and fuel moisture. Climate change also may increase winds that spread fires. Faster fires are harder to contain, and thus are more likely to expand into residential neighborhoods.

Population, Property, and Critical Facilities

According to the Cal-Adapt projections provided earlier in this chapter, wildfire risk in San Mateo County is not expected to increase dramatically. As a result, it is unlikely that exposure and vulnerability to the wildfire hazard would increase significantly.

Environment

It is possible that the exposure and vulnerability of the environment will be affected by impacts on wildfire risk from climate change. Natural fire regimes may change, resulting in more frequent or higher intensity burns. These impacts may alter the composition of the ecosystems in and around the planning area.

Chapter 3.
Dam Failure

3.1 Hazard Description

3.1.1 Causes of Dam Failure

Dam failures can be catastrophic to human life and property downstream. Dam failures in the United States typically occur in one of four primary ways:

- Overtopping of the primary dam structure, which accounts for 34 percent of all dam failures, can occur due to inadequate spillway design, settlement of the dam crest, blockage of spillways, and other factors.
- Foundation defects due to differential settlement, slides, slope instability, uplift pressures, and foundation seepage can also cause dam failure. These account for 30 percent of all dam failures.
- Failure due to piping and seepage accounts for 20 percent of all failures. These are caused by internal erosion due to piping and seepage, erosion along hydraulic structures such as spillways, erosion due to animal burrows, and cracks in the dam structure.
- Failure due to problems with conduits and valves, typically caused by the piping of embankment material into conduits through joints or cracks, constitutes 10 percent of all failures.

The remaining 6 percent of dam failures stem from other miscellaneous causes. Many historical dam failures in the United States have been secondary results of other disasters—prominently earthquakes, landslides, extreme storms, massive snowmelt, equipment malfunction, structural damage, foundation failures, and sabotage.

The most likely disaster-related causes of dam failure in San Mateo County are earthquakes, excessive rainfall, and

DEFINITIONS

Dam—Any artificial barrier, together with appurtenant works, that does or may impound or divert water, and that either (a) is 25 feet or more in height from the natural bed of the stream or watercourse at the downstream toe of the barrier (or from the lowest elevation of the outside limit of the barrier if it is not across a stream channel or watercourse) to the maximum possible water storage elevation; or (b) has an impounding capacity of 50 acre-feet or more (CA Water Code, Division 3).

Dam Failure—An uncontrolled release of impounded water due to structural deficiencies in a dam.

Emergency Action Plan—A formal document that identifies potential emergency conditions at a dam and specifies actions to minimize property damage and loss of life, including actions the dam owner should take to alleviate problems at a dam. This plan conveys procedures and information to assist the dam owner in issuing early warning and notification messages regarding the emergency situation to responsible downstream emergency management authorities. The plan also includes inundation maps to show emergency management authorities critical areas for action in case of an emergency (Federal Emergency Management Agency [FEMA] 64).

High Hazard Dam—Dam where failure or mis-operation will probably cause loss of human life (FEMA 333).

Significant Hazard Dam—Dam where failure or mis-operation would result in no probable loss of human life but could cause economic loss, environmental damage, or disruption of lifeline facilities, or could lead to other concerns. Significant hazard dams are often within rural or agricultural areas but could be within areas of significant population and infrastructure (FEMA 333).

landslides. Poor construction, lack of maintenance and repair, and deficient operational procedures are preventable or correctable via a program of regular inspections. Terrorism and vandalism are serious concerns for which all operators of public facilities must plan; these threats are under continuous review by public safety agencies.

3.1.2 Regulatory Oversight

National Dam Safety Act

Potential for catastrophic flooding due to dam failures led to passage of the National Dam Safety Act (Public Law 92-367). The National Dam Safety Program (NDSP) requires a periodic engineering analysis of the majority of dams in the country; exceptions include (1) dams under jurisdiction of the Bureau of Reclamation, Tennessee Valley Authority, or International Boundary and Water Commission; (2) dams constructed pursuant to licenses issued under the Federal Power Act; and (3) dams which the Secretary of the Army determines do not pose any threat to human life or property. The goal of this FEMA-monitored effort is to identify and mitigate the risk of dam failure so as to protect lives and property of the public. The NDSP is a partnership among the states, federal agencies, and other stakeholders that encourages individual and community responsibility for dam safety. Under FEMA's leadership, state assistance funds have allowed all participating states to improve their programs through increased inspections, emergency action planning, and purchases of needed equipment. FEMA has also expanded existing and initiated new training programs. Grant assistance from FEMA provides support for improvement of dam safety programs that regulate most of the dams in the United States (FEMA 2013).

California Division of Safety of Dams

California's Division of Safety of Dams (a division of the Department of Water Resources [DWR]) monitors the dam maintenance and safety at the state level. When a new dam is proposed, Division engineers and geologists inspect the site and the subsurface. Upon submittal of an application, the Division reviews the plans and specifications prepared by the owner to ensure that the dam is designed to meet minimum requirements and that the design is appropriate for the known geologic conditions. After approval of the application, the Division inspects all aspects of the construction to ensure that the work accords with the approved plans and specifications. After construction, the Division inspects each dam annually to ensure performance as intended and to identify developing problems. Roughly a third of these inspections include in-depth reviews of instrumentation. Finally, the Division periodically reviews stability of dams and their major appurtenances in light of improved design approaches, requirements, and new findings regarding earthquake hazards and hydrologic estimates in California (DWR Website 2007).

U.S. Army Corps of Engineers Dam Safety Program

The U.S. Army Corps of Engineers (USACE) is responsible for safety inspections of some federal and non-federal dams in the United States that meet size and storage limitations specified in the National Dam Safety Act. USACE has inventoried dams; surveyed each state and federal agency's capabilities, practices, and regulations regarding design, construction, operation, and maintenance of dams; and developed guidelines for inspection and evaluation of dam safety (USACE 1997). The USACE National Inventory of Dams (NID) provides the most recent inspection dates for 24 of the San Mateo County dams. These are as follows:

TABLE 3-1. SAN MATEO COUNTY DAM INSPECTION DATES

San Mateo County Dam	Inspection Date
Bean Hollow #1	April 24, 2012
Bean Hollow #3	April 24, 2012
Bear Gulch	March 23, 2012
Canada Road	March 22, 2012
Coastways	January 5, 2012
Crocker	August 10, 2010
Emerald Lake 1 Lower	January 4. 2012
Green Oaks #1	January 18, 2012
Johnston	March 22, 2012
Laurel Creek	January 4, 2012
Lower Crystal Springs	January 25, 2012
Lower Pond	May 11, 2012
Lake Lucerne	April 24, 2012
Marina Lagoon	January 4, 2012
Mud Pond	June 24, 2011
Notre Dame	January 25, 2012
Pilarcitos	January 25, 2012
Pomponio Ranch	January 8, 2012
Purisima	March 22, 2012
Rickey	January 25, 2012
San Andreas	January 25, 2012
Searsville	July 13, 2012
Spencer Lake	March 22, 2012
Upper Pond	May11, 2012

Federal Energy Regulatory Commission Dam Safety Program

The Federal Energy Regulatory Commission (FERC) has the largest dam safety program in the United States. FERC cooperates with a large number of federal and state agencies to ensure and promote dam safety and, more recently, homeland security. Approximately 3,036 dams that are part of regulated hydroelectric projects are in the FERC program. Two-thirds of these dams are more than 50 years old. As dams age, concern about their safety and integrity grows, and oversight and a regular inspection program are extremely important. FERC staff inspects hydroelectric projects on an unscheduled basis to investigate the following:

- Potential dam safety problems
- Complaints about constructing and operating a project
- Safety concerns related to natural disasters
- Issues concerning compliance with terms and conditions of a license.

Every 5 years, an independent consulting engineer, approved by FERC, must inspect and evaluate projects with dams higher than 32.8 feet, or with a total storage capacity of more than 2,000 acre-feet.

FERC staff monitor and evaluate seismic research in geographic areas such as California where concerns about possible seismic activity are significant. This information is applied during investigations and structural analyses of hydroelectric projects in these areas. FERC staff also evaluate effects of potential and actual large floods on safety of dams. During and following floods, FERC staff visit dams and licensed projects, determine extent of damage, if any, and direct any necessary studies or remedial measures the licensee must undertake. The FERC publication *Engineering Guidelines for the Evaluation of Hydropower Projects* guides FERC engineering staff and licensees in evaluating dam safety. The publication is frequently revised to reflect current information and methodologies.

FERC requires licensees to prepare emergency action plans, and conducts training sessions on how to develop and test these plans. The plans outline an early warning system pertaining to actual or potential sudden release of water from a dam due to failure or accident. The plans include operational procedures that may be applied, such as reducing reservoir levels and downstream flows, or notifying affected residents and agencies responsible for emergency management. Updates and tests of these plans occur frequently to ensure that everyone knows what to do in emergency situations (FERC 2005).

3.2 Hazard Profile

3.2.1 Past Events

Even under normal operating conditions, dam failures can occur suddenly, without warning (referred to as a "sunny-day" failure). Dam failures may also occur during a large storm event. Significant rainfall can quickly inundate an area and cause floodwaters to overwhelm a reservoir. If the spillway of the dam cannot safely pass the resulting flows, water will begin flowing in areas not designed for such flows, and a failure may occur.

No dam failures have been recorded in San Mateo County or the Bay Area. If a dam is determined unsafe, the California Department of Water Resources Division of Safety of Dams (DSOD) requires reduction of the water level to allow for partial collapse without catastrophic loss of water.

3.2.2 Location

According to DSOD, 21 dams are in San Mateo County. Of these, 13 dams could endanger lives and property if an uncontrolled release or catastrophic failure occurs (including one dam in Santa Clara County, on the border of San Mateo County). Eleven of these dams are of sufficient size and at locations that would endanger a significant number of people during a failure. Table 3-2 lists dams with potential to endanger lives and property in the County.

TABLE 3 2. SAN MATEO COUNTY DAMS WITH POTENTIAL TO ENDANGER LIVES AND PROPERTY

Name	National ID#	Water Course	Owner	Year Built	Dam Type	Crest Length (feet)	Height (feet)	Storage Capacity (acre-feet)	Drainage area (sq. mi.)
Bear Gulch	CA00658	Tributary, San Francisco Bay	Cal Water Svc	1896	Earth	730	61	672	0.2
Spencer Lake	CA00673	Tributary, San Francisco Bay	Hillsborough	1876	Earth	400	87	73	0.2
Crocker	CA00672	Sanchez Creek	Hillsborough	1890	Earth	200	45	22	0.26
Lower Crystal Spring	CA00127	San Mateo Creek	SF PUC Water Department	1888	Gravity	600	140	57,910	28.71
Emerald Lake	CA00668	Lower Emerald Lake	Emerald Lake CC	1885	Earth	280	57	45	0.25
Felt Lake[a]	CA00670	Tributary, Los Trancos Creek	Stanford University	1930	Earth	590	67	900	0.2
Johnston	CA00667	Arroyo Leon	Peninsula Open Space Trust	1919	Gravity	132	31	30	7.6
Laurel	CA00901	Laurel Creek	San Mateo	1969	Earth	287	40	55	0.9
Notre Dame	CA00674	Belmont Creek	Belmont	[b]	Earth	210	51	120	0.53
Pilarcitos	CA00128	Pilarcitos Creek	SF PUC Water Department	1866	Earth	520	103	3,100	3.8
Rickey/West	CA01009	Peters Creek	Mid-Peninsula Open Space District	1951	Earth	200	64	47	0.23
San Andreas	CA00129	Tributary, San Mateo Creek	SF PUC Water Department	1870	Earth	727	107	19,027	4.4
Searsville	CA00669	Corte Madera Creek	Stanford University	1890	Gravity	260	68	952	14.8

a. Felt Lake is within Santa Clara County, approximately 1,300 feet from San Mateo boundary lines. It has been included here due to its proximity to the County.
b. Year built unavailable.
Sources: San Mateo County Sheriff 2015; USACE NID 2016; DSOD 2016

The Lower Crystal Springs Dam is the largest dam within San Mateo County, making it a higher priority for county, state, and federal officials in regards to regulation and preventative maintenance. This dam impounds water to form the Lower Crystal Springs Reservoir, which serves as a water supply for San Francisco and most cities in San Mateo County. Although located directly on the San Andreas Fault, the dam survived both the 1906 San Francisco earthquake and 1989 Loma Prieta earthquake. In 2010, DSOD inspected the Lower Crystal Springs Dam to investigate effects of an 8.3 magnitude earthquake (on the Richter scale), and determined dam failure to be a low probability. Despite this low probability, the County and dam owner, San Francisco Public Utilities Commission (SFPUC), are dedicated to enhancing safety and quality of the dam. Significant upgrades to the dam and a nearby overpass bridge occurred between fall 2010 and spring 2015 to restore maximum storage capacity of the reservoir. The project involved widening the spillway, raising the parapet wall, and replacing the stilling basin with a new and larger facility (San Mateo County Sheriff 2015).

3.2.3 Frequency

Dam failure events are infrequent and usually coincide with the events causing them, such as earthquakes, landslides, or excessive rainfall and snowmelt. Dams pose “residual risk”—risk remaining after implementation of safeguards. Residual risk is associated with events beyond those the dam was designed to withstand. However, probability of occurrence of any type of dam failure event is considered low in today’s regulatory and dam safety oversight environment.

3.2.4 Severity

Dam failure can be catastrophic to all life and property downstream. Measure of extent or severity of a dam failure is through the classification of the dam. Moreover, two additional factors influence potential severity of a full or partial dam failure: (1) amount of water impounded, and (2) downstream development and infrastructure (density, type, and value) (City of Sacramento Development Service Department 2005). Several classification tools are available to identify the hazards of a dam. For the purpose of this hazard profile and Hazard Mitigation Plan (HMP) Update, the USACE hazard classification will be used. USACE developed the classification system presented in Table 3-3. This hazard rating system is based only on potential consequences of a dam failure; it does not take into account probability of such failures.

TABLE 3-3. HAZARD POTENTIAL CLASSIFICATION

Hazard Category[a]	Direct Loss of Life[b]	Lifeline Losses[c]	Property Losses[d]	Environmental Losses[e]
Low	None (rural location, no permanent structures for human habitation)	No disruption of services (cosmetic or rapidly repairable damage)	Private agricultural lands, equipment, and isolated buildings	Minimal incremental damage
Significant	Rural location, only transient or day-use facilities	Disruption of essential facilities and access	Major public and private facilities	Major mitigation required
High	Certain (one or more) extensive residential, commercial, or industrial development	Disruption of essential facilities and access	Extensive public and private facilities	Extensive mitigation cost or impossible to mitigate

a. Categories are assigned to overall projects, not individual structures at a project.

b. Loss of life potential based on inundation mapping of area downstream of the project. Analyses of loss of life potential should take into account the population at risk, time of flood wave travel, and warning time.
c. Indirect threats to life caused by interruption of lifeline services due to project failure or operational disruption—for example, loss of critical medical facilities or access to these.
d. Damage to project facilities and downstream property and indirect impact due to loss of project services, such as impact due to loss of a dam and navigation pool, or impact due to loss of water or power supply.
e. Environmental impact downstream caused by the incremental flood wave produced by project failure, beyond what would normally be expected for the magnitude flood event under which the failure occurs.

Source: USACE 1995

3.2.5 Warning Time

Warning time for dam failure varies depending on the cause of the failure. Evacuations prior to events of extreme precipitation or massive snowmelt can be planned given sufficient time. A structural failure due to earthquake, however, possibly would allow no warning time. A dam's structural type also affects warning time. Earthen dams do not tend to fail completely or instantaneously. Once a breach is initiated, discharging water erodes the breach until either the reservoir water is depleted or the breach resists further erosion. Concrete gravity dams also tend to have partial breaches as one or more monolith sections formed during dam construction are forced apart by escaping water. Time for breach formation ranges from a few minutes to a few hours (USACE 1997).

San Mateo County and its planning partners have established protocols for emergency warning and response through its adopted emergency operations plan (EOP). The San Mateo County Sheriff's Office of Emergency Services maintains copies of the most recent dam emergency action plans (EAP) and inundation maps, and it has used this information to plan notification needs for downstream areas in the event of a failure (San Mateo County Sheriff 2015).

3.3 Secondary Hazards

Dam failure can cause severe downstream flooding depending on magnitude of the failure. Other potential secondary hazards of dam failure include landslides around the reservoir perimeter, bank erosion on the rivers, and destruction of downstream habitat.

3.4 Exposure

Exposure and vulnerability to dam failure hazard was assessed by use of spatial analysis. Dam inundation areas for which inundation mapping was available were combined into a single inundation area and overlaid with planning area features including general building stock and critical facility databases. Dams included in the combined inundation area were Bear Gulch, Emerald Lake, Felt Lake, Laurel Creek, Lower Crystal Springs, Pilarcitos, Ricky Dam, San Andreas, and Searsville. Although simultaneous failure of all dams is highly unlikely, the assessment provides information adequate for planning purposes. However, this assessment may not capture risk posed by all dams in the County.

3.4.1 Population

All populations within a dam failure inundation zone would be exposed to the risk of a dam failure. Potential for loss of life is affected by capacity and number of evacuation routes available to populations living within areas of potential inundation. Estimated population living within the mapped inundation areas is 116,451, or 15.5 percent of the County's population. Table 3-4 lists population exposure estimates by jurisdiction.

TABLE 3-4. POPULATION WITHIN DAM FAILURE INUNDATION AREAS[b]

	Population Exposed[a]	% of Total Population
Atherton	333	4.8%
Belmont	1,790	6.7%
Brisbane	0	0.0%
Burlingame	993	3.3%
Colma	0	0.0%
Daly City	0	0.0%
East Palo Alto	141	0.5%
Foster City	32,390	100.0%
Half Moon Bay	454	3.8%
Hillsborough	1,234	10.8%
Menlo Park	3,373	10.1%
Millbrae	0	0.0%
Pacifica	0	0.0%
Portola Valley	0	0.0%
Redwood City	8,510	10.4%
San Bruno	0	0.0%
San Carlos	0	0.0%
San Mateo	66,064	65.1%
South San Francisco	0	0.0%
Woodside	14	0.3%
Unincorporated	1,156	1.8%
Total	**116,452**	**15.5%**

a. Determined by percent of total residential buildings exposed multiplied by estimated 2015 population.
b. These estimates are derived from the planning scenario event, not for all possible dam failure risk in the County.

3.4.2 Property

Table 3-5 summarizes values of planning area buildings within the mapped inundation area. More than 14 percent of total replacement value within the planning area is exposed to the dam failure hazard. Table 3-6 lists structure types of buildings within the inundation areas and also represents the distribution of land uses within the dam inundation area.

TABLE 3-5. VALUE OF STRUCTURES IN DAM FAILURE INUNDATION AREA[b]

	Value Exposed			% of Total
	Building	Contents	Total	Replacement Value[a]
Atherton	$244,788,197	$202,129,464	$446,917,661	11.5%
Belmont	$308,456,306	$220,868,233	$529,324,539	5.1%
Brisbane	$0	$0	$0	0.0%
Burlingame	$111,558,338	$81,598,480	$193,156,818	0.9%
Colma	$0	$0	$0	0.0%
Daly City	$0	$0	$0	0.0%
East Palo Alto	$8,273,294	$6,158,767	$14,432,060	0.2%
Foster City	$4,859,871,460	$3,359,006,796	$8,218,878,256	100.0%
Half Moon Bay	$440,474,259	$420,197,446	$860,671,706	11.0%
Hillsborough	$370,525,354	$243,136,791	$613,662,145	13.1%
Menlo Park	$575,971,438	$389,075,302	$965,046,740	5.2%
Millbrae	$0	$0	$0	0.0%
Pacifica	$0	$0	$0	0.0%
Portola Valley	$0	$0	$0	0.0%
Redwood City	$1,904,626,976	$1,575,450,944	$3,480,077,920	9.7%
San Bruno	$0	$0	$0	0.0%
San Carlos	$0	$0	$0	0.0%
San Mateo	$16,236,106,569	$13,261,869,886	$29,497,976,455	68.1%
South San Francisco	$0	$0	$0	0.0%
Woodside	$2,442,452	$1,221,226	$3,663,677	0.1%
Unincorporated	$363,502,223	$314,421,833	$677,924,056	2.1%
Total	**$25,426,596,866**	**$20,075,135,168**	**$45,501,732,033**	**14.2%**

a. Percentages are based on total replacement value for individual jurisdictions, not for the planning area as a whole. The "total" percentage shown is based on the sum of replacement values for jurisdictions in this table.
b. These estimates are derived from the planning scenario event, not for all possible dam failure risk in the County.
Note: Values shown are accurate only for comparison among results in this plan. See Section 2, Chapter 1 for a discussion of data limitations.

TABLE 3-6. PRESENT LAND USE IN DAM FAILURE INUNDATION AREAS

	Number of Structures[a,b]							
	Residential	Commercial	Industrial	Agriculture/ Forestry	Religion	Government	Education	Total
Atherton	119	6	0	0	0	0	2	127
Belmont	497	8	2	0	1	0	0	508
Brisbane	0	0	0	0	0	0	0	0
Burlingame	258	8	1	0	1	0	0	268
Colma	0	0	0	0	0	0	0	0
Daly City	0	0	0	0	0	0	0	0

Table 3-6. Present Land Use in Dam Failure Inundation Areas

	Number of Structures[a,b]							
	Residential	Commercial	Industrial	Agriculture/ Forestry	Religion	Government	Education	Total
East Palo Alto	22	1	0	0	0	0	0	23
Foster City	8,750	118	22	0	8	0	7	8,905
Half Moon Bay	140	34	0	2	0	0	0	176
Hillsborough	419	6	0	0	0	0	1	426
Menlo Park	936	15	0	0	1	0	2	954
Millbrae	0	0	0	0	0	0	0	0
Pacifica	0	0	0	0	0	0	0	0
Portola Valley	0	0	0	0	0	0	0	0
Redwood City	1,975	92	2	0	9	0	6	2,084
San Bruno	0	0	0	0	0	0	0	0
San Carlos	0	0	0	0	0	0	0	0
San Mateo	17,485	803	87	1	30	3	18	18,427
South San Francisco	0	0	0	0	0	0	0	0
Woodside	5	0	0	0	0	0	0	5
Unincorporated	326	14	0	11	0	0	1	352
Total	**30,932**	**1,105**	**114**	**14**	**50**	**3**	**37**	**32,255**

a. Present land use information in this plan is for planning purposes only. Discrepancies may exist between these estimates and official records maintained by participating jurisdictions.
b. These estimates are derived from the planning scenario event, not for all possible dam failure risk in the County.

Geographic Information System (GIS) analysis was applied to determine the number of critical facilities within the mapped dam inundation areas. As Table 3-7 indicates, 155 of the planning area's critical facilities are within the inundation areas. In addition, the following major roads are exposed to the dam failure hazard:

- State Highway 1 (Pacific Coast Highway)
- State Highway 82 (El Camino Real)
- State Highway 84 (Woodside Road)
- State Highway 92
- State Highway 109 (University Avenue, East Palo Alto)
- State Highway 114 (Willow Road, Menlo Park)
- US Highway 101
- Interstate 380

Additional critical facilities and infrastructure are likely present within inundation areas for which mapping was not available.

TABLE 3-7. CRITICAL FACILITIES IN DAM FAILURE INUNDATION AREAS IN SAN MATEO COUNTY

	Medical and Health Services	Emergency Services	Government	Utilities	Transportation Infrastructure	Hazardous Materials	Community Economic Facilities	Other Assets	Total
Atherton	0	0	0	0	0	0	0	1	**1**
Belmont	0	0	0	0	3	0	0	0	**3**
Brisbane	0	0	0	0	0	0	0	0	**0**
Burlingame	0	0	0	0	0	0	0	0	**0**
Colma	0	0	0	0	0	0	0	0	**0**
Daly City	0	0	0	0	0	0	0	0	**0**
East Palo Alto	0	0	0	0	0	0	0	0	**0**
Foster City	0	2	1	1	10	2	2	10	**28**
Half Moon Bay	0	0	0	0	3	0	0	0	**3**
Hillsborough	0	0	0	0	4	0	0	1	**5**
Menlo Park	0	0	0	0	3	0	0	1	**4**
Millbrae	0	0	0	0	0	0	0	0	**0**
Pacifica	0	0	0	0	0	0	0	0	**0**
Portola Valley	0	0	0	0	0	0	0	0	**0**
Redwood City	0	1	2	0	3	0	0	5	**11**
San Bruno	0	0	0	0	0	0	0	0	**0**
San Carlos	0	0	0	0	0	0	0	0	**0**
San Mateo	1	4	1	14	49	1	2	16	**88**
South San Francisco	0	0	0	0	0	0	0	0	**0**
Woodside	0	0	0	0	0	0	0	0	**0**
Unincorporated	0	0	0	2	9	0	0	1	**12**
Total	**1**	**7**	**4**	**17**	**84**	**3**	**4**	**35**	**155**

3.4.3 Environment

Reservoirs held behind dams affect many ecological aspects of a river. River topography and dynamics depend on a wide range of flows, but rivers below dams often undergo long periods of very stable flow conditions or saw-tooth flow patterns caused by releases followed by no releases. Water releases from a reservoir, including those exiting a turbine, usually contain very little suspended sediment; this can lead to scouring of river beds and loss of riverbanks.

The environment would be exposed to a number of risks in the event of dam failure. The inundation could introduce many foreign elements into local waterways, possibly destroying downstream habitat and exerting detrimental effects on many species of animals.

3.5 Vulnerability

The dam failure hazard is significant to San Mateo County because of presence of more than 20 dams across the County, including more than 10 higher hazard dams (13 dams were identified by San Mateo County Sheriff's Office as having potential to endanger lives and property; however, the County did not note whether this hazard classification corresponds to USACE hazard classes or is unique to San Mateo County). Direct and indirect losses associated with dam failures include injury and loss of life, damage to structures and infrastructure, agricultural losses, utility failure (power outages), and stress on community resources.

3.5.1 Population

The entire population residing within a dam failure inundation zone is considered exposed and vulnerable. Of the population exposed, the most vulnerable include the economically disadvantaged and the population over age 65. Economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make decisions to evacuate based on net economic impact on their families. The population over age 65 is also highly vulnerable because they are more likely to seek or need medical attention that may not be available because of isolation during a flood event, and they may have more difficulty evacuating. The vulnerable population also includes those who would not have adequate warning from a television or radio emergency warning system.

3.5.2 Property

Vulnerable properties are those closest to the dam inundation area. These properties would undergo the largest, most destructive surge of water. Low-lying areas are also vulnerable because dam waters would collect there.

Loss estimates were not generated for the dam failure hazard by use of Hazus-MH. Instead, loss potentials were developed representing 10 percent, 30 percent, and 50 percent of replacement value of exposed structures. This allows emergency managers to select a range of economic impact based on an estimate of percent of damage to general building stock. Damage exceeding 50 percent is considered substantial by most building codes, and typically requires total reconstruction of the structure. Table 3-8 lists general building stock loss estimates within dam failure inundation areas. That all dams included in the inundation mapping would fail at the same time is highly unlikely.

TABLE 3-8. VALUE OF STRUCTURES AND CONTENTS IN DAM FAILURE INUNDATION AREA[a]

		Estimated Loss Potential from Dam Failure		
	Exposed Value	10% Damage	30% Damage	50% Damage
Atherton	$446,917,661	$44,691,766	$134,075,298	$223,458,831
Belmont	$529,324,539	$52,932,454	$158,797,362	$264,662,269
Brisbane	$0	$0	$0	$0
Burlingame	$193,156,818	$19,315,682	$57,947,045	$96,578,409
Colma	$0	$0	$0	$0
Daly City	$0	$0	$0	$0

TABLE 3-8. VALUE OF STRUCTURES AND CONTENTS IN DAM FAILURE INUNDATION AREA[a]

		Estimated Loss Potential from Dam Failure		
	Exposed Value	10% Damage	30% Damage	50% Damage
East Palo Alto	$14,432,060	$1,443,206	$4,329,618	$7,216,030
Foster City	$8,218,878,256	$821,887,826	$2,465,663,477	$4,109,439,128
Half Moon Bay	$860,671,706	$86,067,171	$258,201,512	$430,335,853
Hillsborough	$613,662,145	$61,366,215	$184,098,644	$306,831,073
Menlo Park	$965,046,740	$96,504,674	$289,514,022	$482,523,370
Millbrae	$0	$0	$0	$0
Pacifica	$0	$0	$0	$0
Portola Valley	$0	$0	$0	$0
Redwood City	$3,480,077,920	$348,007,792	$1,044,023,376	$1,740,038,960
San Bruno	$0	$0	$0	$0
San Carlos	$0	$0	$0	$0
San Mateo	$29,497,976,455	$2,949,797,646	$8,849,392,937	$14,748,988,228
South San Francisco	$0	$0	$0	$0
Woodside	$3,663,677	$366,368	$1,099,103	$1,831,839
Unincorporated	$677,924,056	$67,792,406	$203,377,217	$338,962,028
Total	$45,501,732,033	**$4,550,173,203**	**$13,650,519,610**	**$22,750,866,017**

a. These estimates are derived from the planning scenario event, not for all possible dam failure risk in the County.

Note: Values are accurate only for comparison among results in this plan. See Section 2, Chapter 1 of this volume for a discussion of data limitations.

3.5.3 Critical Facilities

All critical facilities within dam inundation areas are vulnerable to the dam failure hazard. Transportation routes—including all roads, railroads, and bridges in the path of a dam inundation—are vulnerable and could be wiped out, creating isolation issues. Critical facilities most vulnerable are those already in poor condition and thus not able to withstand a large water surge. Utilities such as overhead power lines, cable, and phone lines could also be vulnerable. Loss of these utilities could create additional isolation issues within the inundation areas.

3.5.4 Environment

Dam failure poses a number of risks to the environment. The inundation could introduce foreign elements into local waterways, resulting in destruction of downstream habitat and detrimental effects on many species of animals. Releases of hazardous materials pose the most significant threat to the environment within an inundation area. Fixed site facilities within the inundation area may contain highly flammable or highly toxic materials, and tanks may rupture, releasing the material into the environment. Depending on characteristics of a hazardous material, affected environments may take years to recover.

Extent of vulnerability of the environment is the same as exposure of the environment.

3.5.5 Economic Impact

Dam failure can cause severe downstream flooding and may transport large volumes of sediment and debris, depending on the magnitude of the event, resulting in direct repair costs for the County or associated jurisdictions to manage the debris. Widespread damage to buildings and infrastructure affected by an event would require large monetary expenditures for repair of those. Beyond costs stemming from physical damage, closures of businesses may be necessary while flood waters retreat and the area awaits resumption of utilities services.

3.6 Future Trends in Development

Land use within the planning area will conform to general plans adopted under California's General Planning Law. The safety elements of these general plans establish standards and plans for protection of the community from hazards. Dam failure is currently addressed as part of the flooding hazard in jurisdictional safety elements. Municipal planning partners have established comprehensive policies regarding sound land use within identified flood hazard areas. Flood-related policies in the general plans will help reduce risk associated with the dam failure hazard to all future development within the planning area.

TABLE 3-9. DAM FAILURE FUTURE LAND USE

	Agriculture/Resource Extraction		Commercial		Education		Industrial		Mixed Use		Other/Unknown		Parks/Open Space		Residential		Water		Total
Jurisdiction	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)
ATHERTON	0.0	0.00%	0.0	0.00%	11.2	5.71%	0.0	0.00%	0.0	0.00%	2.1	1.06%	6.4	3.27%	175.9	89.96%	0.0	0.00%	195.6
BELMONT	0.0	0.00%	0.8	0.39%	1.2	0.63%	0.0	0.00%	66.2	34.41%	34.5	17.95%	22.2	11.53%	67.5	35.09%	0.0	0.00%	192.3
BRISBANE	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
BURLINGAME	0.0	0.00%	7.4	10.48%	0.0	0.00%	0.0	0.00%	0.0	0.00%	26.1	37.02%	2.2	3.18%	34.8	49.32%	0.0	0.00%	70.5
COLMA	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
DALY CITY	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
EAST PALO ALTO	0.0	0.00%	0.7	1.53%	0.1	0.32%	0.0	0.00%	0.0	0.00%	18.4	41.85%	15.6	35.42%	9.2	20.87%	0.0	0.00%	44.1
FOSTER CITY	0.0	0.00%	455.1	16.42%	87.6	3.16%	54.8	1.98%	13.1	0.47%	90.1	3.25%	280.0	10.10%	1,558.4	56.23%	232.3	8.38%	2,771.4
HALF MOON BAY	14.7	5.95%	34.4	13.96%	7.5	3.05%	3.6	1.46%	0.0	0.00%	85.5	34.68%	75.4	30.59%	25.4	10.31%	0.0	0.00%	246.4
HILLSBOROUGH	0.0	0.00%	0.0	0.00%	7.1	1.53%	0.0	0.00%	0.0	0.00%	61.2	13.25%	25.2	5.46%	368.3	79.76%	0.0	0.00%	461.7
MENLO PARK	0.0	0.00%	82.1	14.47%	108.2	19.07%	0.0	0.00%	0.0	0.00%	12.6	2.22%	26.6	4.69%	338.0	59.55%	0.0	0.00%	567.5
MILLBRAE	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
PACIFICA	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
PORTOLA VALLEY	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
REDWOOD CITY	0.0	0.00%	40.3	4.68%	41.9	4.87%	0.0	0.00%	12.7	1.48%	298.7	34.73%	114.5	13.31%	352.0	40.93%	0.0	0.00%	860.0
SAN BRUNO	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
SAN CARLOS	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
SAN MATEO	0.0	0.00%	571.8	11.84%	295.9	6.13%	21.2	0.44%	178.4	3.69%	497.8	10.31%	615.0	12.73%	2,649.7	54.86%	0.1	0.00%	4,829.8
SOUTH SAN FRANCISCO	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
WOODSIDE	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	17.3	100.00%	0.0	0.00%	17.3
UNINCORPORATED	309.6	22.89%	0.0	0.00%	0.1	0.01%	0.0	0.00%	356.2	26.33%	90.9	6.72%	478.7	35.38%	117.3	8.67%	0.0	0.00%	1,352.8
Total	324.3	2.79%	1,192.4	10.27%	560.9	4.83%	79.6	0.69%	626.5	5.40%	1,217.8	10.49%	1,661.8	14.31%	5,713.7	49.22%	232.4	2.00%	11,609.4

3.7 Scenario

An earthquake in the region could lead to liquefaction of soils around a dam, without warning during any time of the day. A human-caused incident such as a terrorist attack also could trigger a catastrophic failure of a dam that would impact the planning area. Failure of a high hazard dam in the County would likely result in losses of life, roadways, structures, and property, and exert severe impacts on the local economy. While the possibility of failure is remote, results would be devastating. The worst-case scenario would involve failure of the Lower Crystal Springs Dam. In addition to severe property damage and potential injuries, loss of water from the Crystal Springs Reservoir could lead to reduction in available potable water for the County and Bay Area. Coupled with the ongoing drought throughout the State and already low water supply availability, this damage could lead to significant water shortages.

While probability of dam failure is very low, probability of flooding associated with changes in dam operational parameters in response to climate change is higher. Dam designs and operations are developed based on hydrographs from historical records. If these hydrographs change significantly over time due to effects of climate change, current dam designs and operations may no longer be valid. Specified release rates and impound thresholds may have to be changed, which could result in increased discharges downstream of these facilities, thus increasing probability and severity of flooding.

3.8 Issues

The most significant issues associated with dam failure involve properties and populations within inundation zones. Flooding as a result of a dam failure would significantly impact these areas. Warning time for dam failure plausibly would be limited. Moreover, dam failure is frequently associated with other natural hazard events such as earthquakes, landslides, or severe weather, which limits predictability of dam failure and compounds the hazard. Important issues associated with dam failure hazards are as follows:

- USACE NID and DSOD dam lists are inconsistent regarding the number of dams in San Mateo County. These lists should be evaluated and corrected where needed. Currently, NID lists 24 dams within the County, while DSOD has record of 21.
- Federally regulated dams are adequately overseen, and emergency action plans for public notification in the unlikely event of failures of these are sophisticated. However, protocols for notification of downstream citizens of imminent failure must be tied to local emergency response planning.
- Mapping for federally regulated dams is already required and available; however, mapping for non-federally regulated dams that estimates inundation depths is needed to better assess risks associated with failure of these dams. Moreover, although mapping is required for federally regulated dams, development downstream of dams and upgrades to older dams may have altered inundation areas; however, these inundation maps may not have been updated for significant periods of time. Encouraging property owners of dams to update EAPs and inundation maps will ensure availability of the most accurate data to assist emergency planners and local officials.

- Most dam failure mapping required at federal levels requires determination of the probable maximum flood. While the probable maximum flood represents a worst-case scenario, it is generally the event with the lowest probability of occurrence. Mapping of dam failure scenarios for non-federal-regulated dams that are less extreme than the probable maximum flood, but have a higher probability of occurrence, can be valuable to emergency managers and community officials downstream of these facilities. This type of mapping can illustrate areas potentially impacted by more frequent events to support emergency response and preparedness actions.
- The concept of residual risk associated with structural flood control projects should be considered in designs of capital projects and applications of land use regulations.
- Addressing security concerns and the need to inform the public of risk associated with dam failure are challenges for public officials.
- Limited financial resources for dam maintenance during economic downturns result in decreased attention to dam structure operational integrity, because available funding is often directed to more urgent needs. This could increase potential for maintenance failures.
- Dam failure inundation areas are often not considered special flood hazard areas under the National Flood Insurance Program, so flood insurance coverage in these areas is not common.

Chapter 4. Drought

4.1 General Background

Most of California's precipitation comes from storms moving across the Pacific Ocean. The path followed by the storms is determined by the position of an atmospheric high pressure belt that normally shifts southward during the winter, allowing low pressure systems to move into the State. On average, 75 percent of California's annual precipitation occurs between November and March, with 50 percent occurring between December and February. A persistent Pacific high pressure zone over California in mid-winter signals a tendency for a dry water year.

DEFINITIONS

Drought—Cumulative impacts of several dry years on water users, which can include deficiencies in surface and subsurface water supplies, and effects on health, wellbeing, and quality of life.

Hydrological Drought— Deficiencies in surface and subsurface water supplies.

Socioeconomic Drought— Drought impacts on health, wellbeing, and quality of life.

A typical water year produces about 100 inches of rainfall over the North Coast, 50 inches of precipitation (combination of rain and snow) over the Northern Sierra, 18 inches in the Sacramento area, and 15 inches in the Los Angeles area. In extremely dry years, these annual totals can fall to as little as one half, or even one third of these amounts.

Determination of when drought begins requires knowledge of drought impacts on water users, including supplies available to local water users and stored water available to them in surface reservoirs or groundwater basins. Different local water agencies have different criteria for defining drought conditions within their jurisdictions. Some agencies issue drought watch or drought warning announcements to their customers. Determinations of regional or statewide drought conditions are usually based on a combination of hydrologic and water supply factors (CA Department of Water Resources [DWR] 2016). The California water code does not include a statutory definition of drought; however, analysis of text in the code indicates that legal matters most frequently focus on drought conditions during times of water shortages (*California Code of Regulations* [CCR] 2016).

The Sierra Nevada snowpack serves as the primary agent for replenishing water in the San Francisco Bay area, including San Mateo County, and for much of the State of California. A reduction in spring snowpack runoff, whether due to drier winters or to increasing temperatures leading to more rain than snow, can increase risk of summer or fall water shortages throughout the region (City and County of San Francisco 2014).

4.1.1 Water Supply Strategy

San Mateo County receives approximately 92 percent of its water through the regional Hetch Hetchy Water System, with the remainder of the County's water supply coming from surface, ground, and recycled water (San Mateo County Sheriff 2015). The water system was so-named because 85 percent of the water supply comes from the Sierra Nevada snowmelt stored in the Hetch Hetchy reservoir along the Tuolumne River in

Yosemite National Park; the remaining 15 percent of water comes from runoff in Alameda and Peninsula watersheds (Bay Area Water Supply Conservation Agency [BAWSCA] 2016)
BAWSCA is the main water provider for much of the Bay Area, allowing San Mateo County (through its cities), other jurisdictions, water districts, and private utilities to coordinate in order to ensure continual water supply necessary to maintain health, safety, and economic wellbeing of residents, businesses, and community organizations. BAWSCA agencies manage two-thirds of water consumption from the Hetch Hetchy Water System, providing water to 2.4 million people in San Francisco, Santa Clara, Alameda, and San Mateo Counties. In San Mateo County, BAWSCA services Brisbane, Burlingame, Daly City, East Palo Alto, Hillsborough, Menlo Park, Millbrae, Redwood City, San Bruno, Coastside County Water District, Estero Municipal Improvement District, Guadalupe Valley Municipal Improvement District, Mid-Peninsula Water District, Westborough Water District, and California Water Service Company (private utility) (BAWSCA 2016).

BAWSCA developed a reliable, two-phase, long-term water supply strategy for customers in San Mateo County and throughout the Bay Area. Purposes of this comprehensive strategy are as follows: (1) quantifying water supply reliability needs of BAWSCA member agencies through 2040, (2) identifying water supply management programs or programs that can be developed to meet those regional water reliability needs, and (3) developing an implementation plan for the water supply strategy.

This water supply strategy recognized that drought year shortfalls could be significant, although determining that normal year water supply would be adequate through at least 2014. Dry years could result in system-wide cutbacks of up to 20 percent, but 10 to 15 percent is the more consistent standard. BAWSCA also noted impacts of water shortages would be regional and could lead to secondary detrimental economic effects. To address this concern, BAWSCA focused on (1) identifying options for filling all or portions of the drought year supply shortfall, and (2) investigating and potentially implementing actions that seem most beneficial.

In addition to the Long-Term Reliable Water Supply Strategy, BAWSCA also developed a Water Conservation Implementation Plan (WCIP). The WCIP focuses on the following objectives:

- Assist BACSWA member agencies in evaluating potential water savings and cost-effectiveness associated with implementing additional water conservation measures, beyond their commitments in 2004.
- Determine potential water savings in 2018 and 2030 based on a selected range of new conservation measures and the 2004 water conservation commitments.
- Determine BAWSCA’s role in helping member agencies achieve individual water conservation goals.
- Develop a coordinated regional plan for water conservation implementation measures to serve as a guideline for member agencies (BAWSCA 2009).

While BAWSCA is the primary water service agent in the County, it is not the only option for residents and businesses. The County Public Works Department operates County Service Area (CSA) No. 7 and CSA No. 11. These service areas provide potable water to approximately 70 customers in the La Honda community and 90 customers in the Pescadero community, respectively. CSA 7 also supplies two County facilities—Camp Glenwood Boys Ranch and Sam McDonald Park (San Mateo County 2016).

Moreover, some County residents have domestic wells on their property. The South Central Regional Office of California DWR monitors wells for San Mateo County to help protect groundwater quality (CA DWR 2016). As of 2013, San Mateo County had 4,898 wells within its limits. Of these wells, 1,372 were for domestic use, 462 for irrigation, 36 for public supply, and the rest for monitoring, industrial, or other uses (CA DWR 2013).

4.1.2 Water Supply Infrastructure

The Hetch Hetchy Water System (source of much of the water consumed in the Bay Area) was approved in 1913 under the Raker Act, which allowed use of federal lands in the Sierra Nevada Mountains to build that water system. The water system was constructed by San Francisco over the next 20 years, with first delivery of water in 1934. Although the system is owned by San Francisco, it was designed from the beginning to serve as a regional water supply system (BAWSCA 2016). Figure 4-1 shows the Hetch Hetchy Water System.

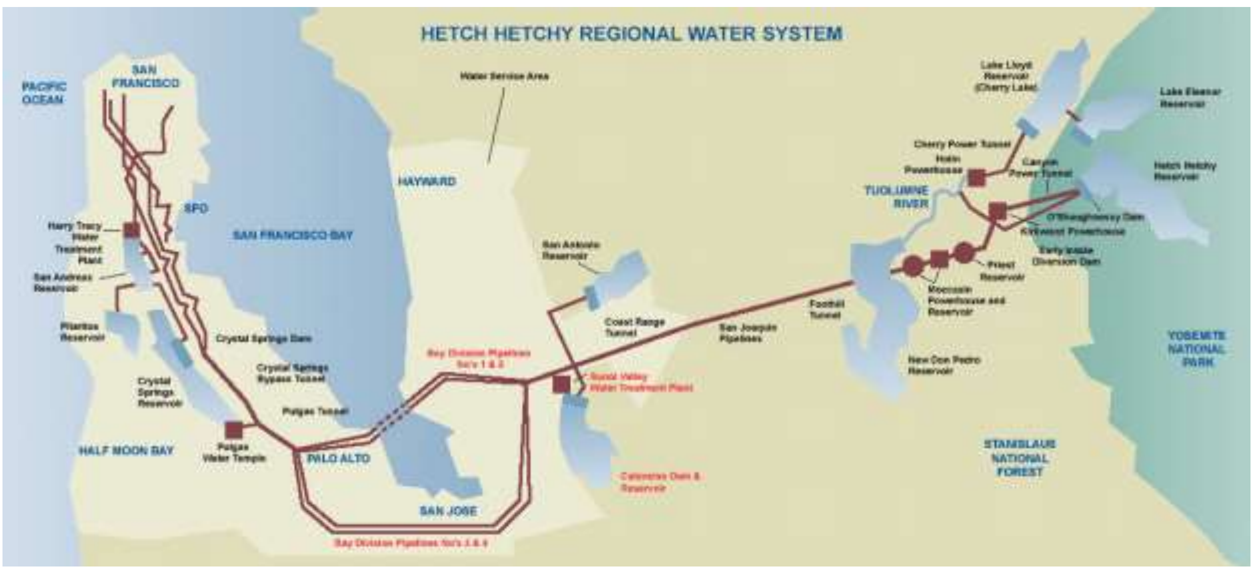


FIGURE 4-1. HETCH HETCHY WATER SYSTEM

In May 2002, the San Francisco Public Utilities Commission (SFPUC) adopted a $2.9 billion capital improvement plan (CIP) to overhaul and enhance the water system. Need for such an overhaul had been recognized after the Loma Prieta earthquake in 1989 and drought in the 1990s. Much of the water supply system is 75 to 100 years old and does not meet modern seismic codes. Major pipelines cross earthquake faults, and the U.S. Geological Survey (USGS) has estimated a 63 percent probability of occurrence of an earthquake of magnitude 6.7 within the next 30 years. A 2000 SFPUC study found that a major earthquake could cripple the water supply system for up to 20-30 days or longer. SFPUC has highlighted nine priority projects in the CIP for implementation, completion of which should help ensure relative continuity of operations of the water supply system following a large seismic event (BAWSCA 2016).

San Mateo County maintains the infrastructure for CSA 7 and CSA 11, the two local water systems within its borders. CSA 7 includes an intake and pump in Alpine Creek, a water treatment plan, a 500,000-gallon storage tank, and a distribution system. The treatment plant was constructed in the early 1990s, but parts of the distribution system date back to the 1920s. CSA 11 was established in 1988 and consists of two wells, one

135,000-gallon distribution tank, and a distribution system. Water flows from the distribution tank through the water system under force of gravity; no distribution pumps are required. CSA 11 was determined necessary after relatively high concentrations of nitrate and other naturally occurring salts were found in local groundwater sources, raising concern that continued use of previously utilized small domestic wells could lead to unintended health consequences (San Mateo County 2016).

4.1.3 Defined Drought Levels

Neither San Mateo County nor BAWSCA have defined "drought level." County and regional drought response is determined case by case, and response priorities are typically based on imminence of potential water shortages. BAWSCA has developed both Tier 1 and Tier 2 Drought Implementation Plans (DRIP); however, these plans do not specify specific trigger levels. The Tier 1 DRIP is for SFPUC and BAWSCA, while the Tier 2 DRIP is for BAWSCA member agencies. The Tier 2 DRIP includes calculations to determine water allocations for member agencies during water shortages. Drought levels defined in the California Drought Contingency Plan (listed as follows) can serve as a reference for County and stakeholder agencies when determining need for response:

- **Level 1 – Abnormally Dry:** The State's precipitation, snowpack, or runoff is lower than normal, or reservoir levels are below average. Conservation measures should be increased voluntarily, to help manage the State's current water supply.
- **Level 2 – First Stage Drought:** The State's precipitation, snowpack, or runoff is lower than normal, or reservoir levels are below average. Conservation measures should be increased voluntarily, to help manage the State's current water supply.
- **Level 3 – Severe Drought:** Reservoirs are low; precipitation, snowpack, and runoff are all well-below normal and forecasted to remain so. Mandatory conservation may need to be enacted in communities that do not have adequate water supplies.
- **Level 4 – Extreme Drought:** Reservoirs are low; precipitation, snowpack, and runoff are all well-below normal and forecasted to remain so. Mandatory conservation may need to be enacted in communities that do not have adequate water supplies.
- **Level 5 – Exceptional Drought:** Extremely dry conditions persist across the State. Water safety, supply, and quality are all at risk due to shortages. All sectors of water usage are facing hardship as a result of inadequate supply and dry conditions.
- **Drought Recovery:** Current Water Conditions throughout the State are at normal levels. No drastic water conservation measures are necessary, although water conservation should always be practiced. The State's reservoirs are full or nearly full, and runoff across the State is at normal levels (California 2010).

4.2 Hazard Profile

Droughts originate from a deficiency of precipitation resulting from an unusual weather pattern. If the weather pattern lasts a short time (a few weeks or a couple months), the drought is considered short-term. If the weather pattern becomes entrenched and precipitation deficits last for several months or years, the drought is considered a long-term drought. A region may undergo a long-term circulation pattern that produces drought, with short-term changes in this long-term pattern that result in short-term wet spells. Conversely, a long-term wet circulation pattern may be interrupted by short-term weather spells that result in short-term drought. Droughts typically occur after 2 or 3 years of below-average rainfall during the period from November to March, when about 75 percent of California's average annual precipitation falls. December, January, and February are when approximately 50 percent of rainfall occurs in California.

4.2.1 Past Events

State of California

California DWR has state hydrologic data from as far back as the early 1900s (http://www.water.ca.gov/waterconditions/). These data indicate occurrences of multi-year droughts from 1912 to 1913, 1918 to 1920, and 1922 to 1924. The 2010 Association of Bay Area Governments (ABAG) Local Hazard Mitigation Plan also identified several droughts in San Mateo County. Since the multi-year drought in 1922-1924, four prolonged periods of drought have occurred in California, and three noteworthy droughts (two short-term and one long-term) have impacted San Mateo County:

- **1928 to 1934 Drought**—This drought established criteria for designing supply and yield of many large Northern California reservoirs. California DWR estimates that this drought caused the driest period in the Sacramento River watershed since approximately the mid-1550s.
- **1976 to 1977 Drought**—California had one of its most severe droughts due to lack of rainfall during the winters of 1976 and 1977. 1977 was the driest period on record in California, with the previous winter recorded as the fourth driest in California's hydrological history. The cumulative impact led to widespread water shortages and severe water conservation measures throughout the State. Only 37 percent of average Sacramento Valley runoff was received, with just 6.6 million acre-feet recorded. Over $2.6 billion in crop damage was recorded in 31 counties. A federal disaster declaration was declared in Placer County and surrounding counties.
- San Mateo County was included in the statewide drought declaration on March 26, 1976.
- **1987-1992 Drought**—California received precipitation well below average levels for four consecutive years. While the Central Coast was most affected by lack of rainfall and low runoff, the Sierra Nevadas in Northern California, as well as the Central Valley counties including Placer County, were also affected. During this drought, only 56 percent of average runoff for the Sacramento Valley was received, totaling just 10 million acre-feet. By February 1991, all 58 counties in California were suffering under drought conditions that affected urban, rural, and agricultural areas.
- **June 6, 2006 Drought**—San Mateo was part of a declared water management and fish shortage disaster in 2006. Klamuth River Basin Chinook salmon populations were extremely low due to ocean conditions, drought, water management, water quality, water flows, disease, and eliminated access to historical spawning habitat. This resulted in environmental, recreational, commercial, and economic impacts. Although this event is not technically a direct drought event, it has been included here because it was exacerbated by drought conditions.

- **February 27, 2009 Drought**—A drought declaration was declared statewide after a 3-year drought resulting from below-average rainfall, low snowmelt runoff, and the largest court-ordered water restriction in state history (at the time). The drought led to $300 million in agricultural revenue loss and potential long-term economic losses of $3 billion.
- **2012-2016 (Ongoing) Drought**—California's current drought has set several records for the State. From 2012 to 2014, it ranked as the driest three consecutive years for statewide precipitation. Calendar year 2014 set new climate records for statewide average temperatures and for record-low water allocations from State Water Project and federal Central Valley Project contractors. Calendar year 2013 set minimum annual precipitation records for many communities. The State has detailed executive orders and regulations concerning water conservation and management. Total impacts of the drought cannot be determined until after its conclusion.

San Mateo County has been impacted by current drought conditions across the State. Local news sources indicate significant effects on the southern coastline because many residents in this area rely on creeks and wells that have stopped flowing. Rural communities in the County have faced stringent limitations on bathing, using toilets, and washing items, and the many ranches and farms in the area have undergone significant economic downturns. More urban parts of the San Francisco Bay area, served by big water agencies, have also undergone limitations because of need to conserve water, but not to the extent imposed on rural residents (SFGate 2014).

Although El Niño-related storms in February 2014 brought precipitation to the region, levels of rain and snow did not provide the amount of water needed. As of March 2014, the Hetch Hetchy area had received only 34.7 percent of normal annual precipitation. Even with the February 2014 storms increasing snowpack levels by 10 percent, the snowpacks remained at only 32 percent of median April 1st snowpack conditions. Additionally, Bay Area watersheds had received only 33 percent of normal annual precipitation as of March 2014 (San Mateo County Sheriff 2015).

Responding particularly to the current drought, San Mateo County and its cities have implemented the following initiatives to maintain quantity and quality of their water resources in the County (San Mateo County 2016):

- San Mateo Countywide Water Pollution Program
- Groundwater Protection Program
- Land Use and Septic Wells Program
- Recreational Water Quality Program
- Small Drinking Water Systems Program
- Municipal Facilities Water Conservation Efforts.

4.2.2 Location

The National Oceanic and Atmospheric Administration (NOAA) has developed several indices to measure and map impacts, severities, extents, and locations of droughts:

- The **Palmer Crop Moisture** Index measures short-term drought on a weekly scale and is used to quantify drought's impacts on agriculture during the growing season. Figure 4-2 shows this index for the week ending January 30, 2016.
- The **Palmer Z Index** measures short-term drought on a monthly scale. Figure 4-3 shows this index for December 2015.
- The **Palmer Drought Severity Index (PDSI)** measures duration and intensity of long-term, drought-inducing circulation patterns. Long-term drought is cumulative, so intensity of drought during a given month depends on current weather patterns plus cumulative patterns over previous months. Weather patterns can change quickly from a long-term drought pattern to a long-term wet pattern, and the PDSI can respond fairly rapidly. Figure 4-4 shows this index for December 2015.
- Hydrological impacts of drought (e.g., reservoir levels, groundwater levels, etc.) take longer to develop, and recovery from these impacts can take even longer. The **Palmer Hydrological Drought Index (PHDI)**, another long-term index, was developed to quantify hydrological effects. The PHDI responds more slowly to changing conditions than the PDSI. Figure 4-5 shows this index for December 2015.
- While the Palmer indices consider precipitation, evapotranspiration and runoff, the **Standardized Precipitation Index (SPI)** considers only precipitation. In the SPI, an index of zero indicates the median precipitation amount; the index is negative for drought and positive for wet conditions. The SPI is computed for time scales ranging from 1 to 24 months. Figure 4-6 shows the 24-month SPI map for January 2013 through December 2015.

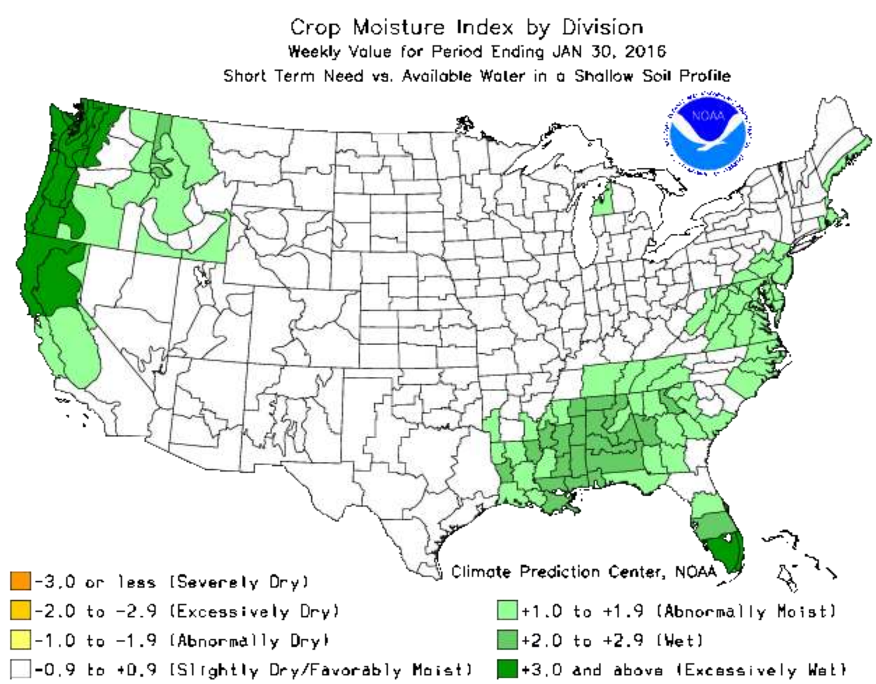


FIGURE 4-2. CROP MOISTURE INDEX FOR WEEK ENDING JANUARY 30, 2016

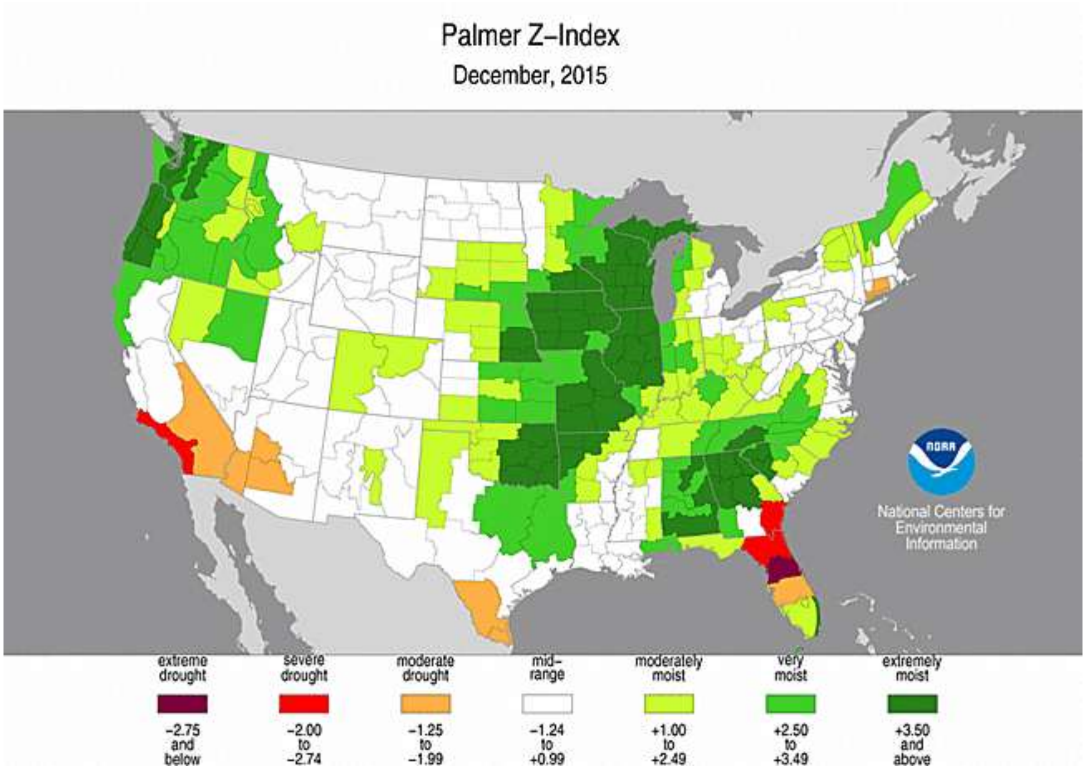


FIGURE 4-3. PALMER Z INDEX SHORT-TERM DROUGHT CONDITIONS (DECEMBER 9, 2015)

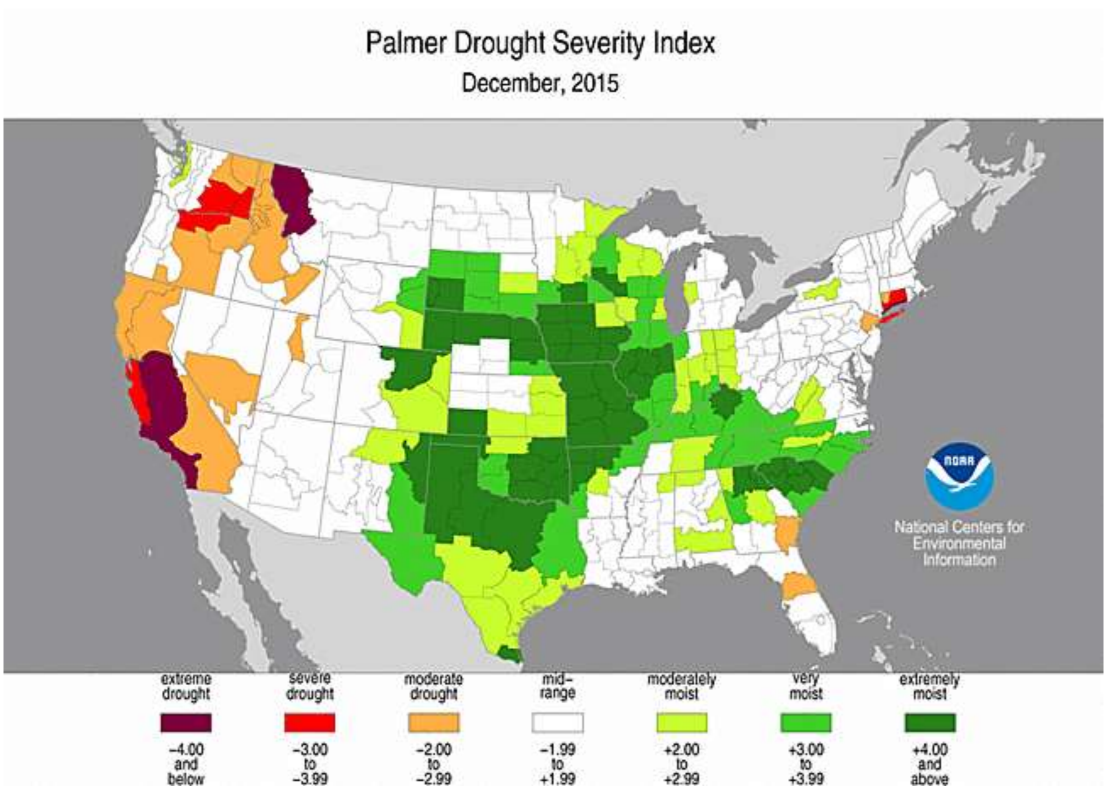


FIGURE 4-4. PALMER DROUGHT SEVERITY INDEX (DECEMBER 2015)

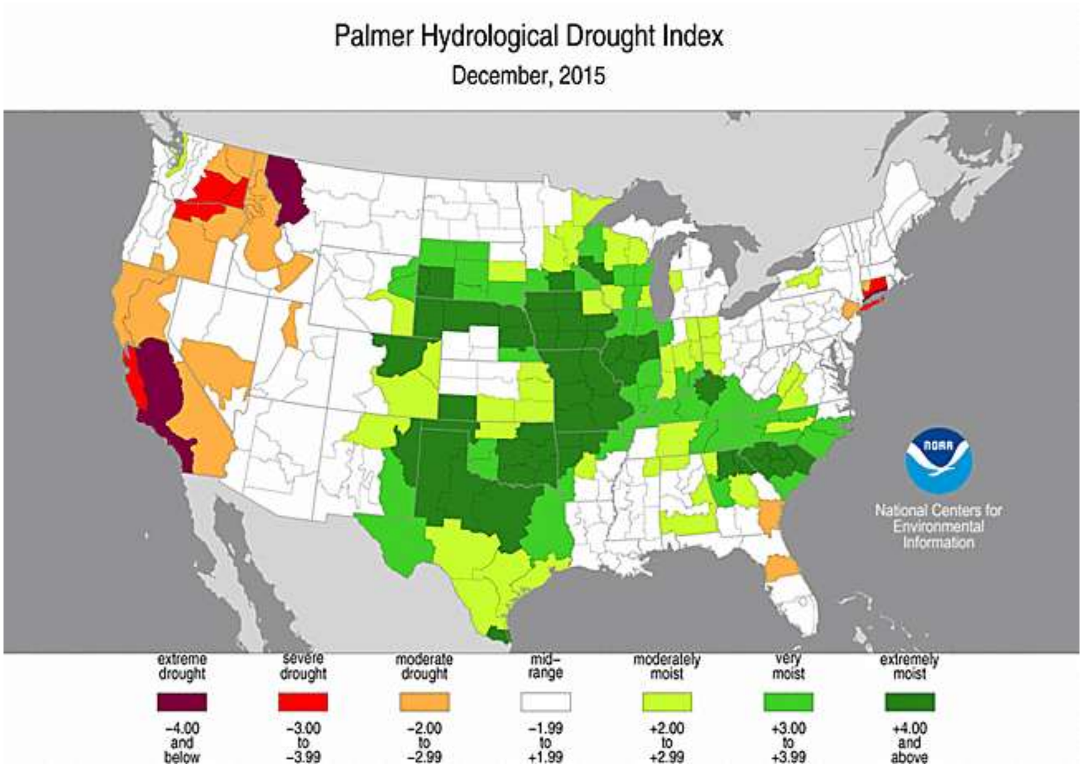


FIGURE 4-5. PALMER HYDROLOGICAL DROUGHT INDEX LONG-TERM HYDROLOGIC CONDITIONS (DECEMBER 2015)

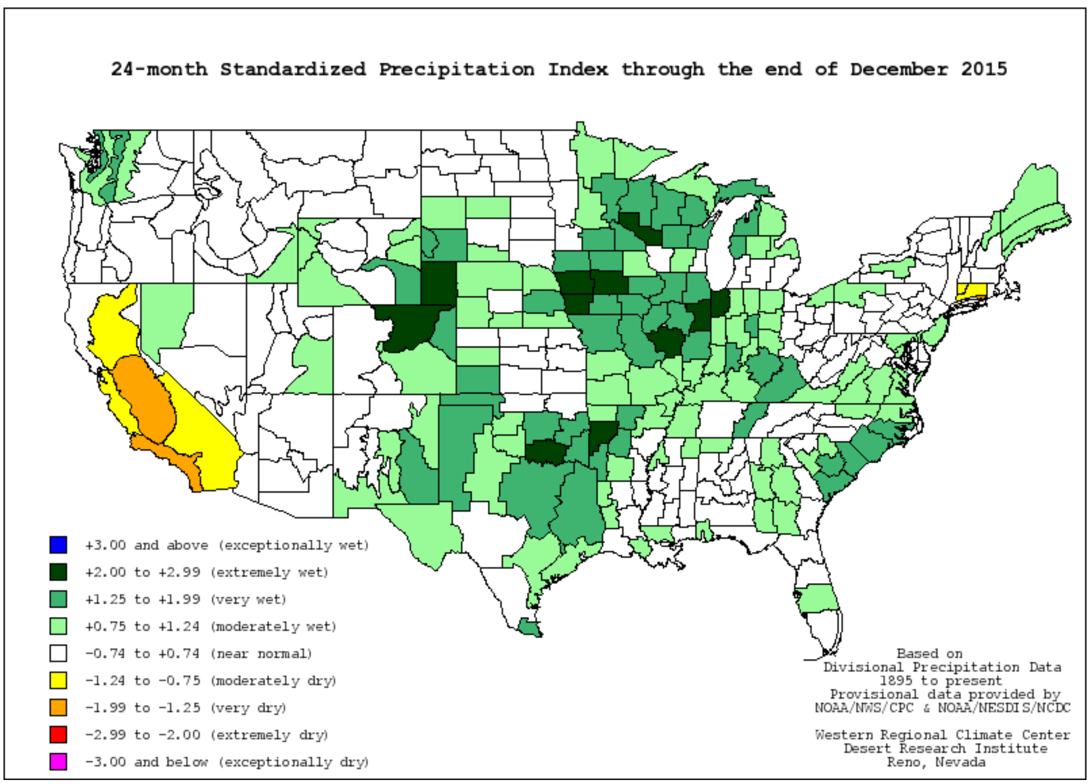


FIGURE 4-6. 24-MONTH STANDARDIZED PRECIPITATION INDEX (JANUARY 2013 – DECEMBER 2015)

4.2.3 Frequency

Historical drought data regarding the San Mateo County region indicate four significant droughts within the last 40 years (the 1987-1992 drought was not noted as directly affecting San Mateo County, and is not included in this count). Based on risk factors and past occurrences, droughts likely will continue to occur in San Mateo County. Moreover, as temperatures increase, probability of future droughts will likely increase as well. Therefore, droughts likely will occur in California and San Mateo County at varied severities in the future, even after conclusion of this current drought.

4.2.4 Severity

Drought can exert widespread impacts on the environment and the economy, although not typically resulting in direct loss of life or damage to property, as do other natural disasters. Nationwide, drought primarily affects the sectors of agriculture, transportation, recreation and tourism, forestry, and energy. Social and environmental impacts are also significant, although determining exact costs of these is difficult. The National Drought Mitigation Center describes likely drought impacts within three categories:

- **Agricultural**—Drought threatens crops that rely on natural precipitation.
- **Water supply**—Drought threatens supplies of water for irrigated crops and for communities.
- **Fire hazard**—Drought increases the threat of wildfires from dry conditions in forest and rangelands.

Severity of a drought depends on degree of moisture deficiency, duration, and size and location of the affected area. The longer the duration of the drought and the larger the area impacted, the more severe the potential impacts. When measuring severity of droughts, analysts typically look at economic impacts. All people could pay more for water if utilities increase rates due to shortages. Agricultural impacts can result in loss of work for farm workers and those in related food processing jobs. Other water- or electricity-dependent industries are commonly forced to shut down all or a portion of their facilities, resulting in further layoffs. A drought can harm recreational companies that use water (e.g., swimming pools, water parks, and river rafting companies), as well as landscape and nursery businesses. Specific impacts of drought on County residents and businesses are described further in the Vulnerability Analysis section of this profile.

Drought generally does not affect groundwater sources as quickly as surface water supplies, but groundwater supplies generally take longer to recover. Reduced precipitation during a drought means that groundwater supplies are not replenished at a normal rate. This can lead to reduction in groundwater levels and problems such as reduced pumping capacity or wells going dry. Shallow wells are more susceptible than deep wells to a reduction in groundwater levels and other problems previously described. Reduced replenishment of groundwater affects streams. Much of the flow in streams comes from groundwater, especially during the summer when precipitation is less and after snowmelt ends. Reduced groundwater levels mean that even less water will enter streams when steam flows are lowest. In San Mateo County, 67 percent of agriculture water supply (2,000 acre-feet) comes from groundwater, while 8 percent of urban use needs (8,500 acre-feet) comes from groundwater. In total, 9 percent (10,500 acre-feet) of the County's water use comes from groundwater resources (DWR 2013).

Significant depletion of groundwater supplies resulting from a drought, excessive groundwater pumping, or a combination of the two can lead to an unanticipated side effect and secondary hazard—subsidence. Without groundwater aquifers to support the weight of the ground, land collapses downward. The greatest cause of subsidence in California is compaction of aquifer systems. Although this is typically due to groundwater pumping and not drought, drought also magnifies need for greater groundwater pumping as freshwater sources elsewhere are not as readily available. This subsidence is significant because it is typically irreversible. It may also cause wetlands to change size and shape, migrate to lower elevations, or disappear entirely; rivers may change course; and erosion/deposition patterns may change (CA Water Science Center 2016). Although land sinkage due to low groundwater levels has not yet occurred in San Mateo County, this subsidence is a significant concern in parts of the State, most notably the San Joaquin Valley and Central Valley. Part of Central Valley, southwest of Mendota, underwent more than 29 feet of subsidence between 1925 and 1977 (CA Water Science Center 2015).

4.2.5 Warning Time

Droughts are climatic patterns that occur over long periods of time. Only generalized warning can occur due to numerous variables that scientists have not pieced together well enough to make accurate and precise predictions.

Empirical studies over the past century have shown that meteorological drought is never the result of a single cause. It is the result of many, often synergistic causes that include global weather patterns which produce persistent, upper-level, high-pressure systems along the West Coast with warm, dry air—resulting in less precipitation.

Scientists currently do not know how to predict drought more than a month in advance for most locations. Predicting drought depends on ability to forecast precipitation and temperature. Anomalies of precipitation and temperature may last from several months to several decades; California is currently undergoing a several-year-long drought, while other areas in the United States may undergo droughts during periods as short as 1 or 2 months. How long droughts last depends on interactions between the atmosphere and the oceans, soil moisture and land surface processes, topography, internal dynamics, and accumulated influence of weather systems on the global scale.

4.3 Secondary Hazards

The secondary hazard most commonly associated with drought is wildfire. A prolonged lack of precipitation dries out vegetation, which becomes increasingly susceptible to ignition as the duration of the drought extends. Millions of board feet of timber have been lost, and in many cases erosion occurred that seriously damaged aquatic life, irrigation, and power production as a result of heavy silting of streams, reservoirs, and rivers.

Drought also is often accompanied by extreme heat, exposing people to risks of sunstroke, heat cramps, and heat exhaustion. Pets and livestock are also vulnerable to heat-related injuries. Crops can be vulnerable as well.

Environmental losses result from damage to plants, animals, wildlife habitat, and air and water quality; forest and range fires; degradation of landscape quality; loss of biodiversity; and soil erosion. Some effects are short-term and conditions quickly return to normal following the end of the drought. Other environmental effects linger for some time or may even become permanent. Wildlife habitat, for example, may be degraded through loss of wetlands, lakes, and vegetation. However, many species will eventually recover from this temporary aberration. Degradation of landscape quality, including increased soil erosion, may lead to a more permanent loss of biological productivity.

Drought-induced subsidence is also a potential secondary hazard, although not as common as wildfire or extreme heat. If subsidence does occur, however, it can significantly impact the local environment, floodplain/wetlands, and water supply. Although environmental losses are difficult to quantify, growing public awareness and concern for environmental quality have forced public officials to focus greater attention and resources on these effects.

4.4 Exposure

All people, property, and environments within San Mateo County would be exposed to some degree to effects of moderate to extreme drought conditions.

4.5 Vulnerability

Drought produces a complex web of impacts that span many sectors of the economy and reach well beyond the area undergoing physical drought. This complexity exists because water is integral to ability to produce goods and provide services. Drought can affect a wide range of economic, environmental, and social activities. Vulnerability of an activity to effects of drought usually depends on its water demand, how the demand is met, and what water supplies are available to meet the demand.

California’s 2005 Water Plan and subsequent updates indicate that water demand in the State will increase through 2030. Although the Department of Water Resources predicts a modest decrease in agricultural water use, the agency anticipates that urban water use will increase by 1.5 to 5.8 million acre-feet per year (CA DWR 2005). The 2013 update to the Water Plan explores measures, benchmarks, and successes in increasing agricultural and urban water use efficiency. Between 1996 and 2005, average amount of water use in the San Francisco Bay area (including San Mateo County) was 155 gallons per capita per day (gpcd); the statewide average was 198 gpcd. The State established a 20 percent water use reduction goal to be achieved by 2020. Although regional estimates were not available, state average for water use reduction was at 16 percent (or 166 gpcd) by 2010 (CA DWR 2013).

4.5.1 Population

The entire population of San Mateo County is vulnerable to drought events. Drought conditions can affect people’s health and safety, including health problems related to low water flows and poor water quality, and health problems related to dust. Droughts can also lead to loss of human life (National Drought Mitigation Center [NDMC] 2014). Other possible impacts on health from drought include increased recreational risks; effects on air quality; diminished living conditions related to energy, air quality, and sanitation and hygiene; compromised food and nutrition; and increased incidence of illness and disease. Health implications of drought are numerous. Some drought-related health effects are short-term while others can be long-term (Centers for Disease Control and Prevention [CDC] 2012).

As previously stated, drought conditions can cause shortages of water for human consumption. Droughts can also lead to reduced local firefighting capabilities. Despite these concerns, the County of San Mateo, BAWSCA, regional water purveyors, and other regional stakeholders have devoted considerable time and effort to protect life, safety, and health during times of consecutive dry years, such as the current drought situation. Provisions and measures have been taken to analyze and account for anticipated water shortages. With coordination from its cities, the County has the ability to minimize and reduce impacts on residents and water consumers in San Mateo County. No significant life or health effects are anticipated as a result of drought in San Mateo County.

4.5.2 Property

No structures will be directly affected by drought conditions in San Mateo County, although some structures may become vulnerable to wildfires, which are more likely following years of drought. Risk to life and property is greatest where forested areas adjoin urbanized areas (high-density residential, commercial, and industrial)—also known as the wildfire urban interface (WUI). Therefore, all assets in and adjacent to the WUI zone, including population, structures, critical facilities, lifelines, and businesses, are considered vulnerable to wildfire. Specific vulnerability regarding wildfire is addressed in Chapter 10.

4.5.3 Critical Facilities

Critical facilities as defined for this Plan will continue to be operational during a drought. Critical facility elements such as landscaping may not be maintained due to limited resources, but risk to the County's critical facilities inventory will be largely aesthetic. For example, when water conservation measures are in place, landscaped areas will not be watered and may die. These aesthetic impacts are not considered significant. Additionally, where possible, the County Office of Sustainability engages in other water conservation measures, such as installation of water conserving fixtures in its municipal facilities (San Mateo County 2016).

4.5.4 Environment

Environmental losses from drought are associated with damage to plants, animals, wildlife habitat, and air and water quality; forest and range fires; degradation of landscape quality; loss of biodiversity; and soil erosion. Some of the effects are short-term and conditions quickly return to normal following the end of the drought. Other environmental effects linger for some time or may even become permanent. Wildlife habitat, for example, may be degraded through loss of wetlands, lakes, and vegetation. However, many species will eventually recover from this temporary aberration. Degradation of landscape quality, including increased soil erosion, may lead to more permanent loss of biological productivity. Although environmental losses are difficult to quantify, growing public awareness and concern for environmental quality has forced public officials to focus greater attention and resources on these effects.

4.5.5 Economic Impact

Drought causes the most significant economic impacts on industries that use water or depend on water for their business, most notably, agriculture and related sectors (forestry, fisheries, and waterborne activities). In addition to losses in yields in crop and livestock production, drought is associated with increased insect infestations, plant diseases, and wind erosion. Drought can lead to other losses because so many sectors are affected—losses that include reduced income for farmers and reduced business for retailers and others who provide goods and services to farmers. This leads to unemployment, increased credit risk for financial institutions, capital shortfalls, and loss of tax revenue. Prices for food, energy, and other products may also increase as supplies decrease.

When a drought occurs, the agricultural industry faces greatest risk of economic impact and damage. During droughts, crops do not mature, resulting in smaller crop yields, undernourishment of wildlife and livestock, decreases in land values, and ultimately financial losses to farmers (Federal Emergency Management Agency [FEMA] 1997). Agriculture production has been a significant and growing factor in San Mateo County, especially as agricultural effects on the economy start to normalize (after a period of decline). Agricultural production created $148.3 million in total economic output within the County ($47.3 million of which resulted from multiplier effects), and indirect and induced spending supported another 3,425 jobs in the County (San Mateo County 2012).

Evaluation of direct effects (i.e., excluding indirect and induced spending benefits) can occur based on information conveyed in U.S. Department of Agriculture (USDA) reports. According to the 2012 Census of Agriculture, 334 farms were present in San Mateo County, encompassing 48,160 acres of total farmland. The average farm size was 144 acres. San Mateo County farms had a total market value of products sold of $75.89 million ($73.137 million in crops including nursery and greenhouse; and $2.751 million in livestock, poultry, and related products), averaging $227,212 per farm. The Census indicated that 187 farm operators reported farming as their primary occupation (USDA 2012). Table 4-1 lists acreage of agricultural land exposed to the drought hazard.

TABLE 4-1. AGRICULTURE LAND IN SAN MATEO COUNTY IN 2012

Number of Farms	Land in Farms (acres)	Total Cropland (acres)	Harvested Cropland (acres)	Irrigated Land (acres)
334	48,160	8,477	4,033	2,822

Source: USDA 2012

In 2012, the top three categories of agricultural products sold in San Mateo County were (1) nursery, greenhouse, floriculture, and sod at $63.4 million; (2) vegetables, melons, potatoes, and sweet potatoes at $7,354 million; and (3) fruits, tree nuts, and berries at $2 million. San Mateo County was fifth highest ranked in both the State and the country in sales of Brussels sprouts; it was eighth highest ranked in the State for sales of cut Christmas trees; and eleventh highest ranked in the State for sales of floriculture and bedding crops (USDA 2012).

A prolonged drought can affect a community's economy significantly. Increased demand for water and electricity may result in shortages and higher costs of these resources. Industries that rely on water for business may be impacted the most (e.g., landscaping businesses). Although most businesses will still be operational, they may be affected aesthetically—especially the recreation and tourism industry. Moreover, droughts within another area could affect food supply/price of food for residents within the County.

4.6 Future Trends in Development

San Mateo County considers land use development, water supply and resource concerns, and other environmental and hazard protection needs in its Shared Vision 2025. The County seeks to ensure a "prosperous community" via encouragement of innovation in the local economy, creation of jobs, and expansion of community and educational opportunities; improved affordability; and closure of achievement gaps. It also seeks a "livable community" that grows near transit locations to promote affordable and interconnected communities. Under its "environmentally conscious community" category, San Mateo seeks to preserve natural resources through stewardship; reduction of carbon emissions; and more efficient uses of energy, water, and land. Performance measures and benchmarks are updated annually on the Shared Vision 2025 website (https://performance.smcgov.org/shared-vision), allowing residents to consistently monitor successes and outcomes of local initiatives.

Additionally, land use planning is also directed by general plans adopted under California's General Planning Law. Municipal planning partners are encouraged to establish General Plans with policies directing land use and dealing with issues of water supply and protection of water resources. These plans increase capability at the local municipal level to protect future development from impacts of drought. All planning partners reviewed their general plans under the capability assessments undertaken for this effort. Deficiencies revealed by these reviews can be identified as mitigation actions to increase capability to deal with future trends in development.

4.7 Scenario

Continuation or exacerbation of the current situation across the State of California (i.e., an extreme, multiyear drought associated with record-breaking rates of low precipitation and high temperatures) is the worst-case scenario for San Mateo County. Low precipitation and high temperatures increase possibility of wildfires throughout the County, increasing need for water when water is already in limited supply. Surrounding counties, also under drought conditions, could increase their demand for the water supplies on which San Mateo County also relies, triggering social and political conflicts. The higher density population of the Bay Area increases likelihood of such conflicts despite existence of the BACSWA DRIP. Additionally, the longer drought conditions last in or near the County, the greater the effect on the local economy; water-dependent industries especially will undergo setbacks.

4.8 Issues

The planning team has identified the following drought-related issues:

- Identification and development of alternative water supplies

- Development of local or regional (BACSWA) drought-level indicators to correspond with DRIP or other water conservation measures
- Monitoring of implementation and benefits of the Long-Term Reliable Water Supply Strategy projects, WCIP projects, and water system CIP upgrades
- Application of alternative techniques (groundwater recharge, water recycle, local capture and reuse, desalination, and transfer) to stabilize and offset Sierra Nevada snowpack water supply shortfalls
- Probability of increased drought frequencies and durations due to climate change
- Promotion of active water conservation even during non-drought periods
- Regular occurrence of drought or multiyear droughts that may limit the County's and residents' ability to successfully recover from or prepare for more occurrences—particularly noteworthy due to longevity of the current ongoing drought.

Chapter 5. Earthquake

5.1 General Background

An earthquake is the vibration of the earth's surface that follows a release of energy in the earth's crust. This energy can be generated by a sudden dislocation of segments of the crust or by a volcanic eruption. Most destructive quakes are caused by dislocations of the crust. The crust may first bend and then, when the stress exceeds the strength of the rocks, break and snap to a new position. Vibrations called "seismic waves" are generated in the process of breaking. These waves travel outward from the source of the earthquake along the surface and through the earth at varying speeds, depending on the material they move through.

Geologists have found that earthquakes tend to reoccur along faults, which are zones of weakness in the earth's crust. Even if a fault zone has recently experienced an earthquake, there is no guarantee that all the stress has been relieved. Another earthquake could still occur. In fact, relieving stress along one part of a fault may increase it in another part.

California is seismically active because of movement of the North American Plate, where everything east of the San Andreas Fault sits, and the Pacific Plate, which includes the coastal communities. The movement of the tectonic plates creates stress released as energy that moves through the earth as waves called earthquakes.

DEFINITIONS

Earthquake—The shaking of the ground caused by an abrupt shift of rock along a fracture in the earth or a contact zone between tectonic plates. Earthquakes are typically measured in both magnitude and intensity.

Epicenter—The point on the earth's surface directly above the hypocenter of an earthquake. The location of an earthquake is commonly described by the geographic position of its epicenter and by its focal depth.

Fault—A fracture in the earth's crust along which two blocks of the crust have slipped with respect to each other.

Focal Depth—The depth from the earth's surface to the hypocenter.

Hypocenter—The region underground where an earthquake's energy originates.

Liquefaction—Loosely packed, water-logged sediments losing their strength in response to strong shaking, causing major damage during earthquakes.

Active faults have experienced displacement in historical time. However, inactive faults, where no such displacements have been recorded, also have the potential to reactivate or experience displacement along a branch sometime in the future. An example of a fault zone that has been reactivated is the Foothills Fault Zone. The zone was considered inactive until evidence of an earthquake (approximately 1.6 million years ago) was found near Spenceville, California. Then, in 1975, an earthquake occurred on another branch of the zone near Oroville, California (now known as the Cleveland Hills Fault). The State Division of Mines and Geology indicates that increased earthquake activity throughout California may cause tectonic movement along currently inactive fault systems.

5.1.1 Damage from Earthquakes

A direct relationship exists between a fault's length and location and its ability to generate damaging ground motion at a given site. Small, local faults produce lower magnitude quakes, but ground shaking can be strong and damage can be significant in areas close to the fault. In contrast, large regional faults can generate earthquakes of great magnitudes but, because of their distance and depth, they may result in only moderate shaking in an area.

Earthquakes can last from a few seconds to more than 5 minutes; they may also occur as a series of tremors over a period of several days. The actual movement of the ground in an earthquake is seldom the direct cause of injury or death. Instead, casualties generally result from falling objects and debris, because the shocks shake, damage, or demolish buildings and other structures. Disruption of communications, electrical power supplies and gas, and sewer and water lines should be expected. Earthquakes may trigger fires, dam failures, landslides, or releases of hazardous material, compounding their disastrous effects.

5.1.2 Earthquake Classifications

Earthquakes are typically classified in one of two ways: By the amount of energy released, measured as **magnitude**; or by the impact on people and structures, measured as **intensity**.

Magnitude

Currently, the most commonly used magnitude scale is the moment magnitude (M_W) scale, with the following classifications of magnitude:

TABLE 5-1. EARTHQUAKE MAGNITUDE CLASS

Magnitude Class	Magnitude Range (M=magnitude)
Great	$M_W \geq 8$
Major	M_W = 7.0 - 7.9
Strong	M_W = 6.0 - 6.9
Moderate	M_W = 5.0 - 5.9
Light	M_W = 4.0 - 4.9
Minor	M_W = 3.0 - 3.9
Micro	$M_W < 3$

Estimates of moment magnitude roughly match the local magnitude scale (ML), commonly called the Richter scale. One advantage of the moment magnitude scale is that, unlike other magnitude scales, it does not saturate at the upper end. That is, there is no value beyond which all large earthquakes have about the same magnitude. For this reason, moment magnitude is now the most often used estimate of large earthquake magnitudes.

Intensity

Currently, the most commonly used intensity scale is the modified Mercalli intensity scale, with ratings defined as follows (USGS 2014):

TABLE 5-2. MODIFIED MERCALLI INTENSITY SCALE

Mercalli Intensity	Shaking	Description
I	Not Felt	Not felt except by a very few under especially favorable conditions.
II	Weak	Felt only by a few persons at rest, especially on upper floors of buildings.
III	Weak	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing automobiles may rock slightly. Vibrations are similar to the passing of a truck. Duration estimated.
IV	Light	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing automobiles rocked noticeably.
V	Moderate	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
VI	Strong	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII	Very Strong	Felt by all. 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.
VIII	Severe	Felt by all. 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.
IX	Violent	Felt by all. 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.
X	Extreme	Felt by all. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.

5.1.3 Ground Motion

Earthquake hazard assessment is also based on expected ground motion. This assessment involves estimating the annual probability that certain ground motion accelerations will be exceeded, and then summing the annual probabilities over the time period of interest. The most commonly mapped ground motion parameters are the horizontal and vertical peak ground accelerations (PGA) for a given soil or rock type. Instruments called accelerographs record levels of ground motion due to earthquakes at stations throughout a region. PGA is measured in g (the acceleration due to gravity) or expressed as a percent acceleration force of gravity (%g). These readings are recorded by state and federal agencies that monitor and predict seismic activity.

Maps of PGA values form the basis of seismic zone maps that are included in building codes such as the International Building Code. Building codes that include seismic provisions specify the horizontal force caused by lateral acceleration that a building should be able to withstand during an earthquake. PGA values are directly related to these lateral forces that could damage “short period structures” (such as single-family dwellings).

Longer period response components control the lateral forces that damage larger structures with longer natural periods (apartment buildings, factories, high-rises, and bridges). Table 5-3 lists damage potential and perceived shaking by PGA factors, compared with the Mercalli scale.

TABLE 5-3. MERCALLI SCALE AND PEAK GROUND ACCELERATION COMPARISON

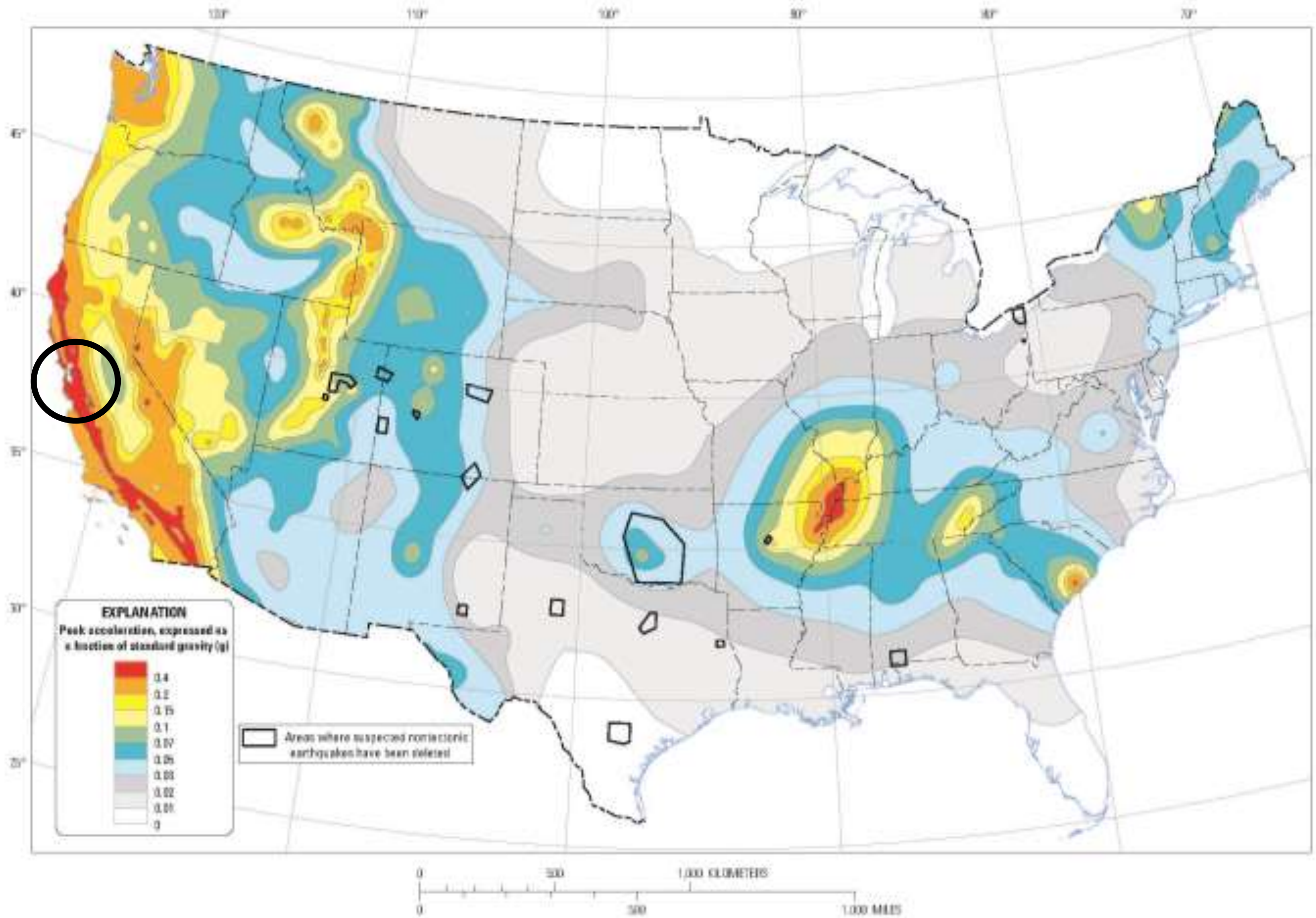
Modified Mercalli Scale	Perceived Shaking	Potential Structure Damage		Estimated PGA[a] (%g)
		Resistant Buildings	Vulnerable Buildings	
I	Not Felt	None	None	<0.17%
II-III	Weak	None	None	0.17% - 1.4%
IV	Light	None	None	1.4% - 3.9%
V	Moderate	Very Light	Light	3.9% - 9.2%
VI	Strong	Light	Moderate	9.2% - 18%
VII	Very Strong	Moderate	Moderate/Heavy	18% - 34%
VIII	Severe	Moderate/Heavy	Heavy	34% - 65%
IX	Violent	Heavy	Very Heavy	65% - 124%
X - XII	Extreme	Very Heavy	Very Heavy	>124%

a. PGA measured in percent of g, where g is the acceleration of gravity

Sources: USGS, 2008; USGS, 2010

The U.S. Geological Survey (USGS) updated the National Seismic Hazard Maps in 2014, which supersede the 2008 and 2002 maps. New seismic, geologic, and geodetic information on earthquake rates and associated ground shaking were incorporated into these revised maps. The 2014 map represents the best available data as determined by the USGS. The 2014 Seismic Hazard Map shows that most of San Mateo County has a PGA of 0.4g or greater, and that a very small portion of the County (along the coast) has a PGA between 0.02g and 0.04g (refer to Figure 5-1). This map is based on peak ground acceleration (g) with 10 percent probability of exceedance in 50 years. Maps further in this profile (under the Location subsection) provide 100-year and 500-year probabilistic PGAs, a San Andreas Fault Scenario PGA, and a San Gregorio Fault PGA.

FIGURE 5-1. PEAK ACCELERATION (%G) WITH 10% PROBABILITY OF EXCEEDANCE IN 50 YEARS



Ten-percent probability of exceedance in 50 years map of peak ground acceleration

Note: The black circle indicates the approximate location of San Mateo County.

5.1.4 Effect of Soil Types

The impact of an earthquake on structures and infrastructure is largely a function of ground shaking, distance from the source of the quake, and liquefaction, a secondary effect of an earthquake caused when soils lose their shear strength and flow or behave as liquid, thereby damaging structures that derive their support from the soil. Liquefaction generally occurs in soft, unconsolidated sedimentary soils. A program called the National Earthquake Hazard Reduction Program (NEHRP) creates maps based on soil characteristics to help identify locations subject to liquefaction. Table 5-4 summarizes NEHRP soil classifications. NEHRP Soils B and C typically can sustain ground shaking without much effect, depending on the earthquake magnitude. The areas that are commonly most affected by ground shaking have NEHRP Soils D, E and F. In general, these areas are also most susceptible to liquefaction.

TABLE 5-4. NEHRP SOIL CLASSIFICATION SYSTEM

NEHRP Soil Type	Description	Mean Shear Velocity to 30 m (m/s)
A	Hard Rock	1,500
B	Firm to Hard Rock	760-1,500
C	Dense Soil/Soft Rock	360-760
D	Stiff Soil	180-360
E	Soft Clays	< 180
F	Special Study Soils (liquefiable soils, sensitive clays, organic soils, soft clays >36 m thick)	

The USGS has created a soil type map for the San Francisco Bay area that provides rough estimates of site effects based on surface geology. NEHRP soil types were assigned to a geologic unit based on the average velocity of that unit, and USGS notes that this approach can lead to some inaccuracy. For instance, a widespread unit consisting of Quaternary sand, gravel, silt, and mud has been assigned as Class C soil types; however, some of the slower soil types in this unit fall under Class D. USGS does not have any way of differentiating units for slower-velocity soils in its digital geologic dataset (USGS 2016).

5.2 Hazard Profile

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 2 inches (50 millimeters) per year (SHMP 2013). Earthquakes in the San Francisco Bay region result from strain energy constantly accumulating across the region because of the northwestward motion of the Pacific Plate relative to the North American Plate.

5.2.1 Past Events

The last significant (≥ 6.0 M) seismic event recorded in the San Mateo vicinity, measuring 7.1 on the Richter scale, occurred in 1989 during the San Andreas Loma Prieta Earthquake that originated 10 miles northeast of Santa Cruz, California. No significant seismic events in the San Mateo County vicinity have been recorded since then. Other significant earthquakes in California include the 1906 earthquake in San Francisco, the 1971 San Fernando Earthquake, the 1994 Northridge earthquake, and the 2014 Napa earthquake.

Although the 1906 earthquake is most commonly associated with the City of San Francisco, San Mateo County was also greatly affected. In 1980, the USGS researched these impacts to use a standard for scenario impacts to the region. Damages are noted by jurisdiction and range from landslides; ground deformation, and infrastructure damage (to roadways, electric car rail lines, and similar infrastructure); house and building collapse, house shifts, and foundation cracks; fires; injuries; ground cracks; and more (USGS 1980).

Table 5-5. Recent Earthquakes Magnitude 5.0 or Larger Within 100-mile radius lists recent earthquakes with a magnitude of 5.0 or greater within a 100-mile radius of San Mateo County.

TABLE 5-5. RECENT EARTHQUAKES MAGNITUDE 5.0 OR LARGER WITHIN 100-MILE RADIUS

Date	Magnitude	Epicenter Location
8/24/2014	6.0	6 miles southwest of Napa, CA
10/31/2007	5.6	10 miles northeast of San Jose, CA
8/10/2001	5.50	9 miles west of Portola, CA
9/3/2000	5.17	8 miles northwest of Napa, CA
10/17/1989	7.1	10 miles northeast of Santa Cruz, CA
3/31/1986	5.70	12 miles east-northeast of Milpitas, CA

Source: USGS

5.2.2 Location

San Mateo County is located in a region of high seismicity because of the presence of the San Andreas Fault that bisects the county on the coastal region and the presence of the Hayward Fault across the bay to the east and the San Gregorio Fault to the west. The primary seismic hazard for the county is potential ground shaking from these three large faults. The San Andreas Fault is a transform boundary that spans approximately 810 miles from the East Pacific rise in the Gulf of California through the Mendocino fracture zone off of the shore of northern California. The fault is estimated to be 28 million years old. The San Andreas Fault is an example of a transform boundary exposed on a continent. The fault forms the tectonic boundary between the Pacific Plate and the North American Plate, and its motion is right-lateral strike-slip.

The San Andreas Fault is typically referenced in three segments. The southern segment extends from its origin at the East Pacific Rise to Parkfield, California, in Monterey County. The central segment extends from Parkfield to Hollister, California. Finally, the northern segment of the fault extends northwest from Hollister, through San Mateo County, to its ultimate junction with the Mendocino fracture zone and the Cascadia subduction zone in the Pacific Ocean.

The San Andreas Fault poses the greatest risk for San Mateo County by passing through the County's center, including passage through the population centers of Daly City and San Bruno, posing considerable risk for surface fault rupture within the two cities. According to the Association of Bay Area Governments (ABAG), the San Andreas Fault has a 21 percent chance of generating a magnitude 6.7 or greater earthquake in the next 30 years. The last earthquake with a magnitude over 5.0 with an epicenter in San Mateo County was the 1957 Daly City earthquake with a magnitude of 5.3. While the epicenter of the magnitude 7.8 earthquake in 1906 on the San Andreas Fault was not located within the county, it still caused extreme ground shaking. A similar earthquake in the future will likely do the same, especially in the heavily populated Bayside, much of which is underlain by alluvial deposits, Bay Mud, and artificial fill. A rupture along the peninsula will cause extremely violent ground shaking throughout the county. The bay margins will also be likely to experience liquefaction in a major earthquake (ABAG 2013).

Hayward Fault

The Hayward Fault is an approximately 45-mile-long fault that parallels the San Andreas Fault on the East Bay. The Hayward Fault extends through some of the Bay Area's most populated areas, including San Jose, Oakland, and Berkeley. The Hayward Fault is a right lateral slip fault.

According to the 2008 Uniform California Rupture Forecast, Version 2, the Hayward Fault has a 31-percent chance of producing a magnitude 6.7 or greater earthquake in the next 30 years. An earthquake of this magnitude has regional implications for the entire Bay Area, as the Hayward Fault crosses numerous transportation and resource infrastructure, such as multiple highways and the Hetch Hetchy Aquaduct. Disruption of the Hetch Hetchy system has the potential to severely impair water services to San Mateo County. The Hayward Fault is increasingly becoming a hazard priority throughout the bay region because of its increased chance for activity and its intersection with multiple highly populated areas and critical infrastructure.

San Gregorio Fault

The San Gregorio Fault is situated toward the western edge of San Mateo County, crossing briefly over uninhabited land in San Mateo County around Pillar Point at Half Moon Bay. The fault line runs from southern Monterey Bay through Bolinas Bay, where the north section of the San Gregorio Fault intersects with the San Andreas Fault offshore north of San Francisco. San Gregorio is considered the principal active fault west of San Andreas for the Bay Area region.

The San Gregorio Fault is one of the less studied fault lines, the result of its primary location offshore and its proximity to the more infamous San Andreas Fault and seemingly more volatile Hayward Fault. USGS concluded that the San Gregorio Fault is a northwest-trending right-lateral slip deformation. The probability of experiencing a magnitude 6.7 or greater earthquake along the San Gregorio Fault within the next 30 years is 6 -percent – significantly less than San Andreas Fault or Hayward Fault. However, the location of the fault poses a significant threat to San Mateo County.

Table 5-6 lists additional faults within the Bay Area outside of the three local major faults, and Figure 5-2. Significant Known Faults in the Bay Area, provides location and probability for these bay area fault lines.

FIGURE 5-2. SIGNIFICANT KNOWN FAULTS IN THE BAY AREA

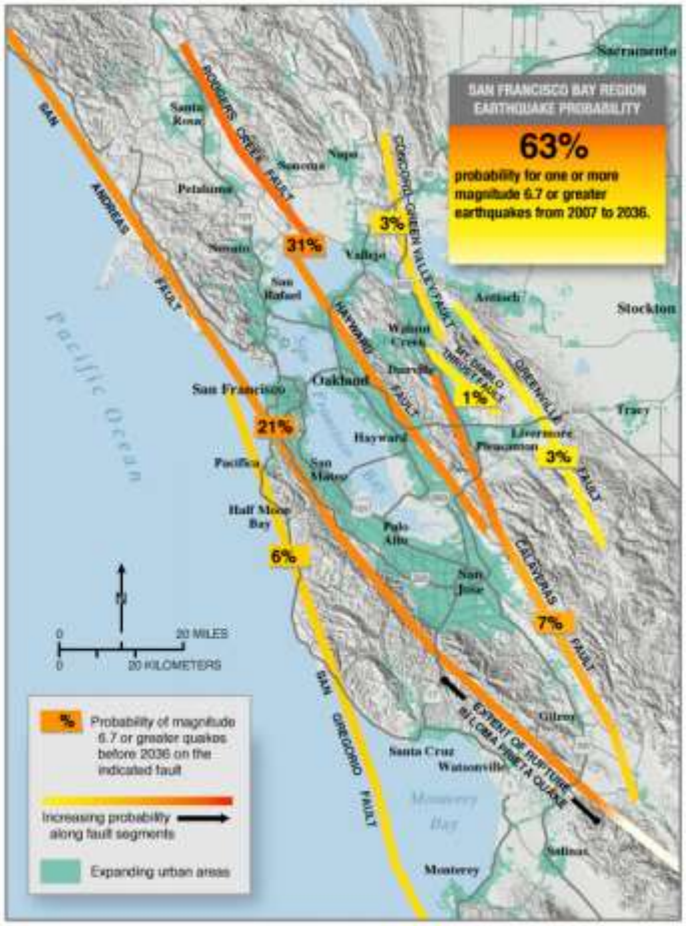


TABLE 5-6. ADDITIONAL FAULTS WITHIN A 50-MILE RADIUS

Fault	Approximate Distance (miles/direction)
Calaveras	17 miles from East Palo Alto
Greenville	23 miles from Menlo Park
Mount Diablo Thrust	27 miles from South San Francisco
Concord-Green Valley	30 miles from South San Francisco
Rogers Creek (Part of Hayward Fault System)	35 miles from South San Francisco

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-percent – significantly less than San Andreas Fault or Hayward Fault. However, the location of the fault poses a significant threat to San Mateo County.

Maps of Earthquake Impact in San Mateo County

Identifying the extent and location of an earthquake is not as simple as it is for other hazards such as flood, landslide or wildfire. The impact of an earthquake is largely a function of the following components:

- Ground shaking (ground motion accelerations)
- Liquefaction (soil instability)
- Distance from the source (both horizontally and vertically).

Mapping that shows the impacts of these components was used to assess the risk of earthquakes within the planning area. While the impacts from each of these components can build upon each other during an earthquake event, the mapping looks at each component individually. The mapping used in this assessment is described below.

Shake Maps

A shake map is a representation of ground shaking produced by an earthquake. The information it presents is different from the earthquake magnitude and epicenter that are released after an earthquake because shake maps focus on the ground shaking resulting from the earthquake, rather than on the parameters describing the earthquake source. An earthquake has only one magnitude and one epicenter, but it produces a range of ground shaking at sites throughout the region, depending on the distance from the earthquake, the rock and soil conditions at the various sites, and variations in the propagation of seismic waves from the earthquake created by complexities in the structure of the earth's crust. A shake map shows the extent and variation of ground shaking in a region immediately after significant earthquakes.

Ground motion and intensity maps are derived from peak ground motion amplitudes recorded on seismic sensors (accelerometers), with interpolation based on estimated amplitudes where data are lacking, and site amplification corrections. Color-coded instrumental intensity maps are derived from empirical relations between peak ground motions and Modified Mercalli intensity.

A probabilistic seismic hazard map shows the hazard from earthquakes that geologists and seismologists agree could occur. The maps are expressed in terms of probability of exceeding a certain ground motion, such as the 10-percent probability of exceedance in 50 years. This level of ground shaking has been used for designing buildings in high seismic areas. Figures 5-3 and 5-4 show the estimated ground motion for the 100-year and 500-year probabilistic earthquakes in San Mateo County.

Earthquake scenario maps describe the expected ground motions and effects of hypothetical large earthquakes for a region. Maps of these scenarios can be used to support all phases of emergency management. Two scenarios were chosen by the Steering Committee for this plan:

- A Magnitude-7.8 event on the San Andreas Fault with an epicenter approximately 138 miles northwest of the City of San Mateo.

- A Magnitude-7.5 event on the San Gregorio Fault with an epicenter approximately 85 miles south southeast of the City of San Mateo.

NEHRP Soil Maps

NEHRP soil types define the locations that will be significantly affected by an earthquake. NEHRP Soils B and C typically can sustain low-magnitude ground shaking without much effect. The areas that are most commonly affected by ground shaking have NEHRP Soils D, E and F. Figure 5-7 shows NEHRP soil classifications in the county.

Liquefaction Maps

Liquefaction involves loose sandy soil with a high water content that undermines the ground's ability to solidly support building structures during an earthquake. Foundations supported on liquefiable soils can lose their ability to support load and can experience settlement on the order of several inches or more. Differential settlement can cause significant damage to buildings, lifelines, and transportation structures, with partial or total collapse.

Soil liquefaction maps are useful tools to assess potential damage from earthquakes. When the ground liquefies, sandy or silty materials saturated with water behave like a liquid, causing pipes to leak, roads and airport runways to buckle, and building foundations to be damaged. In general, areas with NEHRP Soils D, E and F are also susceptible to liquefaction. If there is a dry soil crust, excess water will sometimes come to the surface through cracks in the confining layer, bringing liquefied sand with it, creating sand boils. Figure 5-8 shows the liquefaction susceptibility in the planning area.

Alquist-Priolo Zone Maps

The sudden sliding of one part of the earth's crust past another releases the vast store of elastic energy in the rocks as an earthquake. The resulting fracture is known as a fault, while the sliding movement of earth on either side of a fault is called fault rupture. Fault rupture begins below the ground surface at the earthquake hypocenter, typically between 3 and 10 miles below the ground surface in California. If an earthquake is large enough, the fault rupture will actually travel to the ground surface, potentially destroying structures built across its path (SHMP 2013).

Alquist-Priolo (AP) Zone Maps provide regulatory zones for potential surface fault rupture where fault lines intersect with future development and populated areas. The purpose of these maps is to assist in the geologic investigation before construction begins to ensure that the resulting structure will not be located on an active fault. Daly City and San Bruno are located in designated AP Zones for the San Andreas Fault.

AP Maps were referenced, but not specifically used, in the assessment of risk for this plan as a result of the existence of current extensive studies and regulations and ongoing monitoring and update of AP Zones by the State of California. This plan assumes that the studies conducted and information provided by the State of California are the best available data for surface rupture risk and could not be improved through a separate assessment for this plan. AP Maps are available to the public at:

http://maps.conservation.ca.gov/cgs/informationwarehouse/index.html?map=regulatorymaps.

5.2.3 Frequency

California experiences hundreds of earthquakes each year, most with minimal damage and magnitudes below 3.0 on the Richter Scale. Earthquakes that cause moderate damage to structures occur several times a year. According to the USGS, a strong earthquake measuring greater than 5.0 on the Richter Scale occurs every 2 to 3 years and major earthquakes of more than 7.0 on the Richter Scale occur once a decade. Both the San Andreas and the Hayward Faults have the potential for experiencing major to great events. The USGS estimated in 2008 that there is a 63 percent probability of at least one 6.7 or greater magnitude earthquake before 2036 that could cause widespread damage in the San Francisco Bay area. The State Hazard Mitigation Plan cites projections that there is more than a 99-percent probability of a magnitude 6.7 earthquake in California in the next 30 years and a 94-percent magnitude 7.0 earthquake in California in the next 30 years.

Probabilities for earthquakes on individual faults until 2036 have been estimated by USGS, as shown in Table 5-7, which also shows estimates for average long-term movement (“slip rate”) of each fault in millimeters per year (mm/year).

TABLE 5-7. EARTHQUAKE PROBABILITIES AND SLIP RATES

Segment	Average Long Term Slip Rate	% Probability in Next 30 Years: Characteristic Quake 2002-2031	% Probability in Next 30 Years: Quake ≥6.7 2007-2036
San Andreas			
Santa Cruz Mountains (SAS)	17	2.6	4.0*
Peninsula (SAP)	17	4.4	0.6*
North Bay (SAN)	24	0.9	0.04*
Ocean (north of Bay Area - SAO)	24	0.9	1.9*
South Bay Segments (SAS + SAP)	17	3.5	4.4*
Central Bay Segments (SAP + SAN)	17-24	0.0	0.0*
Northern Segments (SAN + SAO)	24	3.4	4.1*
Bay Area Segments (SAS+SAP+SAN)	17-24	0.1	0.05*
Central + North (SAP + SAN +SAO)	17-24	0.2	0.2*
Entire - Repeat of 1906(SAS + SAP +SAN + SAO)	17-24	4.7	3.8*
Floating M6.9	17-24	7.1	6.8*
San Gregorio			
Southern (Outside Bay Area - SGS)	3	2.3	2.1
Northern (SGN)	7	3.9	3.9
SGS + SGN	3-7	2.6	2.6
Floating M6.9	3-7	2.1	2.0
Hayward/Rodgers Creek			
Southern (HS)	9	11.3	4.8*
Northern (HN)	9	12.3	1.2*
Entire (HS + HN)	9	8.5	8.8*
Rodgers Creek (RC)	9	15.2	16.3*
HN + RC	9	1.8	2.1*

TABLE 5-7. EARTHQUAKE PROBABILITIES AND SLIP RATES

Segment	Average Long Term Slip Rate	% Probability in Next 30 Years	
		Characteristic Quake 2002-2031	Quake >6.7 2007-2036
HS + HN + RC	9	1.0	1.2*
Floating M6.9	9	0.7	0.7
Calaveras			
Southern (Outside Bay Area - CS)	15	21.3	0.0*
Central (CC)	15	13.8	0.0*
CS + CC	15	5.0	0.1*
Northern (CN)	6	12.4	2.4*
CC + CN	6-15	0.3	0.3*
CS + CC + CN	6-15	2.0	3.6*
Floating M6.2	6-15	7.4	0.0
Floating M6.2 on CS + CC	15	7.4	0.0
Concord/Green Valley			
Concord (CON)	4	5.0	0.1
Southern Green Valley (GVS)	5	2.3	0.0
CON + GVS	4-5	1.6	0.3
Northern Green Valley (GVN)	5	6.1	0.0
Entire Green Valley (GVS + GVN)	5	3.2	0.4
Entire (CON + GVS + GVN)	4-5	6.0	2.7
Floating M6.2	4-5	6.2	0.0
Greenville			
Southern (GS)	2	3.1	0.7
Northern (GN)	2	2.9	1.0
Entire (GS + GN)	2	1.5	1.4
Floating M6.2	2	0.4	0.0
Mount Diablo Thrust			
Mount Diablo Thrust (MDT)	2	7.5	0.7*
Based on USGS Working Group on Earthquake Probabilities. 2003 and 2008*			

FIGURE 5-3. 100-YEAR PROBABILISTIC PGA

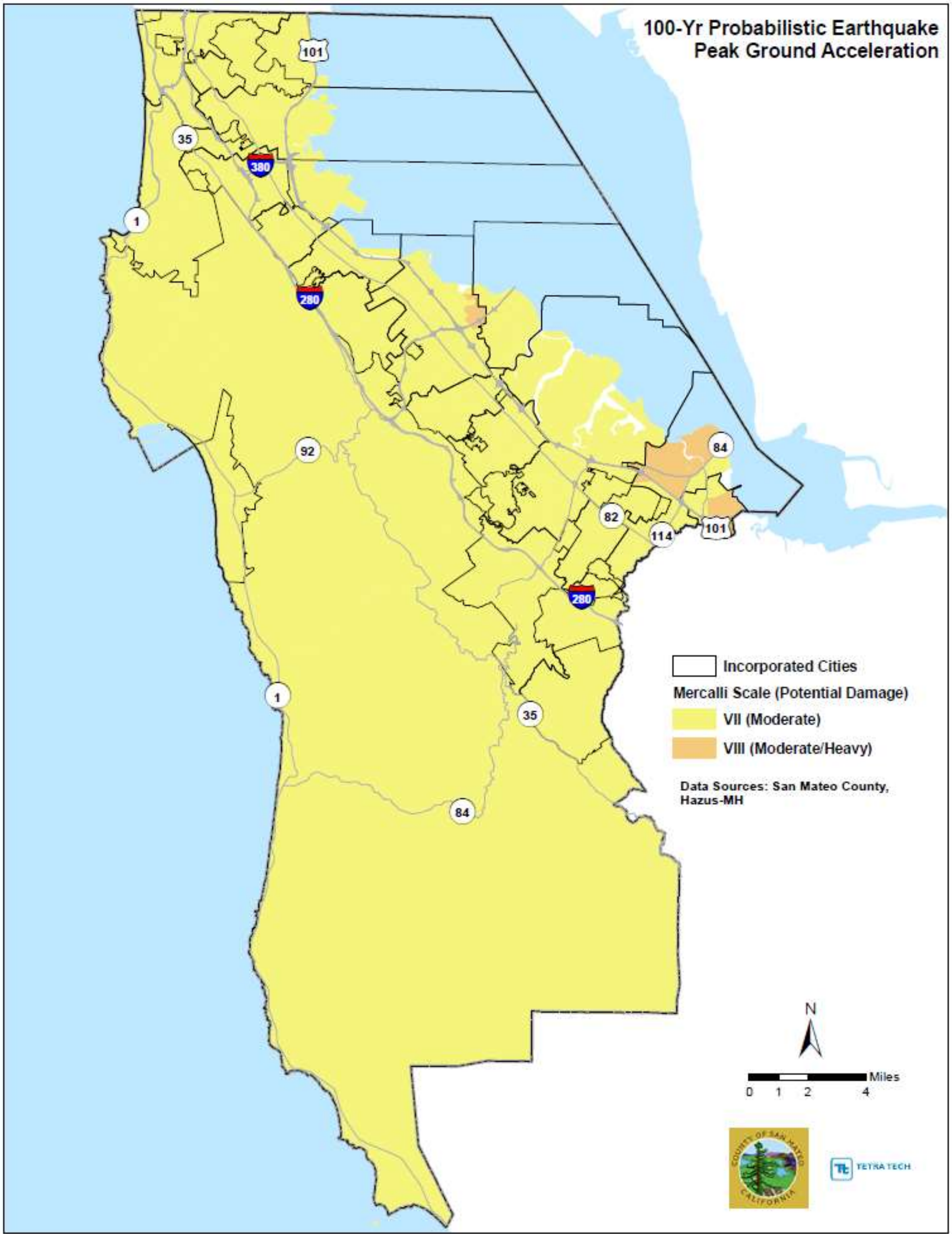


FIGURE 5-4. 500-YEAR PROBABILISTIC PGA

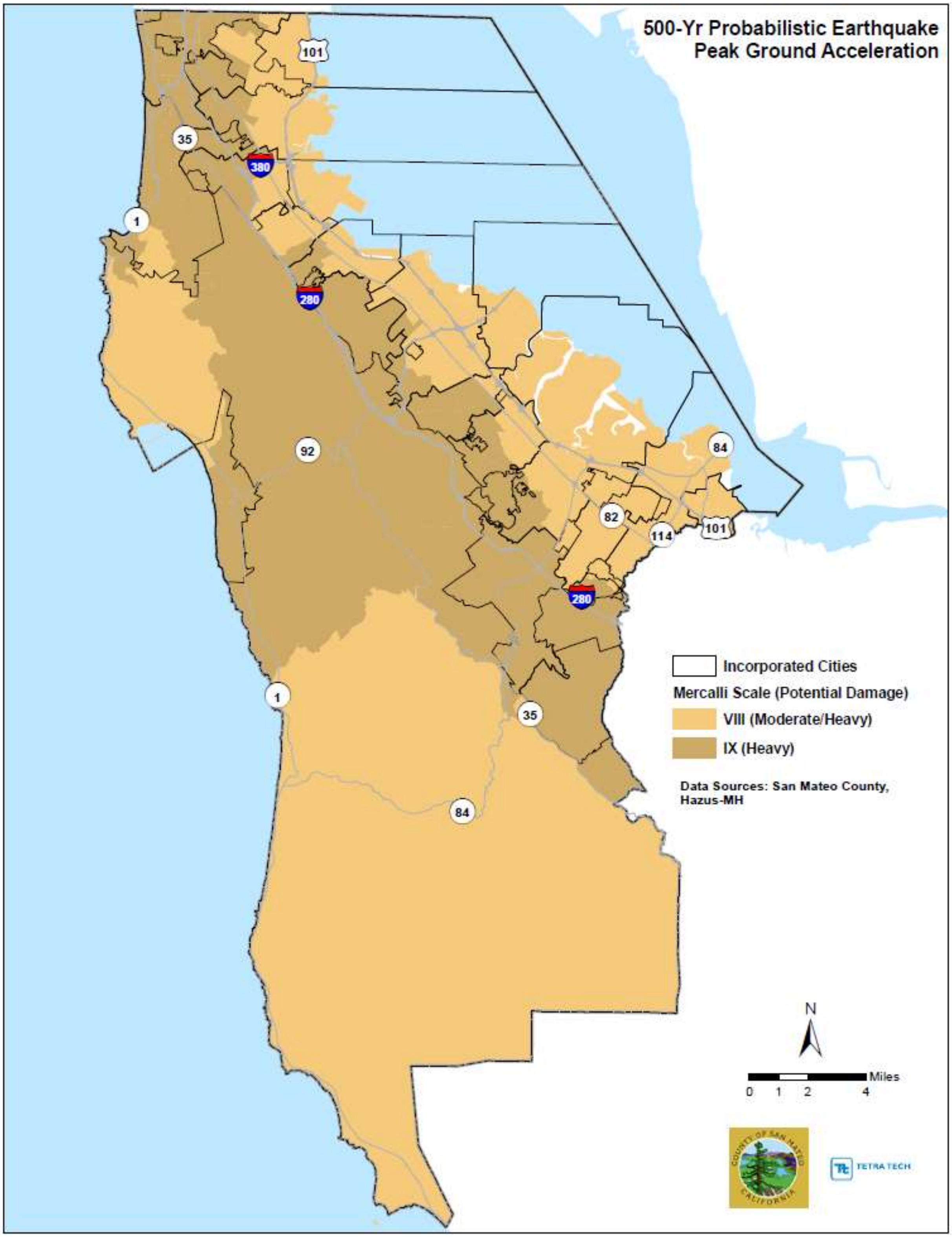


FIGURE 5-5. SAN ANDREAS FAULT SCENARIO PGA

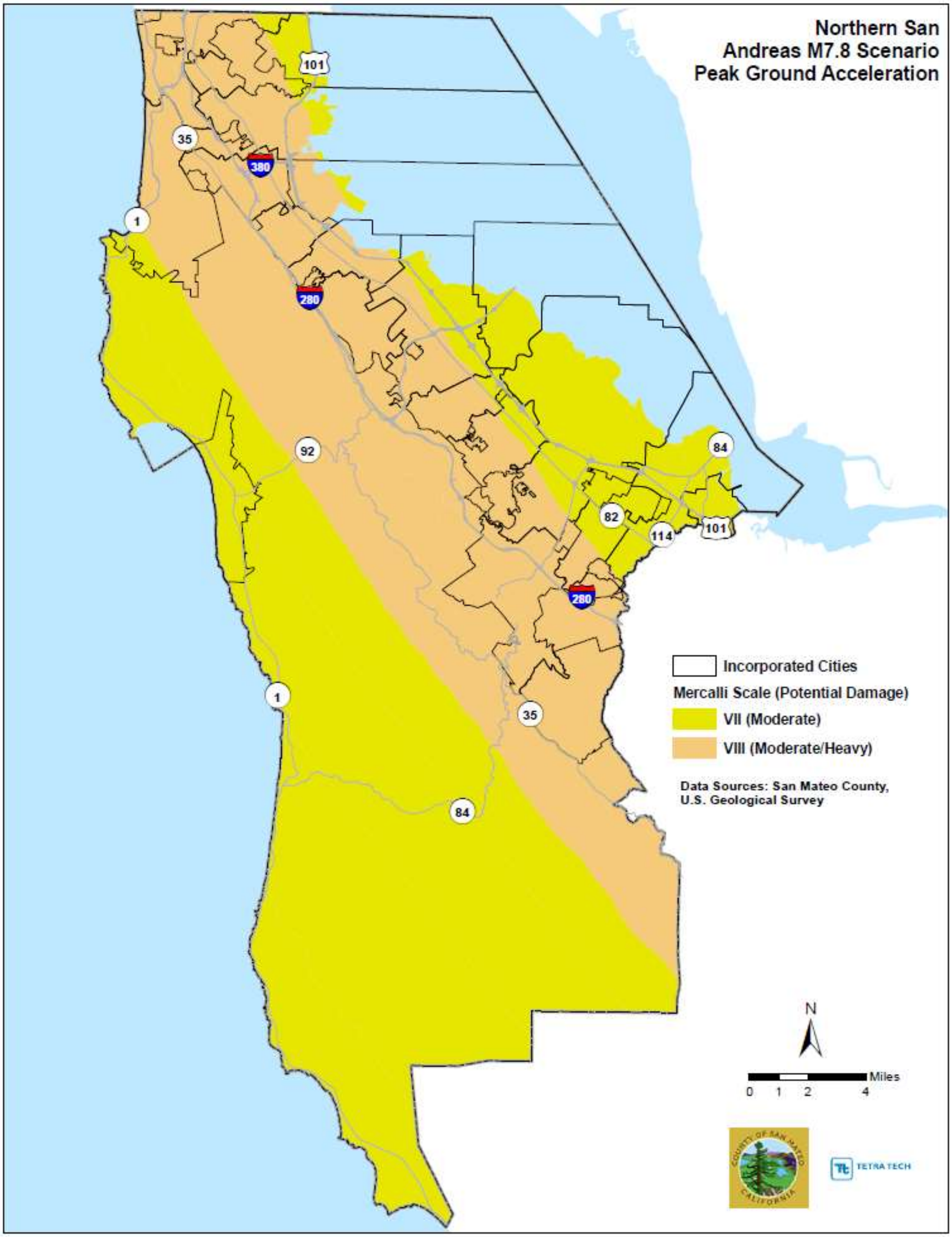


FIGURE 5-6. SAN GREGORIO FAULT SCENARIO PGA

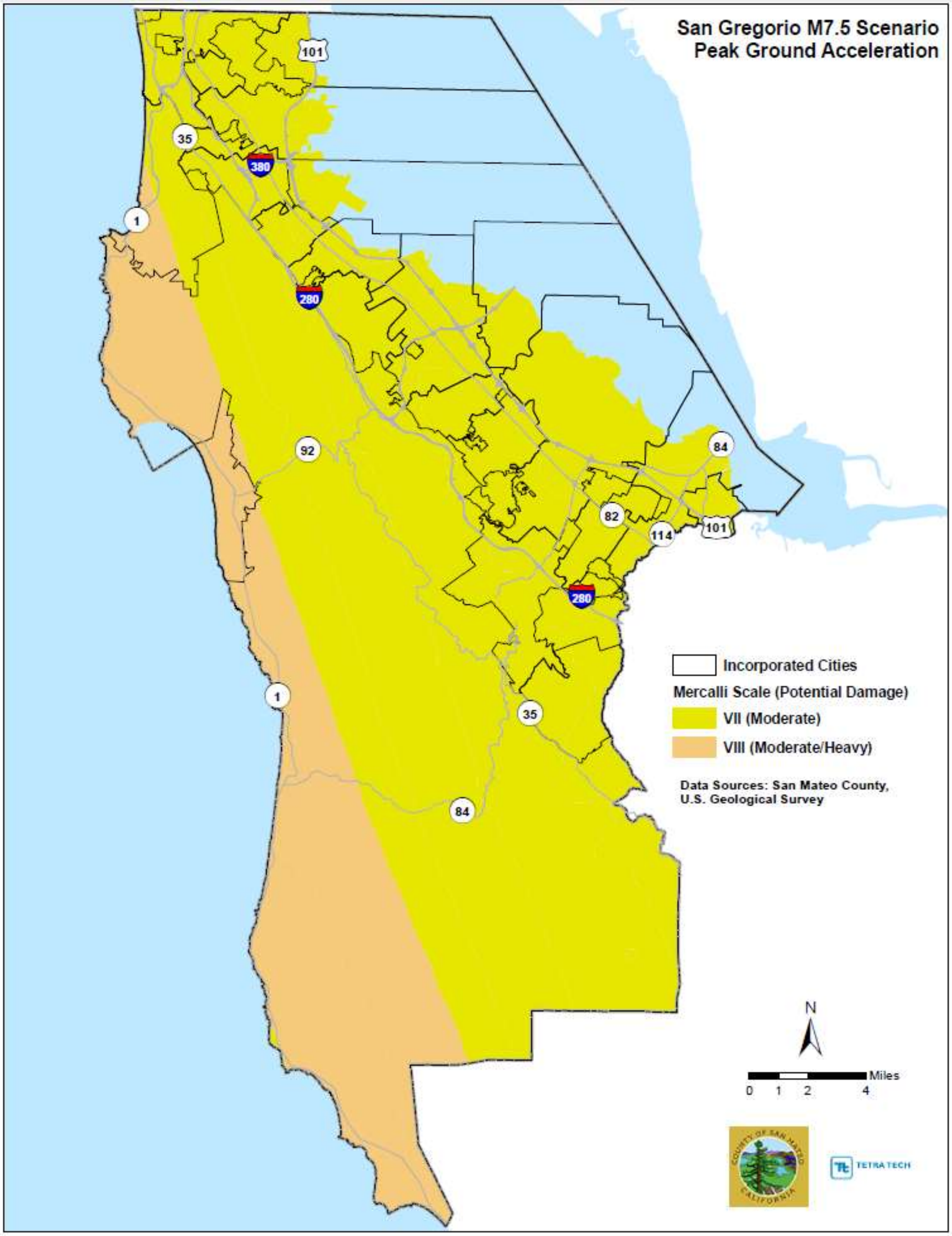


FIGURE 5-7. NATIONAL EARTHQUAKE HAZARD REDUCTION PROGRAM SOIL CLASSIFICATION

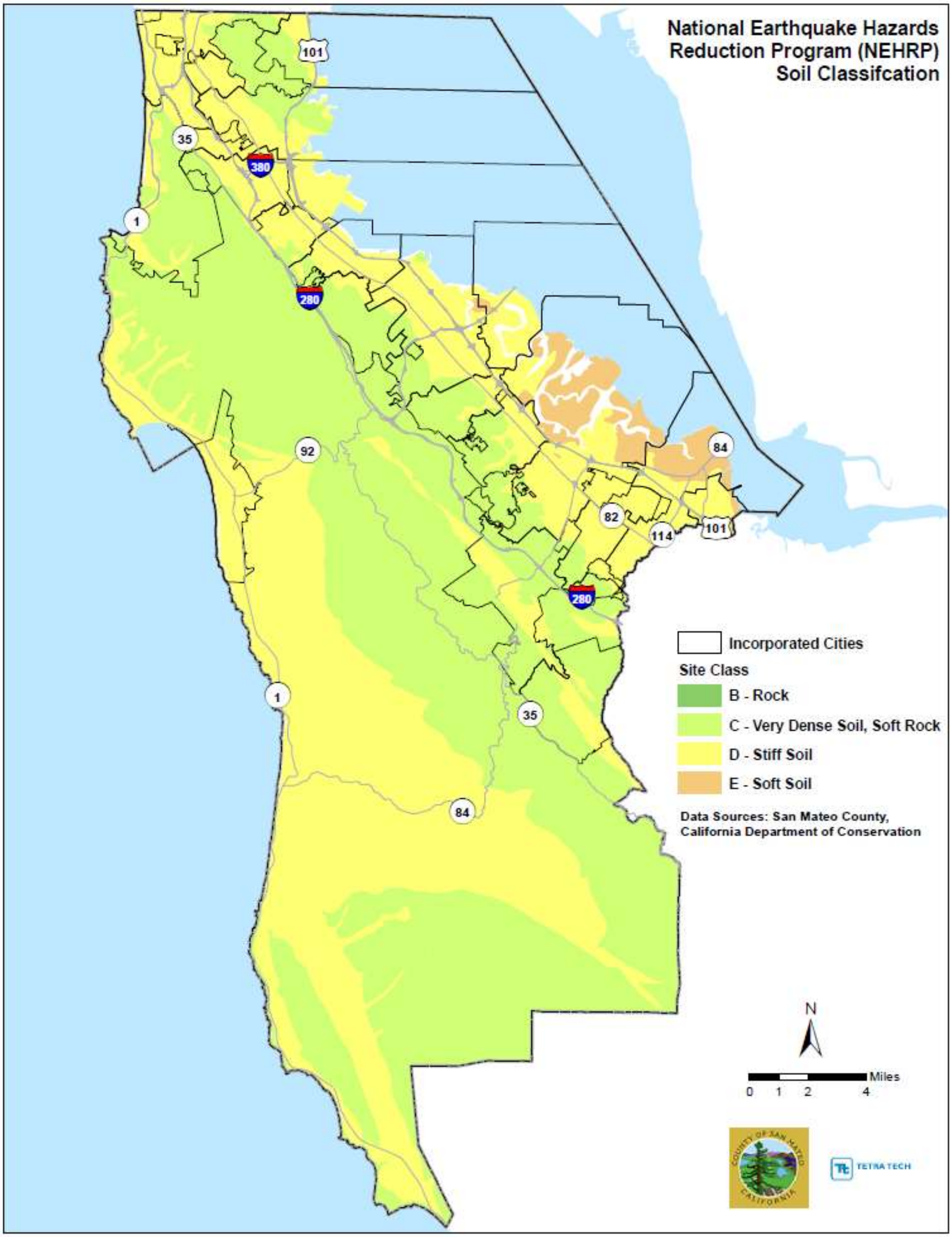
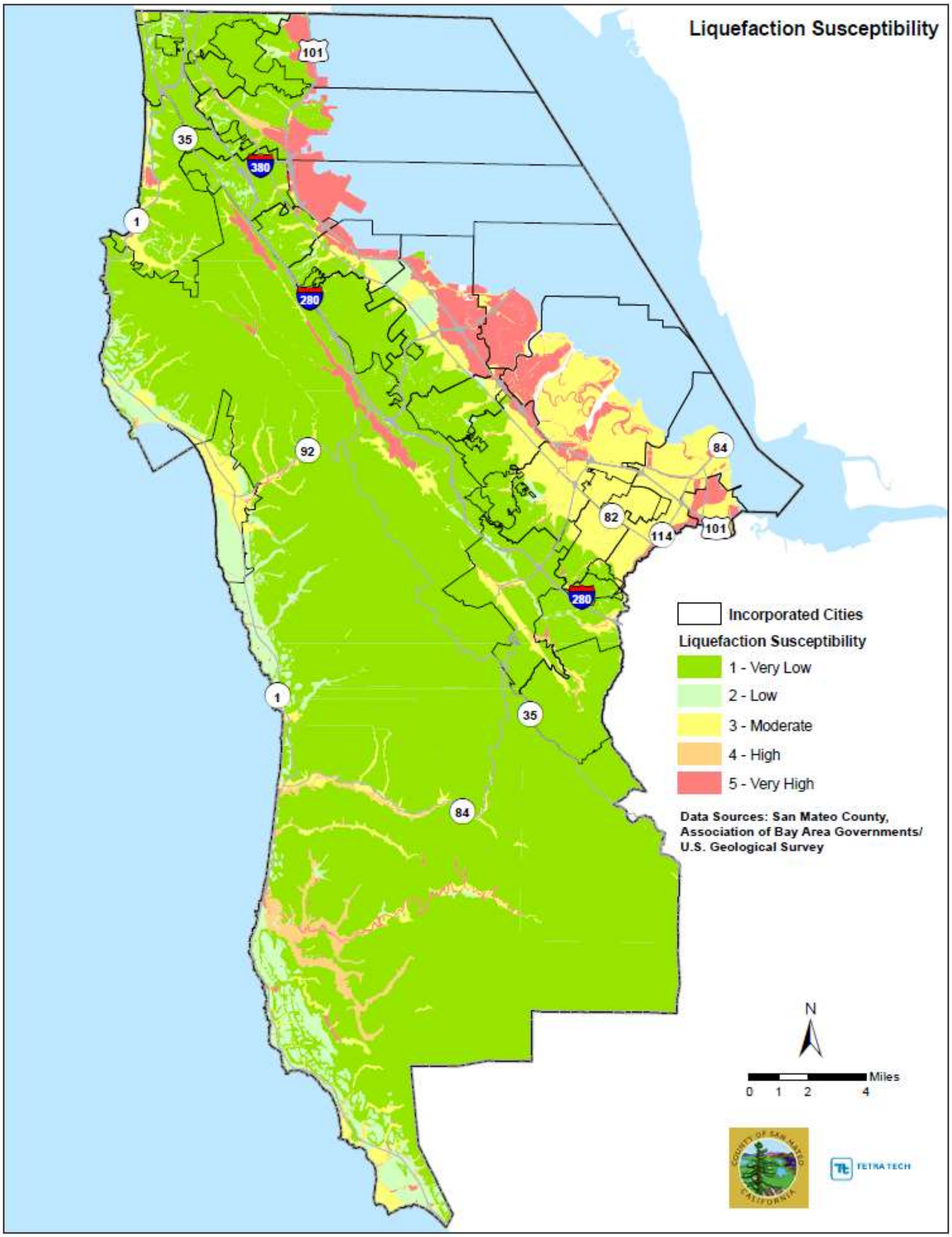


FIGURE 5-8. LIQUEFACTION SUSCEPTIBILITY



5.2.4 Severity

The severity of an earthquake can be expressed in terms of intensity or magnitude:

- Intensity represents the observed effects of ground shaking at any specified location. The intensity of earthquake shaking lessens with distance from the earthquake epicenter. Tabulated peak ground accelerations for a listed “maximum credible earthquakes” (MCE) are a measure of how a site will be affected by seismic events on distant faults.
- Magnitude represents the amount of seismic energy released at the hypocenter of the earthquake. It is based on the amplitude of the earthquake waves recorded on instruments. Magnitude is thus represented by a single, instrumentally determined value.

ABAG estimates a potential loss of 159,000 housing units in Bay Area communities after a large earthquake. This loss would have disastrous effects on local and regional economies. It also means that recovery, repair, and rebuilding time for each household would be very lengthy because of the number of homes that would need repairs or replacement.

5.2.5 Warning Time

There is no current reliable way to predict the day or month that an earthquake will occur at any given location. Research is being done with warning systems that use the low energy waves that precede major earthquakes. These potential warning systems would give approximately 40 seconds notice that a major earthquake is about to occur. The warning time is very short, but it could allow for someone to get under a desk, step away from a hazardous material, or shut down a computer system.

5.3 Secondary Hazards

Earthquakes can cause large and sometimes disastrous landslides and mudslides. River valleys are vulnerable to slope failure, often as a result of loss of cohesion in clay-rich soils. Soil liquefaction occurs when water-saturated sands, silts, or gravelly soils are shaken so violently that the individual grains lose contact with one another and “float” freely in the water, turning the ground into a pudding-like liquid. Building and road foundations lose load-bearing strength and may sink quicksand-like into what was previously solid ground. Unless properly secured, hazardous materials can be released, causing significant damage to the environment and people.

Earthen dams and levees are highly susceptible to seismic events, and the impacts of their eventual failures can be considered secondary risk exposure to earthquakes. Depending on the location, earthquakes can also trigger tsunamis. Tsunamis significantly damage many locations beyond what the earthquake struck; however, coastal communities near the earthquake epicenter that are also vulnerable to tsunamis could experience devastating impacts. See Chapter 9 of this section for more information on the County’s vulnerability to tsunamis. Additionally, fires can result from gas lines or power lines that are broken or downed during the earthquake. It may be difficult to control a fire, particularly if the water lines feeding fire hydrants are also broken. After the 1906 earthquake in San Francisco, for example, a fire burned for 3 days, destroying much of the city and leaving 250,000 people homeless (UPSeis n.d.).

5.4 Exposure

5.4.1 Population

San Mateo County has a quickly growing population, with an estimated 753,123 residents as of January 1, 2015. All of this population would be considered exposed to the potential impacts of an earthquake, either directly or indirectly. The degree of exposure depends on many factors, including the age and construction type of the structures where people live, the soil type their homes are constructed on, and their proximity to the fault. Whether directly or indirectly impacted, the entire population will have to deal with the consequences of earthquakes to some degree. Business interruption could keep people from working, road closures could isolate populations, and loss of functions of utilities could affect populations that suffered no direct damage from an event itself.

5.4.2 Property

According to County Assessor records, there are 207,020 assessment parcels in the planning area, with a total assessed value of more than $319.86 billion. Since all structures in the planning area are susceptible to earthquake impacts to varying degrees, this total represents the countywide property exposure to seismic events. Most of the buildings (95 percent) are residential.

5.4.3 Critical Facilities

All critical facilities in San Mateo County are exposed to the earthquake hazard. Table 5-8 shows the number of each type of facility by jurisdiction.

TABLE 5-8. CRITICAL FACILITIES IN THE PLANNING AREAS

	Medical and Health Services	Emergency Services	Government	Utilities	Hazardous Materials	Community Economic Facilities	Other Assets	Total	Total
Atherton	0	2	1	1	1	0	0	7	**12**
Belmont	0	3	1	25	6	2	2	13	**52**
Brisbane	0	2	1	0	4	1	1	2	**11**
Burlingame	1	4	1	5	11	5	7	12	**46**
Colma	0	1	5	0	3	0	26	0	**35**
Daly City	1	6	1	0	33	0	11	29	**81**
East Palo Alto	0	2	2	2	2	3	1	12	**24**
Foster City	0	2	1	1	10	2	2	10	**28**
Half Moon Bay	1	2	1	1	4	0	3	5	**17**
Hillsborough	0	3	1	2	4	0	0	6	**16**
Menlo Park	1	5	1	8	14	10	2	16	**57**
Millbrae	0	3	1	3	8	0	5	7	**27**
Pacifica	0	4	1	15	11	0	1	15	**47**
Portola Valley	0	1	3	0	5	0	0	3	**12**

TABLE 5-8. CRITICAL FACILITIES IN THE PLANNING AREAS

	Medical and Health Services	Emergency Services	Government	Utilities	Hazardous Materials	Community Economic Facilities	Other Assets	Total	Total
Redwood City	2	7	11	37	34	10	9	24	**134**
San Bruno	0	4	2	0	30	2	3	17	**58**
San Carlos	0	3	7	18	8	16	6	10	**68**
San Mateo	2	7	2	19	57	1	8	32	**128**
South San Francisco	1	6	2	19	38	14	13	18	**111**
Woodside	0	1	1	0	12	0	1	4	**19**
Unincorporated	1	13	4	32	117	5	2	27	**201**
Total	**10**	**81**	**50**	**188**	**412**	**71**	**103**	**269**	**1,184**

5.4.4 Environment

Environmental problems as a result of an earthquake can be numerous. Secondary hazards will likely have some of the most damaging effects on the environment. Earthquake-induced landslides in landslide-prone areas can significantly damage surrounding habitat. It is also possible for streams to be rerouted after an earthquake. Rerouting can change the water quality, possibly damaging habitat and feeding areas. There is a possibility that streams fed by groundwater wells will dry up because of changes in underlying geology.

5.5 Vulnerability

Earthquake vulnerability data was generated using a Level 2 HAZUS-MH analysis. Once the location and size of a hypothetical earthquake are identified, HAZUS-MH estimates the intensity of the ground shaking, the number of buildings damaged, the damage to critical facilities and infrastructure, the number of people displaced from their homes, and additional information that can be used to estimate the cost of repair and clean up.

5.5.1 Population

There are estimated to be 297,452 people in 107,000 households living on soils with moderate to very high liquefaction potential in the planning area, or about 42 percent of the total population. Two groups are particularly vulnerable to earthquake hazards:

- **Population below Poverty Level**—An estimated 10,546 households in the planning area census blocks with moderate to very high liquefaction potential soils have household incomes less than $20,000 per year. This number is about 9.9 percent of all households located on moderate to very high liquefaction potential soils. These households may lack the financial resources to improve their homes to prevent or mitigate earthquake damage. Economically disadvantaged residents are also less likely to have insurance to compensate for losses in earthquakes.
- **Population over 65 Years Old**—An estimated 33,007 residents in the planning area census blocks with moderate to very high liquefaction potential soils are over 65 years old, or about 11.1 percent

of all residents located on moderate to very high liquefaction potential soils. This population group is vulnerable because they are more likely to need special medical attention, which may not be available because of the isolation caused by earthquakes. Elderly residents also have more difficulty leaving their homes during earthquake events and could be stranded in dangerous situations.

Impacts on persons and households in the planning area were estimated for the 100-year and 500-year earthquakes and the two scenario events through the Level 2 HAZUS-MH analysis. Table 5-9 summarizes the results.

TABLE 5-9. ESTIMATED EARTHQUAKE IMPACT ON PERSONS AND HOUSEHOLDS

Scenario	Number of Households Displaced	Number of Persons Requiring Short-Term Shelter
100-Year Earthquake	3,696	2,221
500-Year Earthquake	22,949	13,268
Northern San Andreas Scenario, M7.5	2,363	1,337
San Gregorio Scenario, M7.8	9,463	5,342

Note: Values shown are accurate only for comparison among results in this plan. See Section 2, Chapter 1 for a discussion of data limitations.

5.5.2 Property

Building Age

Table 5-10 identifies significant milestones in building and seismic code requirements that directly affect the structural integrity of development. Using these time periods, the planning team used San Mateo County assessor's data to identify the number of structures in the planning area by date of construction. The number of structures does not reflect the number of total housing units, as many multi-family units and attached housing units are reported as one structure.

TABLE 5-10. AGE OF STRUCTURES IN SAN MATEO COUNTY

Time Period	Number of Current County Structures Built in Period	Significance of Timeframe
Pre-1933	15,734	Before 1933, there were no explicit earthquake requirements in building codes. State law did not require local governments to have building officials or issue building permits.
1933-1940	10,219	In 1940, the first strong motion recording was made.
1941-1960	85,564	In 1960, the Structural Engineers Association of California published guidelines on recommended earthquake provisions.
1961-1975	50,384	In 1975, significant improvements were made to lateral force requirements.
1976-1994	29,495	In 1994, the Uniform Building Code was amended to include provisions for seismic safety.
1995- Present	15,624	Seismic code is currently enforced.

TABLE 5-10. AGE OF STRUCTURES IN SAN MATEO COUNTY

Time Period	Number of Current County Structures Built in Period	Significance of Timeframe
Total	**207,020**	

Soft-Story Buildings

A soft-story building is a multi-story building with one or more floors that are "soft" because of structural design. If a building has a floor that is 70-percent less stiff than the floor above it, it is considered a soft-story building. This soft story creates a major weak point in an earthquake. Since soft stories are typically associated with retail spaces and parking garages, they are often on the lower stories of a building. When they collapse, they can take the whole building down with them, causing serious structural damage that may render the structure totally unusable.

These floors can be especially dangerous in earthquakes because they cannot cope with the lateral forces caused by the swaying of the building during a quake. As a result, the soft story may fail, causing what is known as a soft-story collapse. Soft-story collapse is one of the leading causes of earthquake damage to private residences.

Exposure rates and vulnerability analysis associated with soft-story construction in the planning area are not currently known. ABAG and other agencies in the Bay Area have programs generating this type of data, but it is not known when such data will be available for San Mateo County. This type of data will need to be generated to support future risk assessments of the earthquake hazard.

Unreinforced Masonry Buildings

Unreinforced masonry (URM) buildings are constructed from materials such as adobe, brick, hollow clay tiles, or other masonry materials and do not contain an internal reinforcing structure, such as rebar in concrete or steel bracing for brick. URM poses a significant danger during an earthquake because the mortar holding masonry together is typically not strong enough to withstand significant earthquakes. Additionally, the brittle composition of these houses can break apart and fall away or buckle, potentially causing a complete collapse of the building.

In San Mateo County, URMs are generally brick buildings that were constructed before modern earthquake building codes and designs were enacted. The State of California enacted a law in 1986 that required all local governments in Seismic Zone 4 (nearest to active earthquake faults) to inventory URMs. The law encourages local governments to adopt local mandatory strengthening programs, delineate seismic retrofit standards, and put into place measures to reduce the number of people in URMs.

According to ABAG, housing units in URM buildings account for only 1-percent of the total Bay Area housing stock and 2.9-percent of the total Bay Area multi-family stock.

Loss Potential

Property losses were estimated through the Level 2 HAZUS-MH analysis for the 100-year and 500-year earthquakes and the two scenario events. Tables 5-11 through 5-14 show the results for two types of property loss:

- Structural loss, representing damage to building structures
- Non-structural loss, representing only the value of lost contents and inventory

The total of the two types of losses is also shown in the tables. A summary of the property-related loss results is as follows:

- For a 100-year probabilistic earthquake, the estimated damage potential is $15.3 billion, or 4.8 percent of the total assessed value for the planning area.
- For a 500-year earthquake, the estimated damage potential is $69 billion, or 21.6 percent of the total assessed value for the planning area.
- For a 7.5-magnitude event on the San Gregorio Fault, the estimated damage potential is $12.1 billion, or 3.8 percent of the total assessed value for the planning area.
- For a 7.8-magnitude event on the Northern San Andreas Fault, the estimated damage potential is $39.7 billion, or 12.4 percent of the total assessed value for the planning area.

TABLE 5-11. LOSS ESTIMATES FOR 100- YEAR PROBABILISTIC EARTHQUAKE

	Estimated Loss Associated with Earthquake			
Jurisdiction	Structure	Contents	Total	% of Total Value
Atherton	$113,976,023	$34,655,155	$148,631,178	3.8%
Belmont	$215,989,637	$73,959,552	$289,949,189	2.8%
Brisbane	$100,320,140	$30,642,542	$130,962,682	3.1%
Burlingame	$830,147,394	$258,596,435	$1,088,743,829	5.1%
Colma	$116,760,992	$33,918,847	$150,679,839	6.5%
Daly City	$830,626,158	$236,341,837	$1,066,967,995	4.3%
East Palo Alto	$574,883,497	$184,501,244	$759,384,741	13.0%
Foster City	$401,940,879	$121,004,017	$522,944,896	6.4%
Half Moon Bay	$112,993,953	$38,990,315	$151,984,268	1.9%
Hillsborough	$62,689,622	$20,459,421	$83,149,043	1.8%
Menlo Park	$722,405,057	$265,933,300	$988,338,356	5.3%
Millbrae	$299,930,363	$91,684,803	$391,615,166	4.0%
Pacifica	$236,152,220	$77,139,150	$313,291,370	2.8%
Portola Valley	$69,329,270	$24,064,782	$93,394,052	3.4%
Redwood City	$1,411,640,567	$457,666,205	$1,869,306,771	5.2%
San Bruno	$652,442,245	$193,894,624	$846,336,869	4.9%
San Carlos	$707,967,434	$241,372,711	$949,340,146	4.7%
San Mateo	$1,734,702,671	$537,471,359	$2,272,174,030	5.2%
South San Francisco	$1,479,545,072	$522,703,432	$2,002,248,504	6.3%
Woodside	$36,124,040	$14,370,184	$50,494,224	1.7%
Unincorporated	$844,682,697	$284,270,041	$1,128,952,738	3.5%

TABLE 5-11. LOSS ESTIMATES FOR 100- YEAR PROBABILISTIC EARTHQUAKE

Jurisdiction	Estimated Loss Associated with Earthquake			
	Structure	Contents	Total	% of Total Value
Total	**$11,555,249,930**	**$3,743,639,956**	**$15,298,889,885**	**4.8%**

Note: Values shown are accurate only for comparison among results in this plan. See Section 2, Chapter 1 for a discussion of data limitations.

TABLE 5-12. LOSS ESTIMATES FOR 500- YEAR PROBABILISTIC EARTHQUAKES

Jurisdiction	Estimated Loss Associated with Earthquake			
	Structure	Contents	Total	% of Total Value
Atherton	$492,651,511	$149,187,781	$641,839,292	16.5%
Belmont	$1,311,375,811	$433,979,457	$1,745,355,268	16.9%
Brisbane	$703,014,180	$235,335,025	$938,349,206	22.1%
Burlingame	$3,690,729,606	$1,207,715,662	$4,898,445,269	22.9%
Colma	$590,188,366	$205,153,676	$795,342,043	34.2%
Daly City	$4,716,950,229	$1,524,747,713	$6,241,697,942	25.0%
East Palo Alto	$1,179,253,320	$397,905,279	$1,577,158,599	26.9%
Foster City	$1,126,082,890	$354,110,537	$1,480,193,426	18.0%
Half Moon Bay	$1,004,113,335	$332,806,898	$1,336,920,233	17.0%
Hillsborough	$436,829,316	$133,799,812	$570,629,128	12.1%
Menlo Park	$2,340,895,894	$850,331,931	$3,191,227,825	17.2%
Millbrae	$1,597,406,949	$518,706,860	$2,116,113,808	21.7%
Pacifica	$1,651,528,201	$540,944,605	$2,192,472,806	19.8%
Portola Valley	$357,840,718	$123,558,911	$481,399,629	17.7%
Redwood City	$5,676,232,334	$1,947,526,468	$7,623,758,802	21.2%
San Bruno	$3,344,158,019	$1,104,422,687	$4,448,580,707	25.5%
San Carlos	$3,246,525,158	$1,204,297,786	$4,450,822,943	22.0%
San Mateo	$6,808,844,339	$2,213,630,327	$9,022,474,666	20.8%
South San Francisco	$6,424,306,423	$2,458,427,019	$8,882,733,442	27.7%
Woodside	$254,108,353	$88,027,367	$342,135,720	11.7%
Unincorporated	$4,470,287,731	$1,561,647,690	$6,031,935,421	18.7%
Total	**$51,423,322,684**	**$17,586,263,491**	**$69,009,586,175**	**21.6%**

Note: Values shown are accurate only for comparison among results in this plan. See Section 2, Chapter 1 for a discussion of data limitations.

TABLE 5-13. LOSS ESTIMATES FOR SAN GREGORIO, M7.5

Jurisdiction	Estimated Loss Associated with Earthquake			
	Structure	Contents	Total	% of Total
Atherton	$19,677,204	$9,684,580	$29,361,784	0.8%
Belmont	$93,048,949	$36,404,058	$129,453,007	1.3%
Brisbane	$189,625,154	$40,362,281	$229,987,436	5.4%
Burlingame	$958,824,187	$273,574,191	$1,232,398,378	5.8%

TABLE 5-13. LOSS ESTIMATES FOR SAN GREGORIO, M7.5

Jurisdiction	Estimated Loss Associated with Earthquake			
	Structure	Contents	Total	% of Total
Colma	$89,806,293	$22,071,616	$111,877,909	4.8%
Daly City	$650,745,323	$172,509,268	$823,254,591	3.3%
East Palo Alto	$112,655,019	$39,250,478	$151,905,497	2.6%
Foster City	$267,624,614	$76,132,863	$343,757,477	4.2%
Half Moon Bay	$278,383,417	$76,831,533	$355,214,950	4.5%
Hillsborough	$38,053,962	$15,772,284	$53,826,246	1.1%
Menlo Park	$129,358,772	$60,182,147	$189,540,919	1.0%
Millbrae	$331,905,526	$87,284,291	$419,189,817	4.3%
Pacifica	$455,382,349	$144,202,021	$599,584,370	5.4%
Portola Valley	$17,519,880	$9,485,495	$27,005,376	1.0%
Redwood City	$791,008,476	$222,022,851	$1,013,031,328	2.8%
San Bruno	$656,888,038	$172,089,231	$828,977,269	4.8%
San Carlos	$309,394,109	$101,122,441	$410,516,550	2.0%
San Mateo	$1,138,513,114	$312,269,561	$1,450,782,676	3.3%
South San Francisco	$1,671,589,423	$585,992,614	$2,257,582,037	7.1%
Woodside	$17,457,254	$9,543,071	$27,000,326	0.9%
Unincorporated	$1,075,062,778	$358,724,420	$1,433,787,198	4.5%
Total	**$9,292,523,842**	**$2,825,511,298**	**$12,118,035,139**	**3.8%**

Note: Values shown are accurate only for comparison among results in this plan. See Section 2, Chapter 1 for a discussion of data limitations.

TABLE 5-14. LOSS ESTIMATES FOR SAN ANDREAS, M7.8

Jurisdiction	Estimated Loss Associated with Earthquake			
	Structure	Contents	Total	% of Total
Atherton	$152,011,769	$45,401,160	$197,412,929	5.1%
Belmont	$601,637,193	$186,596,597	$788,233,790	7.6%
Brisbane	$317,029,327	$76,750,817	$393,780,144	9.3%
Burlingame	$2,712,332,551	$835,718,453	$3,548,051,004	16.6%
Colma	$326,424,256	$96,502,478	$422,926,734	18.2%
Daly City	$2,538,674,418	$704,045,022	$3,242,719,440	13.0%
East Palo Alto	$546,342,364	$169,695,479	$716,037,843	12.2%
Foster City	$867,051,330	$265,023,822	$1,132,075,152	13.8%
Half Moon Bay	$304,208,876	$89,851,951	$394,060,826	5.0%
Hillsborough	$265,482,123	$79,246,720	$344,728,843	7.3%
Menlo Park	$775,145,560	$272,064,609	$1,047,210,169	5.7%
Millbrae	$1,217,987,732	$366,606,664	$1,584,594,396	16.2%
Pacifica	$750,537,178	$224,876,654	$975,413,832	8.8%
Portola Valley	$218,798,422	$71,829,801	$290,628,224	10.7%

TABLE 5-14. LOSS ESTIMATES FOR SAN ANDREAS, M7.8

Jurisdiction	Estimated Loss Associated with Earthquake			
	Structure	Contents	Total	% of Total
Redwood City	$3,134,686,143	$970,446,457	$4,105,132,600	11.4%
San Bruno	$2,523,134,653	$770,712,070	$3,293,846,723	18.9%
San Carlos	$2,064,220,283	$711,285,669	$2,775,505,952	13.7%
San Mateo	$4,177,042,528	$1,231,790,690	$5,408,833,218	12.5%
South San Francisco	$4,799,981,960	$1,712,950,502	$6,512,932,462	20.3%
Woodside	$143,477,344	$50,405,067	$193,882,411	6.7%
Unincorporated	$1,808,170,691	$566,788,321	$2,374,959,012	7.4%
Total	$30,244,376,700	$9,498,589,003	$39,742,965,702	**12.4%**

Note: Values shown are accurate only for comparison among results in this plan. See Section 2, Chapter 1 for a discussion of data limitations.

Earthquake-Caused Debris

The HAZUS-MH analysis estimated the amount of earthquake-caused debris in the planning area for the 100-year and 500-year earthquakes and the two scenario events, as summarized in Table 5-15.

TABLE 5-15. ESTIMATED EARTHQUAKE-CAUSED DEBRIS

	Debris to Be Removed (tons)[a]	Estimated Number of Truckloads [b]
100-Year Earthquake	4,202,544	168,102
500-Year Earthquake	18,214,779	728,591
Northern San Andreas Scenario, M7.5	3,708,560	148,342
San Gregorio Scenario, M7.8	12,012,789	480,512

a. Debris generation estimates were based on updated general building stock dataset at a Census Tract analysis level.

b. Hazus-MH assumes 25 tons/trucks

Note: Values shown are accurate only for comparison among results in this plan. See Section 2, Chapter 1 for a discussion of data limitations.

5.5.3 Critical Facilities

Level of Damage

HAZUS-MH classifies the vulnerability of critical facilities to earthquake damage in five categories: no damage, slight damage, moderate damage, extensive damage, or complete damage. The model was used to assign a vulnerability category to each critical facility in the planning area. The analysis was performed for the 100-Year Probabilistic, 500-Year Probabilistic, San Gregorio M 7.5 and N San Andreas M 7.8 events. Results are summarized in Table 5-16 through Table 5-19.

TABLE 5-16. ESTIMATED DAMAGE TO CRITICAL FACILITIES FROM 100-YEAR PROBABILISTIC EARTHQUAKE

Category[a,b]	Damage Extent				
	None	Slight	Moderate	Extensive	Complete
Medical and Health Services	74.59	15.79	1.26%	0.08	8.25

TABLE 5-16. ESTIMATED DAMAGE TO CRITICAL FACILITIES FROM 100-YEAR PROBABILISTIC EARTHQUAKE

Category[a,b]	Damage Extent				
	None	Slight	Moderate	Extensive	Complete
Emergency Services	59.75	25.99	6.90%	0.33	7.01
Government	25.43	21.99	29.65%	13.40	9.51
Utilities	17.98	39.77	31.36%	7.61	3.27
Transportation Infrastructure	67.34	13.66	3.63%	5.59	9.75
Hazardous Materials	21.44	14.75	26.70	20.52	16.56
Community Economic Facilities	33.94	31.54	25.27	4.69	4.52
Other Assets	61.99	29.17	3.76	0.10	4.95
Overall	**45.31**	**24.08**	**16.07**	**6.54**	**7.98**

a. Damage extent was determined by selecting the highest probability damage state for each facility.

b. Hazus-MH does not produce damage estimates for dams. It is likely that owner/operators have already performed in depth, site-specific seismic hazard analysis.

Note: Values shown are accurate only for comparison among results in this plan. See Section 2, Chapter 1 for a discussion of data limitations.

TABLE 5-17. ESTIMATED DAMAGE TO CRITICAL FACILITIES FROM 500-YEAR PROBABILISTIC EARTHQUAKE

Category[a]	Damage Extent				
	None	Slight	Moderate	Extensive	Complete
Medical and Health Services	41.06	40.72	8.18	0.51	9.51
Emergency Services	24.57	37.20	25.75	3.20	9.25
Government	1.04	3.06	15.03	30.51	50.32
Utilities	1.05	10.64	34.41	34.60	19.27
Transportation Infrastructure	28.15	14.10	9.23	17.37	31.13
Hazardous Materials	0.84	2.38	13.30	26.90	56.55
Community Economic Facilities	1.50	6.42	30.15	30.90	31.01
Other Assets	27.82	46.89	17.78	1.10	6.39
Overall	**15.75**	**20.18**	**19.23**	**18.14**	**26.68**

a. Damage extent was determined by selecting the highest probability damage state for each facility.

b. Hazus-MH does not produce damage estimates for dams. It is likely that owner/operators have already performed in depth, site-specific seismic hazard analysis.

Note: Values shown are accurate only for comparison among results in this plan. See Section 2, Chapter 1 for a discussion of data limitations.

TABLE 5-18. ESTIMATED DAMAGE TO CRITICAL FACILITIES FROM SAN GREGORIO M7.5 EARTHQUAKE

Category[a]	Damage Extent				
	None	Slight	Moderate	Extensive	Complete
Medical and Health Services	79.92	10.95	0.30	0.01	8.80
Emergency Services	74.46	17.21	1.74	0.04	6.55
Government	29.01	32.69	26.95	3.91	7.42

TABLE 5-18. ESTIMATED DAMAGE TO CRITICAL FACILITIES FROM SAN GREGORIO M7.5 EARTHQUAKE

Category[a]	Damage Extent				
	None	Slight	Moderate	Extensive	Complete
Utilities	21.35	40.34	28.40	6.35	3.55
Transportation Infrastructure	67.27	13.67	3.61	4.91	10.52
Hazardous Materials	38.55	22.66	22.39	3.60	12.77
Community Economic Facilities	29.52	43.30	21.73	1.94	3.50
Other Assets	78.52	16.55	0.45	0.02	4.44
Overall	**52.33**	**24.67**	**13.20**	**2.60**	**7.19**

c. Damage extent was determined by selecting the highest probability damage state for each facility.

d. Hazus-MH does not produce damage estimates for dams. It is likely that owner/operators have already performed in depth, site-specific seismic hazard analysis.

Note: Values shown are accurate only for comparison among results in this plan. See Section 2, Chapter 1 for a discussion of data limitations.

TABLE 5-19. ESTIMATED DAMAGE TO CRITICAL FACILITIES FROM N SAN ANDREAS M7.8 EARTHQUAKE

Category[a]	Damage Extent				
	None	Slight	Moderate	Extensive	Complete
Medical and Health Services	64.36	25.99	0.73	0.00	8.90
Emergency Services	37.18	42.51	12.10	0.20	7.99
Government	0.66	5.54	33.60	41.45	18.73
Utilities	7.39	28.95	38.66	16.15	8.82
Transportation Infrastructure	49.73	16.88	6.85	9.96	16.56
Hazardous Materials	0.81	2.77	20.24	43.11	33.04
Community Economic Facilities	1.86	15.64	54.62	20.70	7.16
Other Assets	41.88	47.96	4.15	0.01	5.98
Overall	**25.48**	**23.28**	**21.37**	**16.45**	**13.40**

e. Damage extent was determined by selecting the highest probability damage state for each facility.

f. Hazus-MH does not produce damage estimates for dams. It is likely that owner/operators have already performed in depth, site-specific seismic hazard analysis.

Note: Values shown are accurate only for comparison among results in this plan. See Section 2, Chapter 1 for a discussion of data limitations.

Time to Return to Functionality

HAZUS-MH estimates the time to restore critical facilities to fully functional use. Results are presented as probability of being functional at specified time increments: 1, 3, 7, 14, 30 and 90 days after the event. For example, HAZUS-MH may estimate that a facility has 5 percent chance of being fully functional at Day 3, and a 95-percent chance of being fully functional at Day 90. Results from the 100- and 500-year probabilistic and the San gregorio and San Andreas scenario events are summarized in Table 5-20 through Table 5-23.

TABLE 5-20. FUNCTIONALITY OF CRITICAL FACILITIES FOR 100-YEAR EARTHQUAKE

Category[a]	# of Critical Facilities	Probability of Being Fully Functional (%)[a]					
		at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Medical and Health Services	10	74.5	74.9	90.0	90.4	91.6	91.6
Emergency Services	81	59.7	60.3	85.1	85.7	92.6	92.8
Government	50	25.4	26.4	47.3	47.4	77.0	90.1
Utilities	188	50.5	75.4	89.2	93.2	96.7	99.4
Transportation Infrastructure	412	80.4	84.2	85.4	85.6	86.1	89.4
Hazardous Materials	71	21.4	22.1	36.1	36.1	62.8	83.4
Community Economic Facilities	103	33.9	35.4	65.3	65.4	90.7	95.4
Other Assets	269	61.9	62.6	90.4	91.1	94.9	94.9
Total/Average	**1,184**	**51.0**	**55.2**	**73.6**	**74.4**	**86.6**	**92.1**

a. Hazus-MH does not produce functionality estimates for dams. It is likely that owner/operators have already performed in depth, site-specific seismic hazard analysis.

Note: Values shown are accurate only for comparison among results in this plan. See Section 2, Chapter 1 for a discussion of data limitations.

TABLE 5-21. FUNCTIONALITY OF CRITICAL FACILITIES FOR PROBABILISTIC 500-YEAR EARTHQUAKE

	# of Critical Facilities	Probability of Being Fully Functional (%)[a]					
		at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Medical and Health Services	10	41.0	42.0	80.8	81.7	89.9	90.2
Emergency Services	81	24.5	25.4	60.9	61.8	87.5	89.1
Government	50	1.0	1.1	4.0	4.1	19.1	49.2
Utilities	188	20.4	36.1	54.2	65.2	80.8	95.3
Transportation Infrastructure	412	44.2	50.2	53.4	54.2	55.8	66.5
Hazardous Materials	71	0.8	0.9	3.2	3.2	16.5	43.4
Community Economic Facilities	103	1.5	1.8	7.9	7.9	38.0	68.9
Other Assets	269	27.8	28.8	73.6	74.7	92.4	93.0
Total/Average	**1,184**	**20.2**	**23.3**	**42.3**	**44.1**	**60.0**	**74.5**

a. Hazus-MH does not produce functionality estimates for dams. It is likely that owner/operators have already performed in depth, site-specific seismic hazard analysis.

Note: Values shown are accurate only for comparison among results in this plan. See Section 2, Chapter 1 for a discussion of data limitations.

TABLE 5-22. FUNCTIONALITY OF CRITICAL FACILITIES FOR SAN GREGORIO M7.5 EARTHQUAKE

	# of Critical Facilities	Probability of Being Fully Functional (%)[a]					
		at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Medical and Health Services	10	79.9	80.1	90.6	90.8	91.1	91.1
Emergency Services	81	74.4	74.8	91.2	91.6	93.3	93.3
Government	50	29.0	30.5	61.5	61.7	88.6	92.2
Utilities	188	53.5	77.6	90.0	93.5	96.5	99.4
Transportation Infrastructure	412	80.3	84.1	85.3	85.6	86.0	89.0
Hazardous Materials	71	38.5	39.6	61.1	61.2	83.5	87.2
Community Economic Facilities	103	29.5	31.5	72.6	72.8	94.5	96.4
Other Assets	269	78.5	78.8	94.6	95.0	95.5	95.5
Total/Average	**1,184**	**58.0**	**62.1**	**80.9**	**81.5**	**91.1**	**93.0**

b. Hazus-MH does not produce functionality estimates for dams. It is likely that owner/operators have already performed in depth, site-specific seismic hazard analysis.

Note: Values shown are accurate only for comparison among results in this plan. See Section 2, Chapter 1 for a discussion of data limitations.

TABLE 5-23. FUNCTIONALITY OF CRITICAL FACILITIES FOR N SAN ANDREAS M7.8 EARTHQUAKE

	# of Critical Facilities	Probability of Being Fully Functional (%)[a]					
		at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Medical and Health Services	10	64.3	64.9	89.7	90.3	91.0	91.0
Emergency Services	81	37.1	38.1	78.7	79.7	91.7	91.8
Government	50	0.6	0.9	6.1	6.1	39.8	80.9
Utilities	188	36.6	59.7	77.1	83.6	90.9	97.9
Transportation Infrastructure	412	66.5	72.3	74.6	75.1	76.0	82.0
Hazardous Materials	71	0.8	0.9	3.5	3.5	23.8	66.9
Community Economic Facilities	103	1.8	2.6	17.4	17.5	72.1	92.8
Other Assets	269	41.8	42.9	88.7	89.8	93.9	93.9
Total/Average	**1,184**	**31.2**	**35.3**	**54.5**	**55.7**	**72.4**	**87.2**

c. Hazus-MH does not produce functionality estimates for dams. It is likely that owner/operators have already performed in depth, site-specific seismic hazard analysis.

Note: Values shown are accurate only for comparison among results in this plan. See Section 2, Chapter 1 for a discussion of data limitations.

Hazardous Materials

Hazardous material releases from fixed facilities and transportation-related releases can occur during an earthquake.

Transportation

Roads have the potential to be significantly damaged during an earthquake. Access to major roads is crucial to life and safety after a disaster event as well as to response and recovery operations. Disruption in transportation systems are of particular concern to coastal residents, as a major event has the potential to isolate communities from critical assistance and aid. Additionally, Bay Area Rapid Transit (BART) provides transportation service to the northern portion of San Mateo County from South San Francisco to Millbrae and the San Francisco Airport. Much of BART transportation infrastructure located in San Mateo County is underground. BART tunnels may collapse during a high magnitude event, leading to loss of life and potential hazardous materials release.

Bridges

Earthquake events can significantly damage bridges, which often provide the only access to some neighborhoods. Since soft soil regions generally follow floodplain boundaries, bridges that cross water courses are considered vulnerable. Since many of the County's bridges provide access across water courses, most are at least somewhat vulnerable to earthquakes. Key factors in the degree of vulnerability are the facility's age and type of construction, which indicate the standards to which the facility was built.

Water and Sewer Infrastructure

Water and sewer infrastructure would likely suffer considerable damage in the event of an earthquake. This factor is difficult to analyze based on the amount of infrastructure and because water and sewer infrastructure are usually linear easements, which are difficult to thoroughly assess in HAZUS. Without further analysis of individual system components, it should be assumed that these systems are exposed to breakage and failure.

5.5.4 Environment

The environment vulnerable to earthquake hazard is the same as the environment exposed to the hazard.

5.5.5 Economic Impact

Earthquake events can severely disrupt the economy of the affected area. Economic impact will be largely associated with the disruption of services caused by an earthquake event. In general, significant events may cause damage to land, buildings, transportation infrastructure, and businesses. With an event of such significance, economic recovery could take years, depending on available recovery funds.

5.6 Future Trends in Development

The County of San Mateo is expected to grow considerably in the next 10 years, with an estimated population of 832,000 by 2025. Significant non-residential development will occur as well, with increasing establishment of technology companies throughout the County likely in the near future.

San Mateo County considers land use development and environmental and hazard protection needs in its Shared Vision 2025. The County seeks to ensure a "prosperous community" through encouraging innovation in the local economy, creating jobs, and building community and educational opportunities; improving affordability; and closing achievement gaps. It also seeks a "livable community," with growth occurring near transit to promote affordable and interconnected communities. Under its "environmentally conscious community" category, San Mateo seeks to preserve natural resources through stewardship; reduce carbon emissions; and use energy, water, and land more efficiently. Performance measures and benchmarks are updated annually on the Shared Vision 2025 website (https://performance.smcgov.org/shared-vision), allowing residents to consistently assess the success and outcomes of local initiatives.

Unincorporated San Mateo County and the development departments in participating jurisdictions will strictly enforce all seismic building codes and design standards to prevent loss of life and property caused by earthquake. Public education, cooperation with the development community, and individual preparedness are essential as the planning area welcomes thousands of new residents and hundreds of new businesses to each year.

Additionally, land use planning is also directed by general plans adopted under California's General Planning Law. Municipal planning partners are encouraged to establish General Plans with policies directing land use and dealing with issues of geologic and seismic safety. These plans provide the capability at the local municipal level to protect future development from the impacts of earthquakes. All planning partners reviewed their general plans under the capability assessments performed for this effort. Deficiencies identified by these reviews can be identified as mitigation actions to increase the capability to deal with future trends in development.

Since all of San Mateo is located within an earthquake hazard zone, all future development will, to some extent, be exposed to the earthquake hazard. Tables 5-24 through 5-26 provides future development acres and percentages as related specifically to moderate, high, and very high liquefaction susceptibility.

TABLE 5-24. FUTURE DEVELOPMENT ACRES AND PERCENTAGES RELATED TO MODERATE

	Agriculture/Resource Extraction		Commercial		Education		Industrial		Mixed Use		Other/Unknown		Parks/Open Space		Residential		Water		Total
Jurisdiction	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)
ATHERTON	0.0	0.00%	0.6	0.02%	203.0	8.16%	0.0	0.00%	0.0	0.00%	37.7	1.51%	54.8	2.20%	2,192.2	88.10%	0.0	0.00%	**2,488.3**
BELMONT	0.0	0.00%	57.9	15.37%	57.0	15.12%	5.6	1.47%	10.6	2.82%	37.0	9.82%	26.5	7.04%	182.3	48.37%	0.0	0.00%	**376.8**
BRISBANE	0.0	0.00%	40.4	79.95%	0.0	0.00%	0.0	0.00%	0.0	0.00%	9.1	17.91%	0.9	1.70%	0.2	0.44%	0.0	0.00%	**50.6**
BURLINGAME	0.0	0.00%	87.7	13.42%	22.4	3.42%	0.0	0.00%	24.4	3.73%	218.1	33.37%	5.1	0.77%	296.1	45.29%	0.0	0.00%	**653.7**
COLMA	0.0	0.00%	11.6	71.93%	0.0	0.00%	0.0	0.00%	0.0	0.00%	4.5	28.04%	0.0	0.00%	0.0	0.03%	0.0	0.00%	**16.2**
DALY CITY	0.0	0.00%	3.9	12.83%	0.0	0.00%	0.0	0.00%	0.0	0.00%	5.5	17.91%	8.8	28.73%	12.4	40.53%	0.0	0.00%	**30.7**
EAST PALO ALTO	0.2	0.02%	32.0	4.54%	0.0	0.00%	15.8	2.24%	0.0	0.00%	124.2	17.59%	142.2	20.15%	391.4	55.46%	0.0	0.00%	**705.8**
FOSTER CITY	0.0	0.00%	155.5	53.74%	7.0	2.42%	0.3	0.12%	0.5	0.17%	7.5	2.61%	42.5	14.68%	75.0	25.91%	1.0	0.36%	**289.4**
HALF MOON BAY	101.7	6.69%	103.2	6.79%	54.2	3.57%	9.7	0.64%	0.0	0.00%	555.7	36.58%	219.0	14.42%	475.5	31.30%	0.0	0.00%	**1,518.9**
HILLSBOROUGH	0.0	0.00%	0.0	0.00%	6.6	6.00%	0.0	0.00%	0.0	0.00%	21.0	18.99%	0.1	0.12%	82.7	74.89%	0.0	0.00%	**110.4**
MENLO PARK	1,747.2	35.14%	343.4	6.91%	206.0	4.14%	517.6	10.41%	0.0	0.00%	205.1	4.13%	399.8	8.04%	1,552.5	31.23%	0.0	0.00%	**4,971.6**
MILLBRAE	0.0	0.00%	23.1	10.34%	18.3	8.19%	0.0	0.00%	0.1	0.07%	36.2	16.24%	29.8	13.34%	115.7	51.83%	0.0	0.00%	**223.2**
PACIFICA	9.4	0.69%	86.0	6.34%	109.9	8.11%	0.0	0.00%	0.0	0.00%	207.8	15.32%	134.7	9.93%	808.2	59.60%	0.1	0.01%	**1,356.1**
PORTOLA VALLEY	0.0	0.00%	5.9	1.43%	70.1	16.94%	0.0	0.00%	0.0	0.00%	12.8	3.08%	135.0	32.60%	190.2	45.95%	0.0	0.00%	**414.0**
REDWOOD CITY	0.0	0.00%	235.9	2.71%	122.5	1.41%	313.6	3.61%	126.8	1.46%	2,943.6	33.87%	3,338.9	38.42%	1,608.6	18.51%	0.0	0.00%	**8,689.9**
SAN BRUNO	0.0	0.00%	5.4	6.41%	1.9	2.25%	13.3	15.88%	0.0	0.00%	5.2	6.24%	21.4	25.56%	36.5	43.66%	0.0	0.00%	**83.6**
SAN CARLOS	0.0	0.00%	177.5	16.75%	0.0	0.00%	157.9	14.91%	0.0	0.00%	13.4	1.26%	60.7	5.73%	649.8	61.35%	0.0	0.00%	**1,059.3**
SAN MATEO	0.0	0.00%	251.6	17.18%	105.3	7.19%	7.3	0.50%	97.2	6.64%	127.5	8.71%	81.1	5.54%	794.2	54.24%	0.0	0.00%	**1,464.3**
SOUTH SAN FRANCISCO	0.0	0.00%	17.1	11.93%	0.9	0.66%	0.8	0.54%	4.5	3.13%	56.5	39.29%	2.5	1.71%	61.4	42.74%	0.0	0.00%	**143.7**
WOODSIDE	0.0	0.00%	0.3	0.04%	0.0	0.00%	0.0	0.00%	0.3	0.04%	5.9	0.74%	663.9	83.05%	129.0	16.14%	0.0	0.00%	**799.4**
UNINCORPORATED	3,383.6	40.92%	108.9	1.32%	33.9	0.41%	173.3	2.10%	309.4	3.74%	479.7	5.80%	2,573.8	31.13%	1,205.8	14.58%	0.0	0.00%	**8,268.4**
Total	**5,242.1**	**15.55%**	**1,747.9**	**5.18%**	**1,019.1**	**3.02%**	**1,215.1**	**3.60%**	**573.9**	**1.70%**	**5,114.0**	**15.17%**	**7,941.4**	**23.55%**	**10,859.8**	**32.21%**	**1.2**	**0.00%**	**33,714.4**

TABLE 5-25. FUTURE DEVELOPMENT ACRES AND PERCENTAGES RELATED TO HIGH

	Agriculture/Resource Extraction		Commercial		Education		Industrial		Mixed Use		Other/Unknown		Parks/Open Space		Residential		Water		Total
Jurisdiction	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)
ATHERTON	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
BELMONT	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
BRISBANE	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
BURLINGAME	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
COLMA	0.0	0.00%	32.5	45.70%	1.3	1.80%	0.0	0.00%	0.1	0.10%	37.2	52.28%	0.0	0.00%	0.1	0.12%	0.0	0.00%	**71.1**
DALY CITY	0.0	0.00%	4.2	15.38%	7.7	28.51%	0.0	0.00%	0.0	0.00%	1.5	5.37%	5.5	20.32%	8.2	30.42%	0.0	0.00%	**27.0**
EAST PALO ALTO	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
FOSTER CITY	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
HALF MOON BAY	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
HILLSBOROUGH	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
MENLO PARK	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
MILLBRAE	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
PACIFICA	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	3.3	43.80%	4.2	56.20%	0.0	0.00%	0.0	0.00%	**7.5**
PORTOLA VALLEY	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
REDWOOD CITY	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
SAN BRUNO	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
SAN CARLOS	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
SAN MATEO	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
SOUTH SAN FRANCISCO	0.0	0.00%	47.6	14.29%	14.2	4.25%	9.3	2.78%	26.4	7.93%	94.6	28.37%	33.9	10.18%	107.3	32.19%	0.0	0.00%	**333.4**
WOODSIDE	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	2.7	6.29%	4.9	11.30%	35.5	82.02%	0.2	0.38%	0.0	0.00%	**43.3**
UNINCORPORATED	2,467.6	73.81%	13.5	0.40%	32.1	0.96%	0.2	0.01%	68.8	2.06%	35.4	1.06%	616.9	18.45%	108.8	3.26%	0.0	0.00%	**3,343.3**
Total	**2,467.6**	**64.50%**	**97.8**	**2.56%**	**55.3**	**1.44%**	**9.5**	**0.25%**	**98.0**	**2.56%**	**176.7**	**4.62%**	**696.0**	**18.19%**	**224.6**	**5.87%**	**0.0**	**0.00%**	**3,825.5**

TABLE 5-26. FUTURE DEVELOPMENT ACRES AND PERCENTAGES RELATED TO VERY HIGH

	Agriculture/Resource Extraction		Commercial		Education		Industrial		Mixed Use		Other/Unknown		Parks/Open Space		Residential		Water		Total
Jurisdiction	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)
ATHERTON	0.0	0.00%	0.0	0.00%	2.6	3.94%	0.0	0.00%	0.0	0.00%	0.7	1.09%	19.9	30.47%	42.0	64.50%	0.0	0.00%	**65.2**
BELMONT	0.0	0.00%	7.0	3.50%	3.5	1.74%	27.6	13.83%	62.5	31.35%	55.8	27.97%	7.9	3.94%	33.2	16.63%	2.1	1.03%	**199.3**
BRISBANE	0.1	0.01%	645.8	64.70%	0.0	0.00%	0.0	0.00%	0.0	0.00%	210.4	21.08%	141.7	14.19%	0.2	0.02%	0.0	0.00%	**998.1**
BURLINGAME	0.0	0.00%	196.0	26.48%	0.0	0.00%	0.0	0.00%	259.3	35.03%	159.1	21.49%	118.2	15.97%	7.6	1.03%	0.0	0.00%	**740.2**
COLMA	0.0	0.00%	0.1	3.31%	0.0	0.00%	0.0	0.00%	0.0	0.00%	2.9	96.69%	0.0	0.00%	0.0	0.00%	0.0	0.00%	**3.0**
DALY CITY	0.0	0.00%	0.3	0.95%	0.0	0.00%	0.1	0.36%	0.0	0.00%	1.1	3.63%	29.4	95.06%	0.0	0.00%	0.0	0.00%	**30.9**
EAST PALO ALTO	0.5	0.06%	91.3	10.06%	0.2	0.02%	119.0	13.11%	0.0	0.00%	193.6	21.32%	115.6	12.74%	387.5	42.69%	0.0	0.00%	**907.7**
FOSTER CITY	0.0	0.00%	298.2	12.75%	80.6	3.45%	54.5	2.33%	12.6	0.54%	16.7	0.71%	166.0	7.10%	1,478.0	63.22%	231.3	9.89%	**2,337.8**
HALF MOON BAY	11.6	5.57%	9.6	4.59%	3.6	1.71%	1.2	0.59%	0.0	0.00%	69.9	33.57%	106.6	51.19%	5.8	2.79%	0.0	0.00%	**208.2**
HILLSBOROUGH	0.0	0.00%	0.0	0.00%	0.3	0.70%	0.0	0.00%	0.0	0.00%	9.1	21.77%	7.6	18.12%	24.8	59.41%	0.0	0.00%	**41.7**
MENLO PARK	80.5	10.47%	49.9	6.48%	49.7	6.46%	113.7	14.77%	0.0	0.00%	144.2	18.74%	71.5	9.29%	260.0	33.78%	0.0	0.00%	**769.5**
MILLBRAE	0.0	0.00%	15.4	9.90%	0.0	0.00%	19.9	12.80%	0.5	0.30%	86.9	55.96%	11.7	7.54%	21.0	13.50%	0.0	0.00%	**155.3**
PACIFICA	1.2	0.56%	4.8	2.26%	2.3	1.08%	0.0	0.00%	0.0	0.00%	56.5	26.73%	107.5	50.83%	24.5	11.57%	14.7	6.97%	**211.5**
PORTOLA VALLEY	0.0	0.00%	0.0	0.00%	3.2	5.42%	0.0	0.00%	0.0	0.00%	5.9	10.01%	17.1	28.86%	33.1	55.71%	0.0	0.00%	**59.4**
REDWOOD CITY	0.0	0.00%	439.2	15.64%	31.9	1.14%	309.6	11.02%	14.7	0.52%	1,120.7	39.90%	398.5	14.19%	494.4	17.60%	0.0	0.00%	**2,809.0**
SAN BRUNO	0.0	0.00%	0.6	2.10%	0.0	0.00%	11.2	38.53%	0.0	0.00%	1.7	5.75%	0.0	0.00%	15.6	53.61%	0.0	0.00%	**29.2**
SAN CARLOS	0.0	0.00%	36.2	8.90%	9.4	2.31%	156.8	38.59%	0.0	0.00%	183.0	45.03%	10.7	2.64%	10.3	2.53%	0.0	0.00%	**406.3**
SAN MATEO	0.0	0.00%	311.9	11.04%	126.0	4.46%	3.2	0.11%	82.6	2.92%	338.5	11.98%	489.2	17.31%	1,474.2	52.17%	0.0	0.00%	**2,825.7**
SOUTH SAN FRANCISCO	0.0	0.00%	476.1	34.66%	0.0	0.00%	465.7	33.90%	21.4	1.56%	355.7	25.89%	49.9	3.63%	5.1	0.37%	0.0	0.00%	**1,373.9**
WOODSIDE	0.0	0.00%	1.6	1.37%	0.0	0.00%	0.0	0.00%	0.0	0.00%	5.7	4.88%	54.7	47.07%	54.2	46.68%	0.0	0.00%	**116.1**
UNINCORPORATED	669.3	12.54%	7.2	0.13%	3.9	0.07%	17.0	0.32%	102.8	1.93%	2,341.0	43.86%	2,146.4	40.21%	50.0	0.94%	0.0	0.00%	**5,337.5**
Total	**763.2**	**3.89%**	**2,591.0**	**13.20%**	**317.1**	**1.62%**	**1,299.5**	**6.62%**	**556.3**	**2.83%**	**5,359.0**	**27.31%**	**4,070.0**	**20.74%**	**4,421.4**	**22.53%**	**248.1**	**1.26%**	**19,625.6**

5.7 Scenario

Any seismic activity of 6.0 or greater on faults within the planning area would have significant impacts throughout the County. Potential warning systems could give approximately 40 seconds notice that a major earthquake is about to occur. This warning would not provide adequate time for preparation. Earthquakes of this magnitude or higher would lead to massive structural failure of property on NEHRP C, D, E, and F soils. Levees and revetments built on these poor soils would likely fail, representing a loss of critical infrastructure. These events could cause secondary hazards, including landslides and mudslides that would further damage structures. Hydraulic-fill sediment areas are also vulnerable to slope failure, often as a result of loss of cohesion in clay-rich soils. Soil liquefaction would occur in water-saturated sands, silts, or gravelly soils.

5.8 Issues

Important issues associated with an earthquake include but are not limited to the following:

- More information is needed on the exposure and performance of soft-story construction within the planning area.
- Based on the modeling of critical facility performance performed for this plan, a high number of facilities in the planning area are expected to suffer complete or extensive damage from scenario events. These facilities are prime targets for structural retrofits.
- Critical facility owner should be encouraged to create or enhance Continuity of Operations Plans using the information on risk and vulnerability contained in this plan.
- Geotechnical standards should be established that take into account the probable impacts from earthquakes in the design and construction of new or enhanced facilities.
- There are a large number of earthen dams within the planning area. Dam failure warning and evacuation plans and procedures should be reviewed and updated to reflect the dams' risk potential associated with earthquake activity in the region. The County levees should also be included in any assessments for earthquake risk.
- Earthquakes could trigger other natural hazard events such as dam failures, flooding, fire, and landslides, which could severely damage the County.
- A worst-case scenario would be the occurrence of a large seismic event during a flood or high-water event. Levees would fail at multiple locations, increasing the impacts of the individual events.
- Citizens are expected to be self-sufficient up to 3 days after a major earthquake without government response agencies, utilities, private-sector services, and infrastructure components. Education programs are currently in place to facilitate development of individual, family, neighborhood, and business earthquake preparedness. Government alone can never make this region fully prepared. It takes individuals, families, and communities working in concert with one another to truly be prepared for disaster.
- After a major seismic event, San Mateo County is likely to experience disruptions in the flow of goods and services resulting from the destruction of major transportation infrastructure across the broader region.

Chapter 6. Flood

6.1 Hazard Description

Floods are one of the most common natural hazards in the United States. They can develop slowly over a period of days or develop quickly, with disastrous effects that can be local (impacting a neighborhood or community) or regional (affecting entire river basins, coastlines, and multiple counties or states).

DEFINITIONS

Flood —Inundation of normally dry land resulting from rising and overflowing of a body of water.

Floodplain —Land area along the sides of a river that becomes inundated with water during a flood.

Regulatory Floodway —Channel of a river or other watercourse and adjacent land areas that must be reserved for discharge of the base flood without cumulatively increasing water surface elevation more than a designated height. Communities must regulate development in these floodways to ensure no increases in upstream flood elevations.

1-Percent Annual Chance Flood — Also known as the Special Flood Hazard Area (SFHA) or 100-year floodplain. The area inundated by a flood that has a 1-percent chance of being equaled or exceeded each year.

0.2-Percent Annual Chance Flood —Also known as the 500-year floodplain. The area inundated by floodwaters that has a 0.2-percent chance of being equaled or exceeded each year.

Return Period —Average number of years between occurrences of a hazard (equal to the inverse of the annual likelihood of occurrence).

6.1.1 General Background

A floodplain is defined as the land adjoining a channel of a river, stream, ocean, lake, or other watercourse or water body that becomes inundated with water during a flood. Floodplains may be broad, as when a river crosses an extensive flat landscape, or narrow, as when a river is confined in a canyon.

When floodwaters recede after a flood event, they leave behind layers of rock and mud. These gradually build up to create a new floor of the floodplain. Floodplains generally contain unconsolidated sediments (accumulations of sand, gravel, loam, silt, and/or clay), often extending below the bed of the stream. These sediments provide a natural filtering system, with water percolating back into the ground and replenishing groundwater. These are often important aquifers, as water drawn from them has been filtered, unlike water in the stream. Fertile, flat, reclaimed floodplain lands are commonly used for agriculture, commerce, and residential development.

Connections between a water source and its floodplain are most apparent during and after major flood events. These areas form a complex physical and biological system that not only supports a variety of natural resources but also provides natural flood and erosion control. When a river is separated from its floodplain by levees and other flood control facilities, natural, built-in benefits can be lost, altered, or significantly reduced.

6.1.2 Measuring Floods and Floodplains

Frequency and severity of flooding are measured by use of a discharge probability—probability that a certain river discharge (flow) level will be equaled or exceeded in a given year. Flood studies reference historical records to determine probabilities of occurrence of different discharge levels. Flood frequency equals 100 divided by the discharge probability. For example, the 100-year discharge has a 1-percent chance of being equaled or exceeded in any given year. The “annual flood” is the greatest flood event expected to occur in a typical year. Measurements reflect statistical averages only; two or more floods with 100-year or higher recurrence intervals can occur within a short time period. Recurrence intervals can differ at different points on a river; for example, an event may be a 100-year flood on the main river but a 50-year flood on the river’s tributaries or farther downstream.

Extent of flooding associated with a 1-percent annual probability of occurrence (the base flood or 100-year flood) is used as the regulatory boundary by many federal, state, and local agencies. Also referred to as the special flood hazard area (SFHA), this boundary is a convenient tool for assessing vulnerability and risk in flood-prone communities. Many communities have maps that show the extent and likely depth of flooding for the base flood. Corresponding water-surface elevations describe the elevation of water that will result from a given discharge level, one of the most important factors in estimating flood damage.

6.1.3 Floodplain Ecosystems

Floodplains can support ecosystems rich in plant and animal species. A floodplain can contain 100 or even 1,000 times as many species as a river. Wetting of the floodplain soil releases an immediate surge of nutrients: those left over from the last flood, and those that result from rapid decomposition of organic matter that has accumulated since then. Microscopic organisms thrive and larger species enter a rapid breeding cycle. Opportunistic feeders (particularly birds) move in to take advantage. Production of nutrients peaks and falls away quickly, but the surge of new growth endures for some time. This renders floodplains valuable for agriculture. Species growing in floodplains differ markedly from those that grow outside floodplains. For instance, riparian trees (trees that grow in floodplains) tend to be very tolerant of root disturbance and very quick-growing compared to non-riparian trees.

6.1.4 Effects of Human Activities

Because they border water bodies, floodplains have historically been popular sites to establish settlements. Human activities tend to concentrate in floodplains for a number of reasons: water is readily available, land is fertile and suitable for farming, transportation by water is easily accessible, and land is flatter and easier to develop. Yet human activity in floodplains frequently interferes with natural functions of floodplains. It can affect distribution and timing of drainage, thereby increasing flood problems. Human development can create local flooding problems by altering or confining drainage channels, increasing flood potential in two ways: reducing the stream’s capacity to contain flows, and increasing flow rates or velocities downstream during all stages of a flood event. As a result, Flood Insurance Rate Maps (FIRM) delineate regulatory floodways where development is minimized or prohibited. Development projects within floodways are highly regulated and proceed case by case.

6.1.5 Federal Flood Programs

National Flood Insurance Program (NFIP)

The NFIP makes federally backed flood insurance available to homeowners, renters, and business owners in participating communities. For most participating communities, the Federal Emergency Management Agency (FEMA) has prepared a detailed Flood Insurance Study (FIS). The study presents water surface elevations for floods of various magnitudes, including the 1-percent annual chance flood and the 0.2-percent annual chance flood. Base flood elevations and boundaries of the 1-percent and 0.2-percent annual chance floodplains are shown on FIRMs, the principle tool for identifying extent and location of a flood hazard. FIRMs are the most detailed and consistent data source available, and for many communities they represent the minimum area of oversight under their floodplain management program. In recent years, FIRMs have been digitized and renamed Digital Flood Insurance Rate Maps (DFIRM). This change renders the documents more accessible to residents, local governance, and stakeholders.

Minimally, participants in the NFIP must regulate development within floodplain areas in accordance with NFIP criteria. Before issuing a permit to build in a floodplain, participating jurisdictions must ensure that three criteria are met:

- Minimally, new buildings and those undergoing substantial improvements must be elevated to protect against damage by the base flood.
- New floodplain development must not aggravate existing flood problems or increase damage to other properties.
- New floodplain development must exercise a reasonable and prudent effort to reduce its adverse impacts on listed threatened/endangered aquatic species.

In participating communities, structures that had been permitted or built in the planning area before implementation of NFIP and related building code regulations are called “pre-FIRM” structures, and structures built afterwards are called “post-FIRM” structures. Insurance rates differ for these two types of structures. Communities participating in the NFIP may adopt regulations more stringent than those specified in 44 Code of Federal Regulations (CFR) 60.3, but not less stringent.

The most recent DFIRMs in the County are from July 5, 2015, and include revisions made as part of the 2015 FIS for the County. Both the DFIRMs and the FIS are updates from the October 2012 versions. FEMA has also developed preliminary DFIRMs that will be dated 2016. Although the preliminary data are the most recent available, until officially approved and adopted, these data can be used only for review and guidance purposes. Preliminary data are subject to change until official approval, and thus cannot be used to rate flood insurance policies or enforce the federal mandatory purchase requirement.

In the State of California, the Department of Water Resources (DWR) is the coordinating agency for floodplain management. DWR works with FEMA and local governments by providing grants and technical assistance, evaluating community floodplain management programs, reviewing local floodplain ordinances, participating in statewide flood hazard mitigation planning, and facilitating annual statewide workshops. Compliance is monitored by FEMA regional staff and by DWR. Again, maintaining compliance under the NFIP is an important component of flood risk reduction.

FEMA Regulatory Flood Zones

According to FEMA, flood hazard areas are defined as areas shown on a map to be inundated by a flood of a given magnitude. These areas are determined via statistical analyses of records of river flow, storm tides, and rainfall; information obtained through consultation with the community; floodplain topographic surveys; and hydrologic and hydraulic analyses. Flood hazard areas are delineated on DFIRMs, which are official maps of a community on which the Federal Insurance and Mitigation Administration has delineated both SFHAs and risk premium zones applicable to the community. In addition to this, DFIRMS identify locations of specific properties in relation to SFHAs; base flood elevations (1-percent annual chance) at specific sites; magnitudes of flood within specific areas; undeveloped coastal barriers where flood insurance is not available; and regulatory floodways and floodplain boundaries (1-percent and 0.2-percent annual chance floodplain boundaries).

Land area covered by floodwaters of the base flood is the SFHA on a DFIRM—an area where NFIP floodplain management regulations must be enforced, and where mandatory purchase of flood insurance applies. This regulatory boundary is a convenient tool for assessing vulnerability and risk in flood-prone communities, because many communities have maps showing the extent of the base flood and likely depths that will occur.

The 1-percent annual chance flood is also referred to as the base flood elevation. As noted earlier, the NFIP defines the base flood elevation as the elevation of a base flood event or a flood which has a 1-percent chance of occurring in any given year. The base flood elevation is the exact elevation of water that will result from a given discharge level, one of the most important factors in estimating potential damage within a given area. A structure within a 1-percent annual chance floodplain has a 26-percent chance of undergoing flood damage during the term of a 30-year mortgage. The 1-percent annual chance flood is a regulatory standard adopted by federal agencies and most states to administer floodplain management programs. The 1-percent annual chance flood is used by the NFIP as the basis for insurance requirements nationwide. DFIRMs also depict 0.2-percent annual chance flood designations (500-year events).

DFIRM, FIRMs, and other flood hazard information can be used to identify the expected spatial extent of flooding from a 1-percent and 0.2-percent annual chance event. DFIRMS and FIRMS depict SFHAs—those areas subject to inundation from the 1-percent annual chance. Those areas are defined as follows:

- **Zones A1-30 and AE:** SFHAs that are subject to inundation by the base flood, determined using detailed hydraulic analysis. Base Flood Elevations are shown within these zones.
- **Zone A (Also known as Unnumbered A-zones)**: SFHAs where no Base Flood Elevations or depths are shown because detailed hydraulic analyses have not been performed.
- **Zone AO:** SFHAs subject to inundation by types of shallow flooding where average depths are between 1 and 3 feet. These are normally areas prone to shallow sheet flow flooding on sloping terrain.

- **Zone VE, V1-30:** SFHAs along coasts that are subject to inundation by the base flood with additional hazards due to waves with heights of 3 feet or greater. Base Flood Elevations derived from detailed hydraulic analysis are shown within these zones.
- **Zone B and X (shaded):** Zones where the land elevation as been determined to be above the Base Flood Elevation, but below the 500-year flood elevation. These zones are not SFHAs.
- **Zones C and X (unshaded):** Zones where the land elevation has been determined to be above both the Base Flood Elevation and the 500-year flood elevation. These zones are not SFHAs.

Coastal SFHAs are of concern to San Mateo County, particularly along the areas of the coastline at or slightly above sea level. In 2013, FEMA issued additional information regarding the flood hazard area associated with coastal zones

The NFIP depicts two coastal flood hazard zones on its DFIRMS:

- Zone VE, as described above
- Zone AE, where flood elevation includes wave heights less than 3 feet.

Post-storm field visits and laboratory tests throughout coastal areas of the United States have consistently confirmed that wave heights as low as 1.5 feet can cause significant damage to structures built without consideration of coastal hazards. DFIRMs recently published also include a line showing the Limit of Moderate Wave Action (LiMWA), the inland limit of the area expected to receive 1.5-foot or greater breaking waves during the 1-percent annual-chance flood event beyond the coastal VE zones and into the AE zone (Figure 6-1).

Source: FEMA 2014c

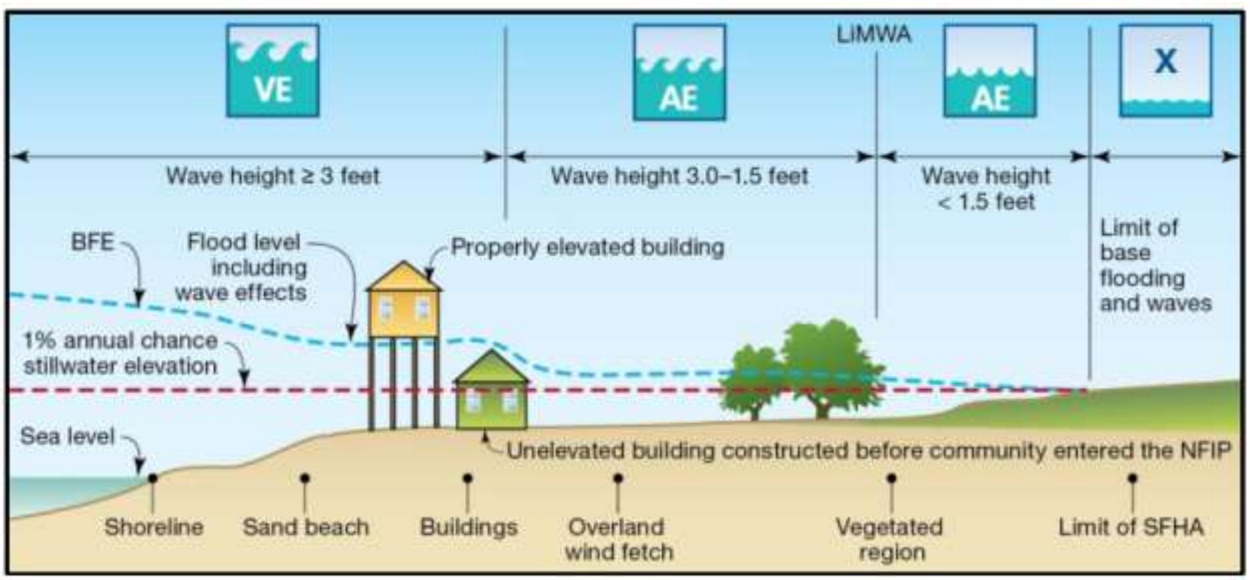


FIGURE 6-1. LIMIT OF MODERATE WAVE ACTION

Addition of LiMWA area to DFIRMs allows communities and individuals to better understand flood risks to their properties. The LiMWA area alerts property owners on the coastal side of the line that despite locations within Zone AE, their properties may be affected by 1.5-foot or higher breaking waves, and may therefore be at significant risk during a 1-percent-annual-chance flood event. While not formally defined in NFIP regulations or mapped as a flood zone, the area between Zone VE and the LiMWA is called the Coastal A Zone. This area is subject to flood hazards associated with floating debris and high-velocity flow that can erode and scour building foundations and, in extreme cases, cause foundation failure (FEMA 2014a).

The current effective DFIRM for the County of San Mateo does not delineate LiMWA areas. Future map updates will include this information and should be used to develop additional coastal flooding mitigation items.

The Community Rating System

The Community Rating System (CRS) is a voluntary program within the NFIP that encourages floodplain management activities exceeding minimum NFIP requirements. Flood insurance premiums are discounted to reflect reduced flood risk resulting from community actions meeting the following three goals of the CRS:

- Reduce flood losses.
- Facilitate accurate insurance rating.
- Promote awareness of flood insurance.

For participating communities, flood insurance premium rates are discounted in increments of 5 percent. For example, a Class 1 community would receive a 45 percent premium discount, and a Class 9 community would receive a 5 percent discount. (Class 10 communities are those that do not participate in the CRS; they receive no discount.) The CRS classes for local communities are based on 18 creditable activities in the following categories:

- Public information
- Mapping and regulations
- Flood damage reduction
- Flood preparedness.

Figure 6-2 shows the nationwide number of CRS communities by class as of May 2016, when 1,391 communities were receiving flood insurance premium discounts under the CRS program.

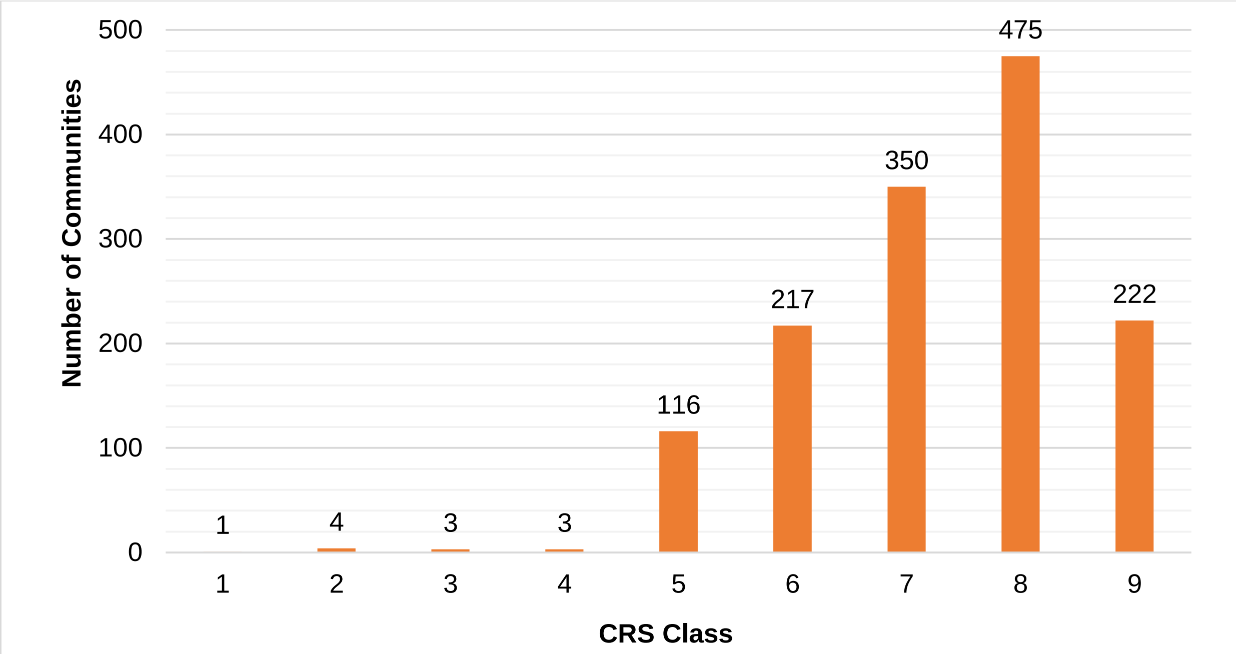


FIGURE 6-2. CRS COMMUNITIES BY CLASS NATIONWIDE AS OF MAY 2016

CRS activities can help save lives and reduce property damage. Communities participating in the CRS represent a significant portion of the nation's flood risk; over 66 percent of the NFIP's policy base is within these communities. Communities receiving premium discounts through the CRS range from small to large and represent a broad mixture of flood risks, including both coastal and riverine flood risks.

Specific CRS ratings are detailed both within each jurisdiction's annex and in Table 6-1 below. As indicated by the table, the discount associated with CRS partially depends on location of the property. Properties outside the SFHA receive smaller discounts—a 10% discount if the community is at Class 1-6 and a 5% discount if the community is at Class 7-9.

TABLE 6-1. CRS PARTICIPATION IN SAN MATEO COUNTY

NFIP Community Number	Community Name	CRS Entry Date	CRS Class	% Premium Discount, SFHA/Non-SFHA
060312	Atherton	Not applicable (N/A)	10	0/0
065016B	Belmont	N/A	10	0/0
060314	Brisbane	N/A	10	0/0
065019B	Burlingame	5/1/2012	9	5/5
060316	Colma	N/A	10	0/0
060317	Daly City	N/A	10	0/0
060708	East Palo Alto	10/1/11	8	10/5
060318	Foster City	N/A	10	0/0
060319	Half Moon Bay	N/A	10	0/0
060320	Hillsborough	N/A	10	0/0
060321	Menlo Park	N/A	10	0/0

TABLE 6-1. CRS PARTICIPATION IN SAN MATEO COUNTY

NFIP Community Number	Community Name	CRS Entry Date	CRS Class	% Premium Discount, SFHA/Non-SFHA
065045	Millbrae	N/A	10	0/0
060323	Pacifica	5/1/13	7	15/5
065052	Portola Valley	N/A	10	0/0
060325	Redwood City	N/A	10	0/0
060326	San Bruno	N/A	10	0/0
060327	San Carlos	5/1/13	9	5/5
060328	San Mateo, City of	N/A	10	0/0
065062	South San Francisco	N/A	10	0/0
060330	Woodside	N/A	10	0/0
060311	San Mateo County, Unincorporated Areas	10/1/10	9	5/5

With five communities in the County participating in CRS and receiving flood insurance premium reductions, many mitigation activities in this Hazard Mitigation Plan (HMP) were developed to be creditable activities under the CRS program. Therefore, successful implementation of this HMP offers potential to enhance the CRS classification.

6.2 Hazard Profile

The following information is largely extracted from the San Mateo County Flood Insurance Study (FEMA 2015):

- Heavy rains are the most frequent cause of flooding within San Mateo County jurisdictions, although coastal jurisdictions may also undergo flooding as a result of high winds, high tides, storm surge, and tsunami events.
- Flood problems occur primarily along streams located on the bayside. This flooding is shallow, with depths of less than 1 foot, and where railroad or highway embankments can become barriers, thus exacerbating ponding or sheetflow flooding.
- Flooding on the oceanside area of the County is confined primarily to well-defined riverine valleys, with flood surface extending uniformly across the floodplain. Flooding is typically associated with concurrent occurrences of high tides, large waves, and storm swells—often during winter. Storms from the southwest are often responsible for the most serious coastal flooding, and they typically bring other hazardous weather phenomena, including high winds, high tides, and heavy rains.
- Stormwater and overland flows exacerbate flooding and create shallow flood zones in some parts of the County, such as San Bruno, Crystal Springs, Lomita, and Holly Street Channels, as well as Belmont Creek. Inadequate or nonexistent stormwater facilities, as well as the aforementioned railroad and highway embankments, contribute to shallow flood issues.

Additionally, San Mateo County notes that its rural mountainous sections often act as a rain trap. Average rainfall in the rural regions can range from 30 to 45 inches per year, depending on locality. Its urban areas receive much less rain; for instance, Redwood City averages around 19 inches of rain per year (San Mateo County Sheriff 2015).

6.3 Types of Flood-Related Hazards

Flooding in San Mateo County typically occurs during the rainy winter season. Four types of flooding primarily affect the County: stormwater runoff, riverine, flash floods, and coastal floods.

Stormwater Runoff Floods

Stormwater flooding is a result of local drainage issues and high groundwater levels. Locally, heavy precipitation, especially during high lunar tide events, may induce flooding within areas other than delineated floodplains or along recognizable channels due to presence of storm system outfalls inadequate to provide gravity drainage into the adjacent body of water. If local conditions cannot accommodate intense precipitation through a combination of infiltration and surface runoff, water may accumulate and cause flooding problems. Flooding issues of this nature generally occur within areas with flat gradients, and generally increase with urbanization, which speeds accumulation of floodwaters because of impervious areas. Shallow street flooding can occur unless channels have been improved to account for increased flows (FEMA 1997). Numerous areas within the County undergo stormwater flooding that contributes to street and structure inundation.

Urban drainage flooding is caused by increased water runoff due to urban development and drainage systems. Drainage systems are designed to remove surface water from developed areas as quickly as possible to prevent localized flooding on streets and within other urban areas. These systems utilize a closed conveyance system that channels water away from an urban area to surrounding streams, and bypasses natural processes of water filtration through the ground, containment, and evaporation of excess water. Because drainage systems reduce the amount of time surface water takes to reach surrounding streams, flooding in those streams can occur more quickly and reach greater depths than prior to development within that area (FEMA 2008).

Riverine Floods

Riverine flooding is overbank flooding of rivers and streams. Natural processes of riverine flooding add sediment and nutrients to fertile floodplain areas. Flooding in large river systems typically results from large-scale weather systems that generate prolonged rainfall over a wide geographic area, causing flooding in hundreds of smaller streams, which then drain into the major rivers. Shallow area flooding is a special type of riverine flooding. FEMA defines shallow flood hazards as areas inundated by the 100-year flood with flood depths of only 1 to 3 feet. These areas are generally flooded by low-velocity sheet flows of water. Two types of flood hazards are generally associated with riverine flooding:

- **Inundation**—Inundation occurs when floodwater is present and debris flows through an area not normally covered by water. These events cause minor to severe damage, depending on velocity and depth of flows, duration of the flood event, quantity of logs and other debris carried by the flows, and amount and type of development and personal property along the floodwater’s path.

- **Channel Migration**—Erosion of banks and soils worn away by flowing water, combined with sediment deposition, causes migration or lateral movement of a river channel across a floodplain. A channel can also abruptly change location (termed "avulsion"); a shift in channel location over a large distance can occur within as short a time as one flood event.

Natural stream channels in rural parts of San Mateo County typically can accommodate average rainfall amounts and mild storm systems; however, severe floods occur in years of abnormally high rainfall or unusually severe storms. During those periods of severe floods, high-velocity floodwaters carry debris over long distances, block stream channels, and create severe localized flooding. To control these floodwaters when they reach more urban areas, the County and its cities have developed various flood control districts and flood improvements, such as culverts, bridges, levees, channel alterations, and underground storm drains (San Mateo County Sheriff 2015).

Flash Floods

A flash flood is:

> *"a rapid and extreme flow of high water into a normally dry area, or a rapid water level rise in a stream or creek above a predetermined flood level, beginning within 6 hours of the causative event (e.g., intense rainfall, dam failure). However, the actual time threshold may vary in different parts of the country. Ongoing flooding can intensify to flash flooding in cases where intense rainfall results in a rapid surge of rising flood waters" (National Weather Service [NWS] 2009).*

Flash floods can tear out trees, undermine buildings and bridges, and scour new channels. In urban areas, flash flooding is an increasingly serious problem due to removal of vegetation and replacement of ground cover with impermeable surfaces such as roads, driveways, and parking lots. The greatest risk from flash floods is occurrence with little to no warning. Major factors in predicting potential damage are intensity and duration of rainfall, and steepness of watershed and streams.

Coastal Floods

Coastal floods are characterized by inundation of normally dry lands by ocean waters, often caused by storm surge associated with severe storms, tsunamis, or extreme high tide events that result in shallow flooding of low lying coastal areas. Storm surge floods typically result in coastal erosion, salinization of freshwater sources, and contamination of water supplies. These floods are also responsible for significant agricultural losses, loss of life, and damage to public and private structures and infrastructure. The San Mateo County coastline extends 55 miles and hosts both residential and agricultural communities (San Mateo County Sheriff 2015). The Pacific Ocean is the most likely source of coastal flooding in the County, although flooding from the San Francisco Bay is also a possibility during significant events.

San Mateo County has mitigated some of its vulnerability to coastal flooding through a series of levees originally installed for salt evaporation ponds in the southeastern part of the County and for flood protection in the north and central parts of the County. These levees were not designed to withstand floods at or greater than the 1-percent-annual-chance flood (San Mateo County Sheriff 2015).

Coastal flooding is becoming increasingly exacerbated by sea level rise as a result of climate change or relative sea level rise caused by local increase in the level of the ocean relative to land as a result of tectonic activity (National Oceanic and Atmospheric Administration [NOAA] no date).

6.3.1 Principal Flooding Sources

Principal flooding sources for San Mateo County as identified on FEMA flood maps include the following streams and waterbodies (for descriptions of each of these areas, refer to Volume I of the San Mateo County FIS [FEMA 2015]):

- Colma Creek
- San Bruno Channel
- Crystal Springs Channel
- Lomita Channel
- Belmont Creek
- Holly Street Channel
- San Francisquito Creek
- Montara Creek
- San Vincente Creek
- Denniston Creek
- El Granada Creek
- Woodhams Creek
- La Honda Creek
- Alpine Creek
- San Gregorio Creek
- Pescadero Creek
- Butano Creek
- Pacific Ocean

Over 20 creeks, channels, and waterbodies, including those identified as principal flooding sources, were assessed as part of the County's FIS. In addition to the waterways above, the FIS identified areas at risk for potential tsunami inundation. The Cities of Half Moon Bay and Pacifica are both associated with potential tsunami issues (FEMA 2015). Additional information regarding the tsunami hazard is in Chapter 13.

Investigation of San Mateo County's vulnerability to flooding can also include assessments of watershed locations. Every watershed has unique qualities that affect its response to rainfall. San Mateo County contains 34 watersheds, all of which are relatively small and drain into either the Pacific Ocean or San Francisco Bay. Unincorporated areas in the County contain 21 major watersheds. Except for Crystal Springs and San Francisquito, which both drain into the San Francisco Bay, all the rural watersheds drain into the Pacific Ocean (San Mateo County Sheriff 2015).

6.3.2 Past Events

Known flood events affecting San Mateo County between 1996 and 2015 are identified in Table 6-2. Flood events prior to 1996 are not included in the NOAA National Climatic Data Center (NCDC) Severe Storms Database, perhaps because they were labeled under another category such as Thunderstorm Wind. Additionally, 45 flood-related Presidentially-declared disasters (DR) or emergencies (EM) have occurred in the State of California since 1954 (all 45 events were non-tsunami flood events). This equates to a major, non-tsunami or hurricane-related flood event impacting the State every 1.37 years on average.

TABLE 6-2. HISTORY OF FLOOD EVENTS

Date	Event	Locations	Deaths or Injuries	Property Damage
December 10, 1996	Flood	San Mateo	0	$0
January 1, 1997*	Flash Flood	Southwest Portion, Countywide	0	$0

TABLE 6-2. HISTORY OF FLOOD EVENTS

Date	Event	Locations	Deaths or Injuries	Property Damage
January 2, 1997*	Flash Flood	Countywide	0	$0
January 25, 1997	Flash Flood	Countywide	0	$0
February 3, 1997	Flash Flood	Loma Mar	1 Death	$0
February 2, 1998*	Flash Flood	Pescadero, East Palo Alto	0	$200,000
February 6, 1998*	Flash Flood	Pescadero, East Palo Alto	0	$0
February 7, 1998*	Flash Flood	Pescadero, East Palo Alto	0	$0
February 13, 2000	Flash Flood	Pescadero	0	$0
December 31, 2005	Flood	Countywide	0	$5,000,000
January 1, 2006	Flood	Countywide	0	$5,000,000
January 5, 2008	Coastal Flood	San Francisco Peninsula Coast	0	$5,000
January 25, 2008	Flash Flood	Moss Beach	0	$100,000
February 16, 2009	Flood	Pescadero	0	$8,000
January 19, 2010	Flood	Ladera	0	$15,000
January 20, 2010	Flood	Pescadero, San Carlos, San Carlos Airport	0	$65,000
December 29, 2010	Coastal Flood	San Francisco Peninsula Coast	0	$0
December 23, 2012*	Flash Flood	Pescadero, Loma Mar	0	$500
December 2, 2014	Flood	Belmont, San Bruno	0	$0
December 11, 2014	Flash Flood, Flood	San Mateo County	0	$505,500
February 6, 2015	Flood	Atherton, West Menlo Park	0	$0

*Multiple locations are associated with this event.
Source: NCDC Storm Events Database 2016, NBC Bay Area 2014

Descriptions of these flood events (from NCDC) are as follows:

December 10, 1996

Widespread urban flooding was reported throughout the County, and Highway 101 was reportedly underwater as a result of the flooding event.

January 1, 1997

Southwest portions of San Mateo County underwent heavy rainfall of approximately ½ inch per hour for several hours. Ground saturation prevented rainfall absorption. Pescadero Creek reached flood stage by late morning. By 10:00 a.m., La Honda Road was closed due to ground saturation and a resulting mudslide. Butano Creek flooded, closing Pescadero Road.

February 3, 1997

A levee breached along a dry creek bed, Arroyo Mocha. The breach cased damage to roads and property, and resulted in the death of an individual. Cascading effects caused flash flooding along San Francisquito Creek and Pescadero Creek.

February 14, 2000

Widespread rain with 24-hour accumulations of more than 5 inches occurred over the area during February 13th into February 14th. Urban and small stream flooding occurred in most counties of the area, including San Mateo. A number of houses in Daly City had to be abandoned and eventually destroyed due to mudslides that resulted from consecutive years of above-average rain.

December 31, 2005

Widespread flooding occurred throughout San Mateo County as a result of small stream overflow and poor drainage. Most damage occurred in East Palo Alto, the City of San Mateo, Daly City, Colma, Brisbane, San Bruno, South San Francisco, and Pacifica. Approximately 3 inches of rain fell on the area over a 24-hour period.

January 20, 2010

A significant storm brought strong winds and heavy rain to the San Francisco and Monterey Bay areas. This storm, the strongest of the week, developed over the Pacific Ocean with a strong parent low pressure based in the Gulf of Alaska. Areas of flooding occurred, causing problems mainly for vehicles. Heavy rain induced Pulgas Creek to overflow its banks and flood some classrooms at Central Middle School in San Carlos. Also, several streets were blocked off in low-lying areas just west of US Highway 101, including Taylor Avenue in San Carlos and parts of Rolison Road in Redwood City. In Atherton, officials closed March Road from Middlefield Road to Fair Oaks Avenue because a creek had begun to flood. Heavy rain caused Harbor Boulevard at the underpass of State Route 82 to flood, submerging a car to the base of its windows. The road was barricaded to stop anyone else from driving into the water. Belmont Creek flooding led to evacuation of a car repair business as 3 inches of water covered the floor.

February 6, 2015

A strong winter storm impacted California following nearly a month and a half of no rain and the driest January on record. The storm brought heavy rain, gusty winds, and damage to trees and power lines, along with some minor flooding of urban areas. Rainfall amounts were heaviest in the mountains, with 5-10 inches or more occurring. Heavy rain resulted in flooding of Southbound US 101 off-ramp in Atherton.

December 2015/January 2016

Although NOAA has not yet compiled 2016 data for the Severe Storms database, heavy rains associated with 2015/2016 winter El Niño storms will likely be included for parts of California. To mitigate impacts of expected associated flooding, the San Mateo County Department of Public Works and cities in the County set up two dozen sites where residents could pick up free sandbags (Patch.com 2016). Compared to previous years, this year's winter storms were much more noteworthy—2016 El Niño rains brought more rain into the Bay Area in 2 days than during the past three Januarys combined (Mercury News 2016). In general, San Mateo County avoided severe damages and flooding from the rains. La Honda recorded the largest amount of rainfall in the County, at 1.5 inches, compared to 4.5 inches in Sonoma County (the area hardest hit by the storms). Other than debris, some power outages, and transportation accidents, the County did not report any major issues. Response personnel for the cities were prepared; they monitored debris build-up, helping to reduce potential events (Silverfarb 2016). The worst effect of these rains was likely significant increase of coastal erosion in the City of Pacifica, placing residents along the cliff lines at risk of losing their homes.

6.3.3 Location

Flooding in San Mateo County has been documented by gage records, high water marks, damage surveys, and personal accounts. This documentation was the basis for the July 2015 Flood Insurance Study that is incorporated in the current effective DFIRMs. The DFIRMs are the most detailed and consistent data source available for determining flood extent. The July 2015 Flood Insurance Study is the sole source of data used in this risk assessment to map extents and locations of flood hazard areas, as shown on Figure 6-3.

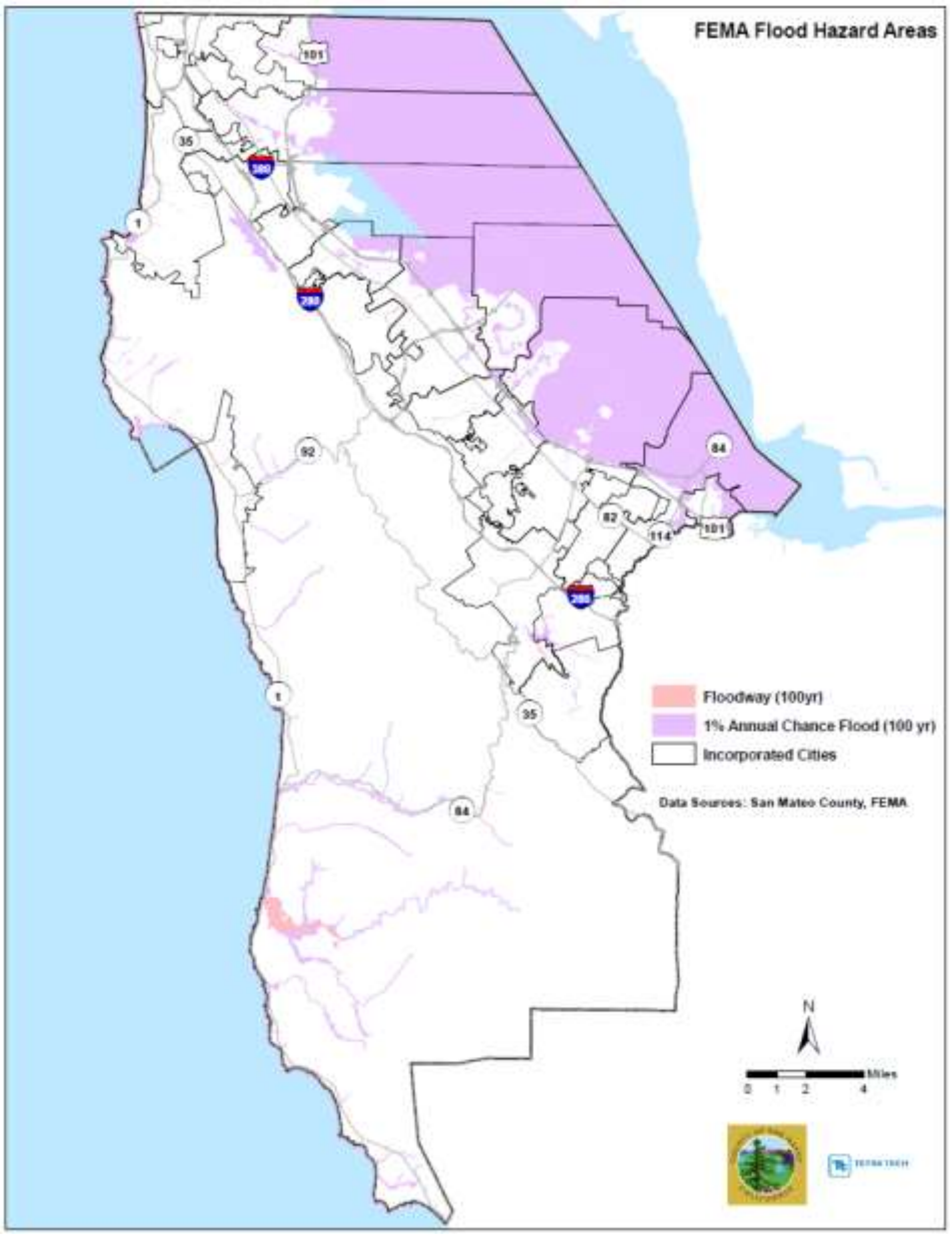


FIGURE 6-3. FEMA DFIRM FLOOD HAZARD AREAS, SAN MATEO COUNTY

6.3.4 Frequency

San Mateo County has undergone 21 significant flooding events since 1996, most of which have been flash floods. Smaller floods may occur more frequently and be categorized under a different hazard event type, typically Severe Weather or Severe Storms. Recurrence intervals and average annual numbers of events in San Mateo County were calculated based on data from 1996 to 2015 in the Storm Events Database. Coastal floods have a 10% chance of occurring in any given year, flash floods have a 55.6% chance, and other floods have a 40% chance of occurrence. Total estimated percent chance of occurrence for any type of flood in a given year is 105%, meaning that flooding will likely continue to be an annual hazard.

6.3.5 Severity

The principal factors affecting flood damage are flood depth and velocity. The deeper and faster flood flows become, the more damage they can cause. Shallow flooding with high velocities can cause as much damage as deep flooding with slow velocity—especially when a channel migrates over a broad floodplain, redirecting high velocity flows and transporting debris and sediment. Flood severity is often evaluated by examining peak discharges. Peak flows used by FEMA to map floodplains within the planning area are listed in Table 6-3.

TABLE 6-3. SUMMARY OF PEAK DISCHARGES – SAN MATEO COUNTY*

Source/Location	Drainage Area (square miles)	Discharge (cubic feet/second [cfs])			
		10-Percent	2-Percent	1 -Percent	0.2-Percent
16th Avenue Drainage					
Southern Pacific Railroad Crossing	--[4]	--[4]	--[4]	490	--[4]
Highway 101	--[4]	--[4]	--[4]	800	--[4]
19th Avenue Drainage Channel					
At South Pacific Railroad Crossing	--[4]	--[4]	--[4]	1,310	--[4]
At Delaware Street	--[4]	--[4]	--[4]	1,330	--[4]
At Bermuda Drive	--[4]	--[4]	--[4]	1,450	--[4]
Highway 101	--[4]	--[4]	--[4]	1,500	--[4]
Atherton Creek					
At Railroad	5.0	350[1]	350[1]	350[1, 2]	350[3]
Belmont Creek					
At El Camino Real	2.5	570	1,000	1,200	1,400
At Highway 101	2.8	660	1,200	1,400	1,600
Colma Creek					
At F Street	1.7	800	1,200	1,400	1,600
Below Hickey Boulevard Tributary	6.0	1,700	2,900	3,400	4,100
At USGS Gage in Orange Park	10.9	2,400	4,100	4,700	5,700
Below Spruce Branch	12.7	2,500	4,400	5,000	6,100
At San Francisco Bay	16.0	2,900	5,100	5,800	7,000
Cordilleras Creek					
At Alameda de las Pulgas	2.6	400	730	890	1,300

TABLE 6-3. SUMMARY OF PEAK DISCHARGES – SAN MATEO COUNTY*

Source/Location	Drainage Area (square miles)	Discharge (cubic feet/second [cfs])			
		10-Percent	2-Percent	1 - Percent	0.2-Percent
At Stanford Lane	3.1	460	900	1,120	1,700
At El Camino Real	3.3	470	940	1,170	1,800
Old County Road	3.3	470	620[6]	680[5, 6]	1,190[6]
Bayshore Freeway	3.6	525	700[7]	850[7]	1,490[7]
Denniston Creek					
At Reservoir	3.2	700	1,200	1,400	1,800
Near Sheltercove Drive	3.8	780	1,300	1,600	2,000
At Half Moon Bay	4.0	800	1,400	1,600	2,100
Easton Creek					
At Railroad	0.79	260	410	470	540
El Granada Creek					
At Reservoir	0.5	160	250	290	370
At Half Moon Bay	0.6	190	300	340	440
Holly Street Channel					
At Highway 101	0.4	240	370[8]	420[8]	420[8]
Industrial Branch					
At Colma Creek	1.5	490	720	800	970
La Honda Creek					
Upstream of confluence with Woodhams Creek	10.0	1,800	3,100	3,600	4,800
Downstream of confluence with Woodhams Creek	10.9	1,900	3,300	3,800	5,200
At confluence with San Gregorio Creek	11.8	2,100	3,500	4,200	5,500
Laurel Creek					
At Alameda de las Pulgas	--[4]	--[4]	--[4]	970	--[4]
At Otay	--[4]	--[4]	--[4]	1,130	--[4]
At George Hall School	--[4]	--[4]	--[4]	1,420	--[4]
At Highway 101	--[4]	--[4]	--[4]	1,950	--[4]
Lomita Channel					
At Railroad[9]	--	--	--	--	--
Mills Creek					
At Railroad	0.52	190	290	330	370
Mills Creek and Easton Creek					
At Highway 101[10]	2.46	750	840	840	840
Montara Creek					
At Riviera Street	0.80	220	360	420	560
At Harte Street	1.30	310	530	620	830
At Pacific Ocean	1.70	380	640	760	1,000
Navigable Slough					
At Colma Creek	0.4	200	270	300	300

TABLE 6-3. SUMMARY OF PEAK DISCHARGES – SAN MATEO COUNTY*

Source/Location	Drainage Area (square miles)	Discharge (cubic feet/second [cfs])			
		10-Percent	2-Percent	1 - Percent	0.2-Percent
Pescadero Creek					
At Pescadero Road east of Town	53.3	7,700	13,900	16,700	20,000
At Pacific Ocean	81.3	11,000	20,000	24,000	29,000
Ralston Creek and Burlingame Creek					
At Railroad	1.65	500	800	930	1,100
Redwood Creek					
At El Camino Real	5.2	1,200	2,11	2,500	3,200
At Broadway	8.8	1,800	3,200	3,800	4,800
At Bayshore Freeway	9.3	1,900	3,300	4,000	5,000
Sanchez Creek					
At Railroad	1.65	500	800	930	1,100
Sanchez Creek, Ralston Creek, and Burlingame Creek					
At Highway 101	4.65	1,100	1,600	1,600	1,600
San Francisquito Creek					
At El Camino Real	40.6	4,350	7,050	8,280	9,850[11]
Upstream of Middlefield Road	41.6	4,350	7,100	8,330	--[4]
Downstream of Middlefield Road	41.6	--[4]	--[4]	6,965	--[4]
Downstream of Pope Street	41.6	--[4]	--[4]	6,250	--[4]
At Highway 101	41.7	4,400	6,020[7]	6,060[7]	6,300[7]
San Francisquito Creek – Overflow					
At Middlefield Road	--[4]	--[4]	--[4]	640	--[4]
At Pope Street	--[4]	--[4]	--[4]	730	--[4]
Combined Middlefield Road and Pope Street Overflows	--[4]	--[4]	--[4]	1,154	--[4]
South of Highway 101	--[4]	--[4]	--[4]	1,154	--[4]
North of Highway 101	--[4]	--[4]	--[4]	570	--[4]
San Gregorio Creek					
At upstream limit of study	9.3	1,800	3,000	3,500	4,500
Upstream of confluence with La Honda Creek	9.5	1,800	3,000	3,600	4,600
Downstream of confluence with La Honda Creek	21.3	3,300	4,800	6,900	9,300
Downstream of State Highway 84	21.8	3,300	4,800	6,900	9,300
At downstream limit of study	22.4	3,500	6,100	7,200	9,700
San Mateo Creek					
At mouth (City of San Mateo)	--[4]	--[4]	--[4]	1,017[7]	--[4]
At downstream side of South Humboldt Street and East Third Avenue	--[4]	--[4]	--[4]	1,493[7]	--[4]
Approximately 400 feet downstream of Crystal Springs Road	33.3	--[4]	--[4]	2,124	--[4]
San Vicente Creek					
At upper study limit	1.4	340	570	660	880

TABLE 6-3. SUMMARY OF PEAK DISCHARGES – SAN MATEO COUNTY*

Source/Location	Drainage Area (square miles)	Discharge (cubic feet/second [cfs])			
		10-Percent	2-Percent	1 -Percent	0.2-Percent
At Etheldore Street	1.7	400	670	780	1,000
At Pacific Ocean	1.9	430	720	840	1,100
Spruce Branch					
At Colma Creek	1.5	540	770	810	830
Woodhams Creek					
At Esmeralda Terrace	0.7	220	340	390	480
At confluence with La Honda Creek	0.9	270	520	480	600

Source: San Mateo County FIS, FEMA 2015

Note: All locations are at mouth unless otherwise noted. Locations do not include jurisdictional boundaries.
1 = Capacity of Atherton Creek box culvert
2 = 1,750 cfs spilled upstream of study area during the 1-percent annual chance flood event
3 = 170 cfs spilled to Redwood City during the 1-percent annual chance flood event
4 = Data not available
5 = 170 cfs spilled to Redwood City during the 1-percent annual chance flood event
6 = Flows reduced due to overflow into San Carlos and Redwood City
7 = Flows reduced due to upstream spill
8 = Values do not include overland flow from Belmont Creek
9 = Inflow to low area west of track; 1-percent annual chance outflow is 170 cfs.
10 = Flows limited by culvert capacity, ponding, and pump capacity
11 = Value reflects spills from the channel into Palo Alto

Although jurisdictions can implement mitigation and take preventative actions to significantly reduce severity and threat of flood events, some type of residual risk will always exist (i.e., risk of a hazard event occurring despite technical and scientific measures applied to reduce/prevent it). Threats associated with residual risk could include failure of a reservoir, a dam breach, or other infrastructure failure, or a severe flood event that exceeds flood design standards or drainage capacity.

6.3.6 Warning Time

Potential warning time available to a community for response to a flooding threat depends on the time span between the first measurable rainfall and the first occurrence of flooding. The time duration necessary to recognize a flooding threat reduces potential warning time for a community that must take actions to protect lives and property. Another element that characterizes a community's flood threat is length of time floodwaters remain above flood stage.

Because of the sequential pattern of weather conditions needed to cause serious flooding, occurrence of a flood without warning is unusual. Warning times for floods can be between 24 and 48 hours. Flash flooding can be less predictable, but populations in potential hazard areas can be warned in advance of flash flooding danger. NWS issues watches and warnings when forecasts indicate rivers may approach bank-full levels. Flood extent or severity categories used by NWS include minor flooding, moderate flooding, and major flooding, based on property damage and public threat:

- **Minor Flooding** – Minimal or no property damage, but possibly some public threat or inconvenience.
- **Moderate Flooding** – Some inundation of structures and roads near streams. Some necessary evacuations of people and/or transfer of property to higher elevations.
- **Major Flooding** – Extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations (NWS 2011).

When a watch is issued, the public should prepare for the possibility of a flood. When a warning is issued, the public is advised to stay tuned to a local radio station for further information and be prepared to take quick action if needed. A warning means a flood is imminent, generally within 12 hours, or is occurring. Local media broadcast NWS warnings. Thresholds for flood warnings have been established on some of the major rivers in San Mateo County, based on available stream gage information, as follows:

- Lower Crystal Springs Reservoir at Dam:
- Action state, minor flooding/initial flood stage, and major flood stage data are not available.
- Moderate flooding is 284 feet.
- San Francisquito Creek At Stanford University:
- Action state is 8 feet.
- Moderate flooding is 9.5 feet.
- Minor flooding/initial flood and major flood stages are not available (NWS 2016).

6.4 Secondary Hazards

The most problematic secondary hazard for riverine flooding is bank erosion, in some cases more harmful than actual flooding. This is especially true in the upper courses of rivers with steep gradients, where floodwaters may pass quickly and without much damage, but scour banks, edging properties closer to the floodplain or causing them to fall in. Flooding is also responsible for hazards such as landslides when high flows over-saturate soils on steep slopes, causing them to fail. Hazardous materials spills are also a secondary hazard of flooding if storage tanks rupture and spill into streams, rivers, or storm sewers. A secondary hazard along the coastal flood area is coastal erosion, which could augment high surf or tsunami/run-up incidents along VE zones.

In San Mateo County and particularly the City of Pacifica, coastal erosion is the secondary hazard of greatest concern. Within the last decade, abandonment of multiple homes, apartment buildings, and other buildings has been necessary, as shoreline and cliff erosions have led to falls of infrastructure and land off the cliff into the ocean. Coastal erosion usually becomes a much more acute hazard during winter, especially when El Niño storms and rains impact the coastline. The Red Cross and City officials have been working with residents forced to evacuate after their homes were labeled uninhabitable because of potential for collapse. Real-time impacts from coastal erosion are evident in online drone videos, for example at: http://mashable.com/2016/01/26/coastal-erosion-pacifica/ (Gilmer 2016).

6.5 Exposure

The Level 2 (user-defined) Hazards United States – Multi-Hazards (Hazus-MH) protocol was used to assess risk and vulnerability to flooding within the planning area. The model used census data at the block level and FEMA floodplain data, which have a level of accuracy acceptable for planning purposes. Where possible, Hazus-MH default data were enhanced by use of local Geographic Information System (GIS) data from county, state, and federal sources.

Importantly, the 1-percent-annual-chance flood hazard (100-year floodplain) and the 0.2-percent-annual-chance flood hazard (500-year floodplain) are very similar for the planning area. For the purposes of this risk assessment, exposure and associated effects were modeled for the 10-percent (10-year floodplain) and the 1-percent-annual-chance flood event. The 0.2 percent event is assumed to affect approximately the same number of people and property as the 1-percent event, although flood depths may be greater, resulting in more losses per property impacted.

6.5.1 Population

Population counts of those living in the floodplain within the planning area were generated by estimating percent of residential buildings in each jurisdiction within the 1-percent-annual-chance flood hazard areas and multiplying this by total population within the planning area. This approach yielded an estimated exposed population within the entire County of 24,388 persons within the 100-year floodplain (3.2 percent of the total County population). Exposure estimates are not available for the 10-percent-annual-chance flood. Table 6-4 lists population estimates by jurisdiction.

TABLE 6-4. POPULATION WITHIN THE 1-PERCENT ANNUAL CHANCE FLOOD HAZARD AREAS

	1-Percent Annual Flood Hazard	
	Population Exposed[a]	% of Total Population
Atherton	0	0.0%
Belmont	540	2.0%
Brisbane	6	0.1%
Burlingame	1,227	4.1%
Colma	0	0.0%
Daly City	0	0.0%
East Palo Alto	8,217	28.2%
Foster City	78	0.2%
Half Moon Bay	29	0.2%
Hillsborough	12	0.1%
Menlo Park	4,410	13.3%
Millbrae	229	1.0%
Pacifica	748	1.9%
Portola Valley	53	1.2%
Redwood City	763	0.9%
San Bruno	0	0.0%

TABLE 6-4. POPULATION WITHIN THE 1-PERCENT ANNUAL CHANCE FLOOD HAZARD AREAS

	1-Percent Annual Flood Hazard	
	Population Exposed[a]	% of Total Population
San Carlos	323	1.1%
San Mateo	5,633	5.6%
South San Francisco	1,045	1.6%
Woodside	3	0.1%
Unincorporated	1,071	1.7%
Total	24,387	**3.2%**

a. Represents percent of residential buildings exposed multiplied by estimated 2015 population.

6.5.2 Property

Structures in the Floodplain

Table 6-5 summarizes total area and number of structures within the 1-percent-annual-chance flood zone by jurisdiction. Spatial analysis determined that 6,479 structures are within the 100-year floodplain, and 87 percent (5,656) of these structures are believed residential. Exposure estimates for the 10-percent-annual-chance flood hazard are not available.

TABLE 6-5. AREA AND STRUCTURES IN THE 1-PERCENT ANNUAL CHANCE FLOODPLAIN

	Area in Floodplain (Acres)[a]	Number of Structures in Floodplain							
		Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Atherton	0	0	0	0	0	0	0	0	**0**
Belmont	128	150	10	1	0	0	0	2	**163**
Brisbane	11,086	2	79	2	0	0	0	0	**83**
Burlingame	707	319	25	3	0	0	0	0	**347**
Colma	0	0	0	0	0	0	0	0	**0**
Daly City	36	0	0	0	0	0	0	0	**0**
East Palo Alto	674	1,279	18	8	0	8	0	2	**1,315**
Foster City	10,179	21	0	0	0	0	0	0	**21**
Half Moon Bay	153	9	0	0	1	0	0	0	**10**
Hillsborough	16	4	0	0	0	0	0	0	**4**
Menlo Park	8,006	1,224	76	62	3	4	0	2	**1,371**
Millbrae	21	65	0	0	0	0	0	1	**66**
Pacifica	273	228	9	0	0	0	0	0	**237**
Portola Valley	81	18	1	0	0	0	0	0	**19**
Redwood City	15,797	177	47	14	1	0	0	0	**239**
San Bruno	0	0	0	0	0	0	0	0	**0**
San Carlos	238	109	153	58	1	0	0	1	**322**
San Mateo	2,815	1,491	49	7	0	3	0	4	**1,554**

TABLE 6-5. AREA AND STRUCTURES IN THE 1-PERCENT ANNUAL CHANCE FLOODPLAIN

	Area in Floodplain (Acres)[a]	Number of Structures in Floodplain							
		Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
South San Francisco	13,121	257	88	18	0	0	0	0	**363**
Woodside	103	1	0	0	0	0	0	0	**1**
Unincorporated	15,005	302	28	1	25	4	3	1	**364**
Total	**78,437**	**5,656**	**583**	**174**	**31**	**19**	**3**	**13**	**6,479**

[a] Includes area acreage submerged by bay waters.

Exposed Value

Table 6-6 summarizes estimated values of exposed buildings within the planning area. An estimated $15 billion worth of building and contents are exposed to the 1-percent-annual-chance flood zone, representing 4.7 percent of total replacement value within the planning area. Exposure estimates are not available for the 10-percent-annual-chance flood hazard area.

TABLE 6-6. VALUE OF STRUCTURES IN THE 1-PERCENT ANNUAL CHANCE FLOOD HAZARD AREA

	Value Exposed			% of Total
	Structure	Contents	Total	Replacement value
Atherton	$0	$0	$0	0.0%
Belmont	$310,129,450	$260,033,735	$570,163,185	5.5%
Brisbane	$430,427,003	$416,870,538	$847,297,541	20.0%
Burlingame	$597,080,937	$479,516,306	$1,076,597,243	5.0%
Colma	$0	$0	$0	0.0%
Daly City	$0	$0	$0	0.0%
East Palo Alto	$574,618,898	$423,738,098	$998,356,996	17.0%
Foster City	$5,672,239	$2,836,119	$8,508,358	0.1%
Half Moon Bay	$6,517,502	$5,280,871	$11,798,373	0.2%
Hillsborough	$3,354,476	$1,677,238	$5,031,714	0.1%
Menlo Park	$1,513,428,916	$1,513,743,477	$3,027,172,393	16.4%
Millbrae	$58,966,027	$43,358,336	$102,324,362	1.0%
Pacifica	$145,419,893	$124,626,167	$270,046,060	2.4%
Portola Valley	$26,935,241	$22,131,741	$49,066,982	1.8%
Redwood City	$380,946,367	$415,452,764	$796,399,132	2.2%
San Bruno	$0	$0	$0	0.0%
San Carlos	$1,296,296,795	$1,391,147,533	$2,687,444,328	13.3%
San Mateo	$1,147,909,623	$892,421,005	$2,040,330,629	4.7%
South San Francisco	$862,088,157	$861,699,354	$1,723,787,512	5.4%
Woodside	$134,885	$67,442	$202,327	0.0%
Unincorporated	$461,513,350	$420,790,755	$882,304,105	2.7%
Total	**$7,821,439,759**	**$7,275,391,479**	**$15,096,831,240**	**4.7%**

Note: Values shown are accurate only for comparisons among results in this plan. See Section 2, Chapter 1 for a discussion of data limitations.

Land Use in the Floodplain

Some land uses are more vulnerable to flooding, such as single-family homes, while others are less vulnerable, such as agricultural land or parks. Table 6-7 lists building counts that intersect the 1-percent-annual-chance flood hazard area.

TABLE 6-7. PRESENT LAND USE IN 100-YEAR FLOODPLAIN

Jurisdiction	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
ATHERTON	0	0	0	0	0	0	0	0
BELMONT	150	10	1	0	0	0	2	163
BRISBANE	2	79	2	0	0	0	0	83
BURLINGAME	319	25	3	0	0	0	0	347
COLMA	0	0	0	0	0	0	0	0
DALY CITY	0	0	0	0	0	0	0	0
EAST PALO ALTO	1,279	18	8	0	8	0	2	1315
FOSTER CITY	21	0	0	0	0	0	0	21
HALF MOON BAY	9	0	0	1	0	0	0	10
HILLSBOROUGH	4	0	0	0	0	0	0	4
MENLO PARK	1,224	76	62	3	4	0	2	1371
MILLBRAE	65	0	0	0	0	0	1	66
PACIFICA	228	9	0	0	0	0	0	237
PORTOLA VALLEY	18	1	0	0	0	0	0	19
REDWOOD CITY	177	47	14	1	0	0	0	239
SAN BRUNO	0	0	0	0	0	0	0	0
SAN CARLOS	109	153	58	1	0	0	1	322
SAN MATEO	1,491	49	7	0	3	0	4	1554
SOUTH SAN FRANCISCO	257	88	18	0	0	0	0	363
WOODSIDE	1	0	0	0	0	0	0	1
UNINCORPORATED	302	28	1	25	4	3	1	364
Total	**5,656**	**583**	**174**	**31**	**19**	**3**	**13**	**6479**

The area of the floodplain that contains vacant, developable land is not known. This would be valuable information for gauging future development potential of the floodplain.

6.5.3 Critical Facilities and Assets

Table 6-8 summarizes critical facilities and assets within the 1-percent-annual-chance flood zone (100-year floodplain) of the planning area. Details appear in the following sections.

Table 6-8. Critical Facilities in the 1-percent-annual-chance Flood Zone

	Medical and Health Services	Emergency Services	Government	Utilities	Transportation Infrastructure	Hazardous Materials	Community Economic Facilities	Other Assets	Total
Atherton	0	0	0	0	0	0	0	0	**0**
Belmont	0	0	0	1	0	1	0	1	**3**
Brisbane	0	0	0	0	0	0	0	0	**0**
Burlingame	0	1	0	2	3	0	0	0	**6**
Colma	0	0	0	0	0	0	0	0	**0**
Daly City	0	0	0	0	0	0	0	0	**0**
East Palo Alto	0	0	0	1	0	2	0	1	**4**
Foster City	0	0	0	0	0	0	0	0	**0**
Half Moon Bay	0	0	0	0	1	0	0	0	**1**
Hillsborough	0	0	0	0	0	0	0	0	**0**
Menlo Park	0	1	0	4	5	9	0	2	**21**
Millbrae	0	0	0	0	1	0	0	0	**1**
Pacifica	0	0	0	6	0	0	0	0	**6**
Portola Valley	0	0	0	0	4	0	0	0	**4**
Redwood City	0	1	0	10	12	3	0	0	**26**
San Bruno	0	0	0	0	0	0	0	0	**0**
San Carlos	0	0	0	3	3	7	0	0	**13**
San Mateo	0	0	0	3	7	0	0	3	**13**
South San Francisco	0	1	0	1	10	2	1	0	**15**
Woodside	0	0	0	0	0	0	0	0	**0**
Unincorporated	0	1	0	3	23	0	1	1	**29**
Total	**0**	**5**	**0**	**34**	**69**	**24**	**2**	**8**	**142**

Toxic Release Inventory Reporting Facilities

Toxic Release Inventory (TRI) facilities are known to manufacture, process, store, or otherwise use certain chemicals above minimum thresholds. If damaged by a flood, these facilities could release chemicals that cause cancer or other human health effects, significant adverse acute human health effects, or significant adverse environmental effects (U.S. Environmental Protection Agency [EPA] 2015). During a flood event, containers holding these materials can rupture and leak into the surrounding area, disastrously affecting the environment and residents. One facility within the 1-percent-annual-chance flood zone is a TRI reporting facility.

Utilities and Infrastructure

It is important to determine who may be at risk if flooding damages infrastructure. Roads blocked or damaged can isolate residents, and can prevent access throughout the planning area for emergency service providers attempting to reach vulnerable populations or make repairs. Washout or blockage of bridges by floods or debris also can isolate individuals or segments of the population. Flooded or backed-up water and sewer systems can trigger health problems. Underground utilities can be damaged. Dikes can fail or be overtopped, inundating the land that they protect. The following sections describe types of critical infrastructure.

Roads

The following major roads within the planning area pass through the 1-percent-annual-chance flood zone (100-year floodplain), and thus are exposed to flooding:

- State Highway 1
- State Highway 82
- State Highway 84
- State Highway 92
- State Highway 109
- State Highway 114
- US Highway 101
- Interstate 380

Some of these roads were built above the flood level, and others function as levees to prevent flooding. Still, during severe flood events, these roads can be blocked or damaged, preventing access to some areas.

Bridges

Flooding events can significantly impact road bridges, important because many provide the only ingress and egress to some neighborhoods. An analysis indicated that 62 bridges are within or cross over the 1-percent-annual-chance flood zone (100-year floodplain).

Levees

Historically, levees have been used to control flooding in portions of San Mateo County. The County constructed levees both for flood protection (in the north and central portions of the County) and for salt evaporation ponds (in the southeast portion of the County). The County does not believe these levees could withstand intensities of a 1-percent-annual-chance flood. Additionally, coastal flooding from San Francisco Bay circumvents levees near the Bay, leading to flooding within the residential area next to San Francisquito Creek on the east side of the City. These risk estimates are based on current flood levels and do not account for potential sea level rise, which would exacerbate vulnerability and even further reduce ability of the levees to prevent/control flooding. Details on San Mateo County levees could not be supplemented by the U.S. Army Corps of Engineers (USACE) National Levee Database (NLD). Although the NLD contains records of the majority of levees within the USACE system, it does not include records of all levees in the United States, which include the levees in San Mateo County.

Levee failures could place large numbers of people and great amounts of property at risk. Unlike dams, levees do not serve any purpose beyond providing flood protection and (less frequently) recreational space for residents. A levee failure could be devastating, depending on severity of flooding and amount of land development present. In addition to damaging buildings, infrastructure, trees, and other large objects, levee failure can result in significant water quality and debris disposal issues. Severe erosion is also a consideration.

Presence and effects of levee systems in San Mateo County are not reflected on the DFIRM, meaning that areas, structures, and populations vulnerable to failures of those levees cannot be determined. However, because the County estimates that the levees in their current state could not withstand a 1-percent-chance annual flood, reflections of effects of the levees on the DFIRM would not be reliable anyway. The 2016 preliminary DFIRMs do account for estimated sea level rise; however, because not yet finalized, these maps could not be utilized to contribute to vulnerability estimates of flooding within leveed areas. Following approval of the 2016 DFIRMs, San Mateo County will consider the extent to which the levees must be updated as a future mitigation action item, and consider protection from sea level rise. Action may not be considered until the next HMP update, and levee vulnerability will also be explored in further detail.

Water and Sewer Infrastructure

Water and sewer systems can be affected by flooding. Floodwaters can back up drainage systems, causing localized flooding. Culverts can be blocked by debris from flood events, also triggering localized urban flooding. Floodwaters can enter and thus contaminate drinking water supplies. Sewer systems can back up, spilling wastewater into homes, neighborhoods, rivers, and streams.

6.5.4 Environment

Flooding is a natural event, and floodplains provide many natural and beneficial functions. Nonetheless, with human development factored in, flooding can impact the environment in negative ways. Migrating fish can wash into roads or over dikes into flooded fields, with no possibility of escape. Pollution from roads, such as oil, and hazardous materials can wash into rivers and streams. During floods, these can settle onto normally dry soils, polluting them for agricultural uses. Human development such as bridge abutments and levees can increase stream bank erosion, causing rivers and streams to migrate into non-natural courses.

6.6 Vulnerability

Many areas exposed to flooding may not undergo serious flooding or flood damage. This section describes vulnerabilities in terms of population, property, infrastructure, and environment.

6.6.1 Population

A geographic analysis of demographics by application of the Hazus-MH model identified populations vulnerable to the flood hazard as follows:

- **Economically Disadvantaged Populations**—An estimated 9.1 percent of households within the 1-percent-annual-chance flood zone (100-year floodplain) are economically disadvantaged (household incomes of $20,000 or less).
- **Population over 65 Years Old**—An estimated 9.1 percent of the population within the 1-percent-annual-chance flood zone (100-year floodplain) is over 65 years old.
- **Population under 16 Years Old**—An estimated 26 percent of the population within the 1-percent-annual-chance flood zone (100-year floodplain) is under 16 years of age.

Additionally, an estimated 100,000+ persons in San Mateo County commute on any given day. This segment of the population is also considered vulnerable to the flood hazard. Commuters whose workplaces or major transportation routes are within or near the 1-percent-annual-chance flood zone (100-year floodplain) may be especially vulnerable.

Impacts on Persons and Households

Table 6-9 summarizes estimated impacts on persons in the planning area within the 10-percent-annual-chance flood zone (10-year floodplain) and 1-percent-annual-chance flood zone (100-year floodplain).

TABLE 6-9. ESTIMATED FLOOD IMPACT ON PERSONS[a]

	10 Percent Annual Chance		1 Percent Annual Chance	
	Displaced Persons	Persons Requiring Short-Term Shelter	Displaced Persons	Persons Requiring Short-Term Shelter
Atherton	0	0	0	**0**
Belmont	0	0	67	**51**
Brisbane	0	0	1	**1**
Burlingame	0	0	270	**207**
Colma	0	0	0	**0**
Daly City	0	0	0	**0**
East Palo Alto	0	0	4,005	**3,836**
Foster City	0	0	7	**5**
Half Moon Bay	0	0	2	**1**
Hillsborough	0	0	1	**0**
Menlo Park	0	0	2,098	**1,957**
Millbrae	0	0	25	**21**
Pacifica	0	0	94	**77**
Portola Valley	0	0	2	**0**
Redwood City	0	0	202	**181**
San Bruno	0	0	0	**0**
San Carlos	0	0	55	**35**
San Mateo	0	0	2,617	**2,550**
South San Francisco	0	0	241	**220**
Woodside	5	0	0	**0**
Unincorporated	297	241	155	**91**
Total	302	241	9,841	9,233

a. Hazus-MH results in this table are not intended to be exact estimates of damage after a hazard event. They represent generalized estimates of damage that may occur as a result of the modeled scenario, based on available data.

Public Health and Safety

Floods and their aftermath present the following threats to public health and safety:

- **Unsafe food—**Floodwaters contain disease-causing bacteria, dirt, oil, human and animal waste, and farm and industrial chemicals. They carry away whatever lies on the ground and upstream. Their contact with food items, including food crops in agricultural lands, can render that food unsafe to eat and hazardous to human health. Power failures caused by floods damage stored food. Refrigerated and frozen foods are affected during the outage periods, and must be carefully monitored and examined prior to consumption. Foods kept inside cardboard, plastic bags, jars, bottles, and paper packaging are subject to disposal if contaminated by floodwaters. Even though the packages do not appear to be wet, they may be unhygienic with mold contamination and deteriorate rapidly.

- **Contaminated drinking and washing water and poor sanitation—**Flooding impairs clean water sources with pollutants. Contact with the contaminants—whether through direct food intake, vector insects such as flies, unclean hands, or dirty plates and utensils—can result in waterborne illnesses and life-threatening infectious disease. The pollutants also saturate into groundwater or can infiltrate sanitary sewer lines through the ground. Wastewater treatment plants, if flooded and caused to malfunction, can be overloaded with polluted runoff waters and sewage beyond their disposal capacity, resulting in backflows of raw sewage to homes and low-lying grounds. Private wells can be contaminated or damaged severely by floodwaters, while private sewage disposal systems can become a cause of infection if broken or overflowing. Unclean drinking and washing water and sanitation, coupled with lack of adequate sewage treatment, can lead to disease outbreaks.
- **Mosquitoes and animals—**Prolonged rainfall and floods provide new breeding grounds for mosquitoes—wet areas and stagnant pools—and can lead to an increase in the number of mosquito-borne diseases such as malaria and dengue and West Nile fevers. Rats and other rodents and wild animals also can carry viruses and diseases. The public should avoid such animals and should dispose of dead animals in accordance with guidelines issued by local animal control authorities. Leptospirosis—a bacterial disease associated predominantly with rats—often accompanies floods in developing countries, although the risk is low in industrialized regions unless cuts or wounds have direct contact with disease-contaminated floodwaters or animals.
- **Mold and mildew—**Excessive exposure to mold and mildew can cause flood victims—especially those with allergies and asthma—to contract upper respiratory diseases, triggering cold-like symptoms. Molds grow in as short a period as 24 to 48 hours in wet and damp areas of buildings and homes that have not been cleaned after flooding, such as water-infiltrated walls, floors, carpets, toilets, and bathrooms. Very small mold spores can be easily inhaled by human bodies and, in large enough quantities, cause allergic reactions, asthma episodes, and other respiratory problems. Infants, children, elderly people, and pregnant women are considered most vulnerable to mold-induced health problems.
- **Carbon monoxide poisoning—**Carbon monoxide poisoning is a potential hazard after major floods. In the event of power outages following floods, flood victims tend to use alternative sources of fuels for heating or cooking inside enclosed or partly enclosed houses, garages, or buildings without adequate levels of air ventilation. Carbon monoxide can be found in combustion fumes such as those generated by small gasoline engines, stoves, generators, lanterns, gas ranges, or burning of charcoal or wood. Built-up carbon monoxide from these sources can poison people and animals.

- **Hazards when reentering and cleaning flooded homes and buildings—**Flooded buildings can pose significant health hazards to people entering and cleaning damaged buildings or working to restore utility service after floodwaters recede. Electrical power systems, including fallen power lines, can become hazardous. Gas leaks from pipelines or propane tanks can trigger fire and explosion. Flood debris—such as broken bottles, wood, stones, and walls—may cause wounds and injuries to those removing contaminated mud and cleaning damaged buildings. Containers of hazardous chemicals, including pesticides, insecticides, fertilizers, car batteries, propane tanks, and other industrial chemicals, may be hidden or buried under flood debris. A health hazard can also occur when hazardous dust and mold in ducts, fans, and ventilators of air-conditioning and heating equipment are circulated through a building and inhaled by those engaged in cleanup and restoration.
- **Mental stress and fatigue—**Having experienced a devastating flood and seen loved ones lost or injured and homes damaged or destroyed, flood victims can experience long-term psychological impact. The expense and effort required to repair flood-damaged homes imposes severe financial and psychological burdens on the people affected, in particular the unprepared and uninsured. Post-flood recovery—especially when prolonged—can cause mental disorders, anxiety, anger, depression, lethargy, hyperactivity, sleeplessness, and, in an extreme case, suicide. Behavior changes may also occur in children, such as increases in bed-wetting and aggression. The affected also harbor long-term concern that their homes can flood again in the future.

Current loss estimation models such as Hazus-MH are not equipped to measure public health impacts such as these. The best preparation for these effects includes awareness that they can occur, education of the public on prevention, and planning to deal with them during responses to flood events.

6.6.2 Property

Structural and Non-Structural Loss

Hazus-MH calculates losses to structures from flooding via examinations of depth of flooding and types of structure. Using historical flood insurance claim data, Hazus-MH estimates percentage of damage to structures and their contents by applying established damage functions to an inventory. For this analysis, local data on facilities were used instead of the default inventory data provided with Hazus-MH.

The analysis is summarized in Table 6-10 and Table 6-11 for the 10-percent-annual-chance event (10-year flood) and 1-percent-annual-chance event (100-year flood), respectively. Loss estimates from the 1-percent-annual-chance flood (100-year floodplain) represent 7.5 percent of total exposure to the 1-percent-annual-chance flood (100-year floodplain) and less than 1 percent of total replacement value within the planning area.

TABLE 6-10. LOSS ESTIMATES FOR 10-PERCENT-ANNUAL-CHANCE EVENT

	Structures Impacted[a]	Estimated Loss Associated with 10-year flood			% of Total Replacement value
		Structure	Contents	Total	
Atherton	0	$0	$0	$0	**0.0%**
Belmont	0	$0	$0	$0	**0.0%**

TABLE 6-10. LOSS ESTIMATES FOR 10-PERCENT-ANNUAL-CHANCE EVENT

	Structures Impacted[a]	Estimated Loss Associated with 10-year flood			% of Total Replacement value
		Structure	Contents	Total	
Brisbane	0	$0	$0	$0	**0.0%**
Burlingame	0	$0	$0	$0	**0.0%**
Colma	0	$0	$0	$0	**0.0%**
Daly City	0	$0	$0	$0	**0.0%**
East Palo Alto	0	$0	$0	$0	**0.0%**
Foster City	0	$0	$0	$0	**0.0%**
Half Moon Bay	0	$0	$0	$0	**0.0%**
Hillsborough	0	$0	$0	$0	**0.0%**
Menlo Park	0	$0	$0	$0	**0.0%**
Millbrae	0	$0	$0	$0	**0.0%**
Pacifica	0	$0	$0	$0	**0.0%**
Portola Valley	0	$0	$0	$0	**0.0%**
Redwood City	0	$0	$0	$0	**0.0%**
San Bruno	0	$0	$0	$0	**0.0%**
San Carlos	0	$0	$0	$0	**0.0%**
San Mateo	0	$0	$0	$0	**0.0%**
South San Francisco	0	$0	$0	$0	**0.0%**
Woodside	0	$0	$0	$0	**0.0%**
Unincorporated	14	$452,557	$427,585	$880,141	**0.0%**
Total	14	**$452,557**	**$427,585**	**$880,141**	0.0%

a. Impacted structures have finished floor elevations below the tsunami water surface elevation, and are most likely to undergo significant damage during a tsunami event.

Note: Values shown are accurate only for comparisons among results in this HMP. See Section 2, Chapter 1 for a discussion of data limitations.

TABLE 6-11. LOSS ESTIMATES FOR 1-PERCENT-ANNUAL-CHANCE EVENT

	Structures Impacted[a]	Estimated Loss Associated with 100-year flood			% of Total Replacement value
		Structure	Contents	Total	
Atherton	0	$0	$0	$0	0.0%
Belmont	17	$7,943,732	$21,056,266	$28,999,997	0.3%
Brisbane	70	$150,636,560	$212,467,161	$363,103,721	8.6%
Burlingame	208	$29,985,664	$60,495,619	$90,481,283	0.4%
Colma	0	$0	$0	$0	0.0%
Daly City	0	$0	$0	$0	0.0%
East Palo Alto	686	$32,638,232	$34,161,212	$66,799,444	1.1%
Foster City	0	$0	$0	$0	0.0%
Half Moon Bay	2	$1,982,901	$3,065,356	$5,048,257	0.1%
Hillsborough	0	$0	$0	$0	0.0%
Menlo Park	445	$25,292,706	$36,797,430	$62,090,137	0.3%

TABLE 6-11. LOSS ESTIMATES FOR 1-PERCENT-ANNUAL-CHANCE EVENT

	Structures Impacted[a]	Estimated Loss Associated with 100-year flood			% of Total Replacement value
		Structure	Contents	Total	
Millbrae	54	$2,278,862	$1,274,668	$3,553,530	0.0%
Pacifica	94	$7,559,058	$10,073,788	$17,632,846	0.2%
Portola Valley	4	$2,303,649	$3,406,702	$5,710,350	0.2%
Redwood City	66	$6,545,094	$13,853,268	$20,398,362	0.1%
San Bruno	0	$0	$0	$0	0.0%
San Carlos	205	$23,093,350	$53,003,642	$76,096,992	0.4%
San Mateo	1,206	$99,239,555	$150,821,285	$250,060,840	0.6%
South San Francisco	259	$17,055,119	$31,222,353	$48,277,472	0.2%
Woodside	0	$0	$0	$0	0.0%
Unincorporated	223	$31,194,421	$56,248,496	$87,442,917	0.3%
Total	3,539	**$437,748,903**	**$687,947,246**	**$1,125,696,148**	**0.4%**

a. Impacted structures have finished floor elevations below the tsunami water surface elevation, and are most likely to undergo significant damage during a tsunami event.

Note: Values shown are accurate only for comparisons among results in this HMP. See Section 2, Chapter 1 for a discussion of data limitations.

Flood-Caused Debris

The Hazus-MH analysis estimated the amount of flood-caused debris within the planning area generated by flooding, as summarized in Table 6-12.

TABLE 6-12. ESTIMATED FLOOD-CAUSED DEBRIS

	10-percent-annual-chance flood		1-percent-annual-chance flood	
	Debris to Be Removed (tons)[a]	Estimated Number of Truckloads[b]	Debris to Be Removed (tons)[a]	Estimated Number of Truckloads[b]
Atherton	0	0	0	**0**
Belmont	0	0	1,657	**66**
Brisbane	0	0	511	**20**
Burlingame	0	0	3,622	**145**
Colma	0	0	0	**0**
Daly City	0	0	637	**25**
East Palo Alto	0	0	6,363	**255**
Foster City	0	0	144	**6**
Half Moon Bay	0	0	107,741	**4,310**
Hillsborough	0	0	294	**12**
Menlo Park	0	0	2,403	**96**
Millbrae	0	0	788	**32**
Pacifica	0	0	11,734	**469**
Portola Valley	0	0	370	**15**
Redwood City	0	0	11,443	**458**

TABLE 6-12. ESTIMATED FLOOD-CAUSED DEBRIS

	10-percent-annual-chance flood		1-percent-annual-chance flood	
	Debris to Be Removed (tons)[a]	Estimated Number of Truckloads[b]	Debris to Be Removed (tons)[a]	Estimated Number of Truckloads[b]
San Bruno	0	0	0	**0**
San Carlos	0	0	2,618	**105**
San Mateo	0	0	23,510	**940**
South San Francisco	0	0	1,065	**43**
Woodside	10	1	123	**5**
Unincorporated	2,030	81	19,205	**768**
Total	2,041	82	194,230	7,769

a. Debris generation estimates were based on updated general building stock dataset at a Census Block analysis level.
b. Hazus-MH assumes 25 tons/trucks.
Note: Values shown are accurate only for comparison among results in this HMP. See Section 2, Chapter 1 for a discussion of data limitations.

National Flood Insurance Program

Unincorporated San Mateo County and all incorporated planning partner municipalities within the County are participants in the NFIP; all are also currently in good standing with the provisions of the NFIP. Maintaining compliance under the NFIP is an important component of flood risk reduction and all NFIP communities have committed to maintain compliance with the NFIP. Multiple jurisdictions within San Mateo County are participants in the NFIP, but do not have any SFHAs within their boundaries. These jurisdictions maintain minimum requirements for NFIP communities with no SFHAs, and are noted in jurisdictional annexes in Volume II. NFIP participants with an identified SFHA will maintain compliance through continuing to enforce floodplain management regulations that meet minimum NFIP criteria. Additionally, all communities have identified mitigation initiatives, further documenting their commitment to NFIP compliance and good standing.

Table 6-13 lists flood insurance statistics that help identify vulnerability within the planning area. More than 6,200 policies are in force providing more than $1.75 billion in insurance. According to FEMA statistics, 853 flood insurance claims were paid between January 1, 1978, and December 31, 2015, for a total of $9.3 million, an average of $10,923 per claim.

Properties constructed after adoption of a FIRM or DFIRM are considered less vulnerable to flooding because they were constructed after adoption of regulations and codes to decrease vulnerability. Properties built before adoption of a FIRM or DFIRM are more vulnerable to flooding because either they do not meet code or are within hazardous areas. The first flood maps of the planning area became available as early as 1971; however, most FIRMs were not available until the 1980s.

TABLE 6-13. FLOOD INSURANCE STATISTICS

Jurisdiction	Date of Entry	# of Flood Insurance Policies, as of 12/31/2015	Insurance In Force	Total Annual Premiums	Claims, 11/1978 to 12/31/2015	Value of Claims Paid, 11/1978 to 12/31/2015
Atherton	10/28/1977	41	$13,256,000	$17,084	6	$235,254.45
Belmont	03/09/1982	105	$37,675,300	$193,183	30	$170,678.17
Brisbane	03/29/1983	26	$12,650,000	$86,440	5	$5,216.07
Burlingame	09/16/1981	295	$81,952,600	$424,853	70	$285,343,40
Colma	11/01/1979	4	$3,600,000	$12,840	2	$1,795.76
Daly City	07/31/1979	63	$10,164,000	$14,992	30	$193,521.77
East Palo Alto	09/19/1984	925	$218,408,500	$1,140,945	33	$197,483.82
Foster City	01/07/1977	257	$81,280,900	$98,861	7	$37,157.09
Half Moon Bay	08/08/1979	104	$34,439,900	$58,904	7	$56,296.05
Hillsborough	09/01/1981	58	$18,978,100	$36,837	9	$24,962.63
Menlo Park	02/04/1981	862	$234,099,300	$1,075,579	31	$241,351.37
Millbrae	09/30/1981	59	$18,021,100	$62,013	38	$151,186.94
Pacifica	02/04/1981	370	$104,294,600	$283,622	110	$756,405.53
Portola Valley	10/17/1978	42	$12,542,599	$43,104	24	$670,141.76
Redwood City	05/17/1982	315	$97,688,100	$254,375	37	$438,904.88
San Bruno	03/30/1981	11	$1,697,400	$12,467	18	$96,668.67
San Carlos	09/15/1977	237	$82,788,500	$330,704	56	$163,319.72
San Mateo (City)	03/30/1981	1,589	$436,456,200	$1,903,073	76	$136,933.83
South San Francisco	09/02/1981	379	$114,596,500	$400,401	70	$3,103,895.86
Woodside	11/15/1979	31	$8,804,000	$13,744	16	$342,979.80
Unincorporated San Mateo County	07/05/1984	457	$133,178,200	$575,964	178	$2,293,176.01
Total	**N/A**	**6,230**	**$1,756,571,799**	**$7,039,985**	**853**	**$9,317,330**

Repetitive Loss

A repetitive loss property is defined by FEMA as an NFIP-insured property that has undergone any of the following since 1978, regardless of any changes in ownership:

- Four or more paid losses exceeding $1,000
- Two paid losses exceeding $1,000 within any rolling 10-year period
- Three or more paid losses equaling or exceeding the current value of the insured property.

Repetitive loss properties make up only 1 percent of flood insurance policies in force nationally, yet they account for 40 percent of the nation's flood insurance claim payments (National Wildlife Federation 2006). In 1998, FEMA reported that the NFIP's 75,000 repetitive loss structures have already cost $2.8 billion in flood insurance payments, and that numerous other flood-prone structures at high risk remain within the floodplain.

The government has instituted programs encouraging communities to identify and mitigate causes of repetitive losses. A report on repetitive losses by the National Wildlife Federation found that 20 percent of these properties are outside any mapped 1-percent-annual-chance (100-year) floodplain. The key identifiers for repetitive loss properties are existence of flood insurance policies and claims paid by the policies. With potential for minor flood events every year and major events every 5 to 7 years, the County and its planning partners consider all mapped floodplain areas susceptible to repetitive flooding.

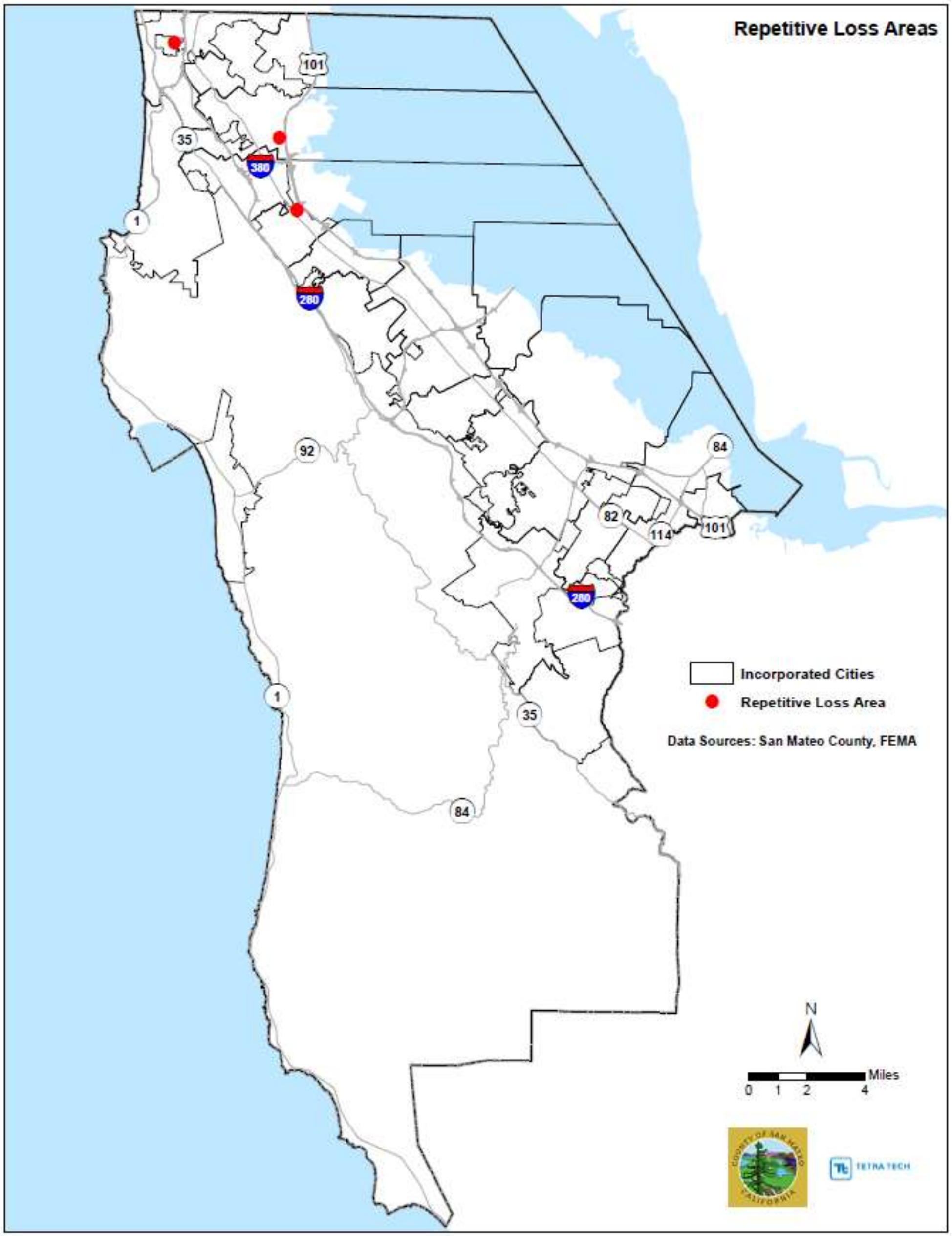
FEMA-sponsored programs, such as the CRS, require participating communities to identify repetitive loss areas. A repetitive loss area is the portion of a floodplain hosting structures that FEMA has identified as meeting the definition of repetitive loss. Identifying repetitive loss areas helps identify structures at risk but not on FEMA's list of repetitive loss structures because no flood insurance policy was in force at the time of loss.

The San Mateo County planning area contains no repetitive loss structures and three severe repetitive loss (SRL) properties per the FEMA definition above:

Jurisdiction Name	Number of SRL Properties
Millbrae	1
South San Francisco	1
Unincorporated San Mateo County	1

Severe repetitive loss properties in San Mateo County are shown on Figure 6-4.

FIGURE 6-4. REPETITIVE LOSS AREAS



6.6.3 Critical Facilities and Assets

Hazus-MH was used to estimate flood loss potential of critical facilities exposed to the flood risk. Using depth/damage function curves to estimate percent of damage to the building and contents of critical facilities, Hazus-MH correlates these estimates to estimate functional down-time (estimated time necessary to restore a facility to 100 percent of its functionality). This helps gauge how long the planning area could have limited usage of facilities deemed critical to flood response and recovery. The Hazus-MH critical facility results are summarized in Table 6-14.

On average, critical facilities would undergo 3.72 percent damage to the structure and 19.82 percent damage to contents during a 1-percent-annual-chance (100-year) flood event. Estimated time to restore these facilities to 100 percent of functionality is 492 days.

TABLE 6-14. ESTIMATED DAMAGE TO CRITICAL FACILITIES AND INFRASTRUCTURE FROM THE 1-PERCENT ANNUAL CHANCE FLOOD EVENT

	Number of Facilities Affected	Average % of Total Value Damaged		Days to 100% Functionality
		Building	Content	
Medical and Health Services	0	N/A	N/A	N/A
Emergency Services	5	2.92	6.73	480
Government	0	N/A	N/A	N/A
Utilities	34	10.40	N/A	N/A
Transportation Infrastructure	69	0.93	N/A	N/A
Hazardous Materials	24	6.07	N/A	N/A
Community Economic Facilities	2	0.0	N/A	N/A
Other Assets	8	4.62	28.00	499
Total	**142**	**3.72**	**19.82**	**492**

6.6.4 Environment

The environment vulnerable to flood hazard is the same as the environment exposed to the hazard. Loss estimation platforms such as Hazus-MH are not currently equipped to measure environmental impacts of flood hazards. The best gauge of vulnerability of the environment would be a review of damage from past flood events. Loss data that segregates damage to the environment were not available at the time of this HMP. Capturing this data from future events could be beneficial in measuring vulnerability of the environment for future updates.

Additionally, while the vulnerability assessment typically focuses on human vulnerability to flood events, the opposite is also worth noting. Floodplains have many natural and beneficial functions; however, due to negative impacts of floods, many structural and other measures have been devised to limit how far a floodplain can extend. Disruption of natural systems can have long-term consequences for entire regions; however, this potential impact has only recently been noted. Some well-known, water-related functions of floodplains (noted by FEMA) include:

- Natural flood and erosion control
- Provide flood storage and conveyance
- Reduce flood velocities
- Reduce flood peaks
- Reduce sedimentation
- Surface water quality maintenance
- Filter nutrients and impurities from runoff
- Process organic wastes
- Moderate temperatures of water
- Groundwater recharge
- Promote infiltration and aquifer recharge
- Reduce frequency and duration of low surface flows.

Areas within the floodplain that typically provide these natural functions are wetlands, riparian areas, sensitive areas, and habitats for rare and endangered species

6.6.5 Economic Impact

Locations of flooding will undergo heaviest economic impact. Within these areas, renovations of commercial buildings may be necessary, disrupting associated services. Additionally, significant damage within agricultural areas may occur with destruction of crops and other agricultural products. The tourism industry may also be affected by major flood events, as popular vacation areas tend to overlap flood hazard zones. Finally, flooding can cause extensive damage to public utilities and disruptions to delivery of services. Loss of power and communications may occur; and drinking water and wastewater treatment facilities may be temporarily out of operation.

6.7 Future Trends in Development

As discussed under the County Profile, areas targeted for future growth and development have been identified across the County. Any areas of growth could be impacted by the flood hazard if located within the identified hazard areas. The County intends to discourage development within vulnerable areas and/or to encourage higher regulatory standards on the local level.

The County and its jurisdictions are equipped to handle future growth within flood hazard areas. All municipal planning partners have general plans that address frequently flooded areas in their safety elements. All partners have committed to link their general plans to this HMP. This will create an opportunity for wise land use decisions as future growth impacts flood hazard areas.

Additionally, all municipal planning partners are participants in the NFIP and have adopted flood damage prevention ordinances in response to its requirements. With 25 percent of communities in the County participating in the CRS program, there is incentive to adopt consistent, appropriate, higher regulatory standards in communities with the highest degree of flood risk. All municipal planning partners have committed to maintain their good standing under the NFIP through initiatives identified in this HMP. Communities participating or considering participation in the CRS program will be able to refine this commitment using CRS programs and templates as a guide.

	Agriculture/Resource Extraction		Commercial		Education		Industrial		Mixed Use		Other/Water		Parks/Open Space		Residential		Total
Jurisdiction	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)
ATHERTON	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
BELMONT	0.0	0.00%	6.9	5.37%	1.8	1.38%	10.1	7.93%	56.5	44.15%	8.6	6.76%	26.4	20.65%	14.4	11.28%	**127.9**
BRISBANE	0.0	0.00%	91.7	0.83%	0.0	0.00%	0.0	0.00%	0.0	0.00%	10,830.6	97.75%	157.9	1.43%	0.0	0.00%	**11,080.2**
BURLINGAME	0.0	0.00%	24.2	3.43%	0.9	0.13%	0.0	0.00%	6.6	0.93%	568.3	80.44%	64.0	9.06%	42.4	6.01%	**706.4**
COLMA	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	39.58%	0.0	0.00%	0.0	60.42%	**0.0**
DALY CITY	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	10.5	29.43%	25.1	70.57%	0.0	0.00%	**35.6**
EAST PALO ALTO	0.6	0.09%	10.3	1.53%	0.0	0.00%	77.7	11.53%	0.0	0.00%	113.1	16.78%	257.9	38.26%	214.4	31.81%	**674.1**
FOSTER CITY	0.0	0.00%	28.9	0.28%	0.0	0.00%	0.7	0.01%	0.0	0.00%	9,953.3	97.84%	142.4	1.40%	47.7	0.47%	**10,172.9**
HALF MOON BAY	7.7	5.03%	5.7	3.73%	2.2	1.42%	0.1	0.05%	0.0	0.00%	38.6	25.23%	94.9	62.09%	3.7	2.45%	**152.9**
HILLSBOROUGH	0.0	0.00%	0.0	0.00%	0.4	2.77%	0.0	0.00%	0.0	0.00%	2.5	15.76%	0.2	1.00%	12.7	80.47%	**15.8**
MENLO PARK	1,908.4	23.85%	22.9	0.29%	43.4	0.54%	494.4	6.18%	0.0	0.00%	4,871.9	60.89%	408.7	5.11%	251.8	3.15%	**8,001.4**
MILLBRAE	0.0	0.00%	0.5	2.34%	0.0	0.17%	0.0	0.00%	0.6	2.64%	4.1	19.22%	1.5	7.06%	14.5	68.57%	**21.1**
PACIFICA	0.8	0.29%	20.5	7.50%	9.3	3.40%	0.0	0.00%	0.0	0.00%	153.0	56.03%	25.5	9.36%	63.9	23.42%	**273.0**
PORTOLA VALLEY	0.0	0.00%	0.0	0.00%	0.9	1.09%	0.0	0.00%	0.0	0.00%	4.6	5.72%	17.7	21.73%	58.1	71.46%	**81.3**
REDWOOD CITY	0.0	0.00%	70.3	0.45%	13.1	0.08%	159.5	1.01%	26.8	0.17%	11,842.0	75.01%	3,573.1	22.63%	103.5	0.66%	**15,788.2**
SAN BRUNO	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	9.78%	0.0	90.22%	0.0	0.00%	**0.0**
SAN CARLOS	0.0	0.00%	69.4	29.19%	0.0	0.00%	116.8	49.13%	0.0	0.00%	16.7	7.04%	9.0	3.79%	25.8	10.85%	**237.8**
SAN MATEO	0.0	0.00%	24.6	0.88%	33.9	1.20%	0.0	0.00%	1.0	0.04%	2,038.3	72.44%	420.0	14.93%	295.7	10.51%	**2,813.5**
SOUTH SAN FRANCISCO	0.0	0.00%	111.3	0.85%	2.9	0.02%	45.5	0.35%	7.4	0.06%	12,842.5	97.94%	63.5	0.48%	40.2	0.31%	**13,113.2**
WOODSIDE	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	2.0	1.94%	5.5	5.36%	93.6	90.89%	1.9	1.81%	**103.0**
UNINCORPORATED	2,583.0	17.22%	38.1	0.25%	19.8	0.13%	7.2	0.05%	157.1	1.05%	10,559.8	70.41%	1,447.9	9.65%	184.4	1.23%	**14,997.2**
Total	**4,500.4**	**5.74%**	**525.4**	**0.67%**	**128.5**	**0.16%**	**912.0**	**1.16%**	**257.9**	**0.33%**	**63,663.6**	**81.21%**	**6,829.3**	**8.71%**	**1,375.0**	**1.75%**	**78,395.7**

6.8 Scenario

Historically, floods have regularly affected San Mateo County. The County can expect noteworthy flooding about once a year, with a flash flood approximately every 2 years. Duration and intensity of heavy winter rains and El Niño storms that cause flooding may increase due to climate change. The floodplains mapped and identified by San Mateo County will continue to take the brunt of these floods. County residents prepare themselves for flooding by seeking and receiving information, and by pursuing mitigation. Impacts of flood events should decrease as the County, local cities, and residents continue to promote and implement hazard mitigation and preparedness.

The worst-case scenario would be a series of heavy rains or storm events during an El Niño event or winter rainy season, particularly if the rains also occur at high tide. These rains could flood numerous areas within a short time. This could overwhelm the response and floodplain management capability within the planning area, as the planning area would be subject immediately to flash flooding and coastal flooding, with subsequent influences on the County's streams. Major roads could be blocked, preventing critical access for many residents and critical functions. High in-channel flows could cause water courses to scour, possibly washing out roads and creating more isolation problems. In the event of multi-basin flooding, San Mateo County would not be able to make repairs quickly enough to restore critical facilities and assets.

6.9 Issues

The planning team has identified the following flood-related issues relevant to the planning area:

- Accuracy of existing flood hazard mapping by FEMA regarding true flood risk within the planning area is questionable. This is most prevalent within areas protected by levees not accredited by the FEMA mapping process.
- Extent of flood protection currently provided by flood control facilities (dams, dikes, and levees) is not known due to lack of established national policy on flood protection standards.
- The levee system within the planning area is not consistently adequate to mitigate effects of a 1-percent annual chance flood.
- Risk associated with the flood hazard overlaps risks associated with other hazards such as earthquakes, landslides, and coastal erosion. This provides opportunity to seek mitigation alternatives with multiple objectives that can reduce risks from multiple hazards.
- Land-use practices are not consistent with the scope of regulatory floodplain management within the planning area.
- How climate change will affect flood conditions in San Mateo County is uncertain.
- More information is needed regarding flood risk to support the concept of risk-based analysis of capital projects.
- To determine cost-effectiveness of future mitigation projects, sustained effort is necessary to gather damage reports and historical damage data such as high water marks on structures.
- Ongoing flood hazard mitigation will require funding from multiple sources.

- A coordinated hazard mitigation effort is necessary among jurisdictions affected by flood hazards within the County.
- Floodplain residents must continue to seek and receive information about flood preparedness and resources available during and after floods.
- The concept of residual risk should be considered in design of future capital flood control projects, and should be communicated to residents living in the floodplain.
- Promotion of flood insurance as a means of protecting private property owners from economic impacts of frequent flood events should continue.
- Existing floodplain-compatible uses such as agricultural and open space must be maintained. Pressure is constant to convert these existing uses to more intense uses within the planning area during times of moderate to high growth.
- The economy affects a jurisdiction’s ability to manage its floodplains. Budget cuts and personnel losses can strain resources needed to support floodplain management.

Chapter 7.
Landslide

7.1 General Background

Landslides and mudslides can be initiated by storms, earthquakes, fires, volcanic eruptions, or human modification of the land. They can move rapidly down slopes or through channels and can strike with little or no warning at avalanche speeds.

According to the U.S. Geological Survey (USGS), the term "landslide" includes a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on an over-steepened slope is the primary reason for a landslide, there are other contributing factors (NJGWS 2013). Landslide hazard areas are areas where characteristics such as the following indicate a risk of downhill movement of material:

- A slope greater than 33 percent
- A history of landslide activity during the last 10,000 years
- Stream or wave activity that has caused erosion or cut into a bank to make the surrounding land unstable
- The presence or potential for snow avalanches
- The presence of an alluvial fan, which indicates vulnerability to the flow of debris or sediments
- The presence of impermeable soils, such as silt or clay, mixed with granular soils such as sand and gravel.

Scientists from the USGS also monitor stream flow, noting changes in sediment load in rivers and streams that may result from landslides. All of these types of landslides are considered aggregately in USGS landslide mapping.

Mudslides (or mudflows or debris flows) are rivers of rock, earth, organic matter, and other soil materials saturated with water. They develop in the soil overlying bedrock on sloping surfaces when water rapidly accumulates in the ground, such as during heavy rainfall or rapid snowmelt. Water pressure in the pore spaces of the material increases to the point that the internal strength of the soil is drastically weakened. The soil's reduced resistance can then easily be overcome by gravity, changing the earth into a flowing river of mud. The material can travel miles from its source, growing as it descends, picking up trees, boulders, cars, and anything else in its path. Although these slides behave as fluids, they pack many times the hydraulic force of water because of the mass of material they encompass.

A debris avalanche (Figure 7-1) is a fast-moving debris flow that travels faster than about 10 miles per hour (mph). Speeds in excess of 20 mph are not uncommon, and speeds in excess of 100 mph, although rare, can occur. Debris avalanches are like mudslides in that they can travel many miles from their source, picking up large objects in their path, and that they can have many times the hydraulic force of water because of the mass of material in them. They can be among the most destructive events in nature.

Several other types of landslides also exist. These include:

- *Rock Falls:* blocks of rock that fall away from a bedrock unit without a rotational component
- *Rock Topples:* blocks of rock that fall away from a bedrock unit with a rotational component
- *Rotational Slump:* blocks of fine grained sediment that rotate and move down slope
- *Transitional Slide:* sediments that move along a flat surface without a rotational component
- *Earth Flows:* fine-grained sediments that flow downhill and typically form a fan structure
- *Creep:* a slow-moving landslide, often noticed only through crooked trees and disturbed structures
- *Block Slides:* blocks of rock that slide along a slip plane as a unit down a slope.

Landslides can pose a serious hazard to properties on or below hillsides. When landslides occur — in response to such changes as increased water content, earthquake shaking, addition of load, or removal of downslope support — they deform and tilt the ground surface. The result can be destruction of foundations, offset of roads, breaking of underground pipes, or overriding of downslope property and structures.

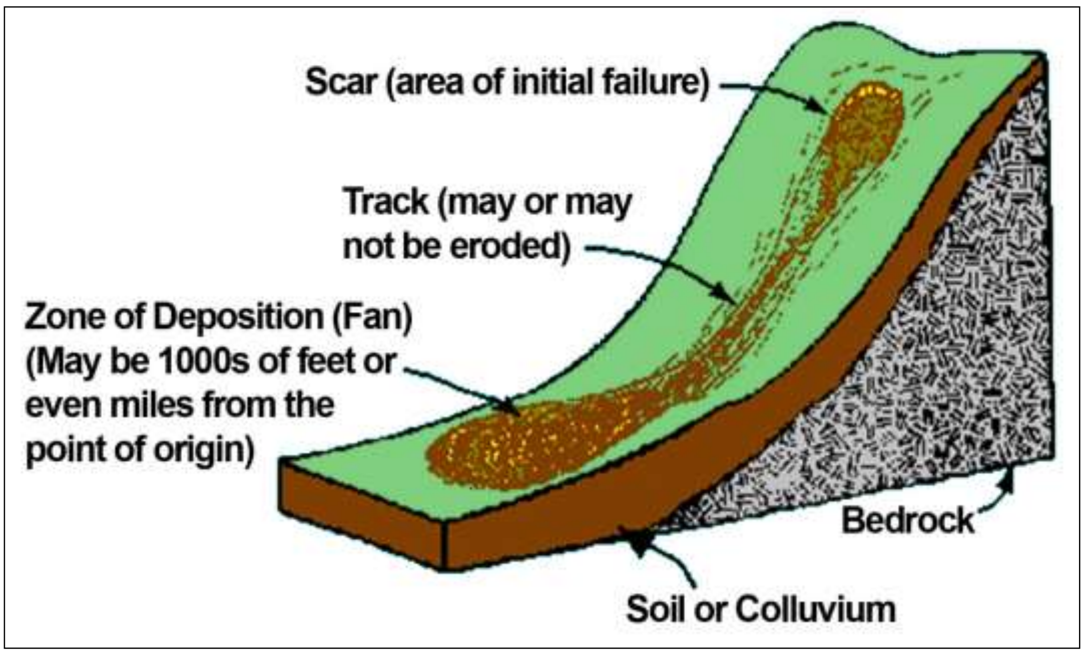


FIGURE 7-1. TYPICAL DEBRIS AVALANCHE SCAR AND TRACK

7.1.1 Landslide Types and Run-Out

Two characteristics are essential to conducting an accurate risk assessment of the landslide hazard:

- The type of initial ground failure that occurs
- The post-failure movement of the loosened material ("run-out"), including travel distance and velocity.

Landslides are commonly categorized by the type of initial ground failure. Figure 7-2 through Figure 7-5 show common types of slides (Ecology 2014). The most common is the shallow colluvial slide, occurring particularly in response to intense, short-duration storms. The largest and most destructive are deep-seated slides, although they are less common than other types.

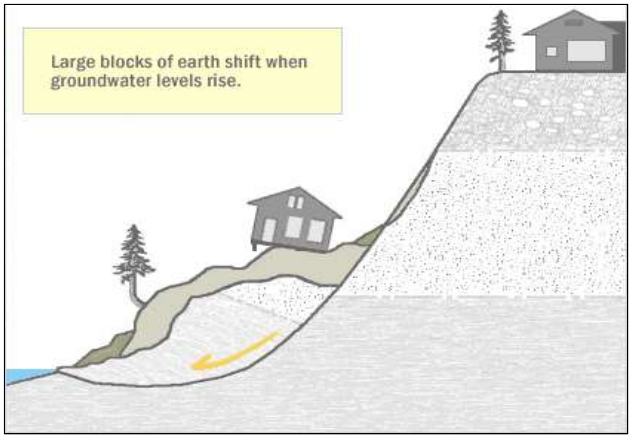


FIGURE 7-2. DEEP SEATED SLIDE

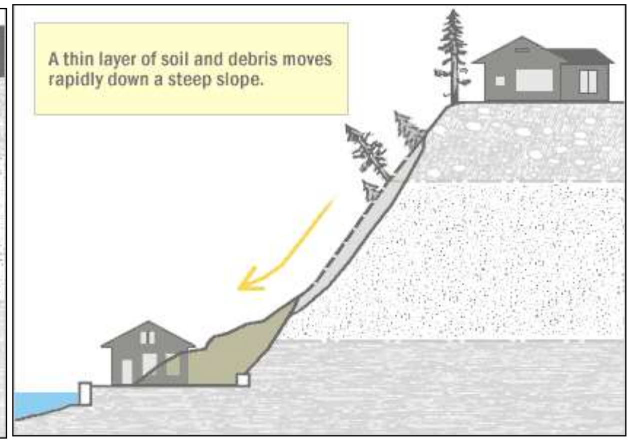


FIGURE 7-3. SHALLOW COLLUVIAL SLIDE

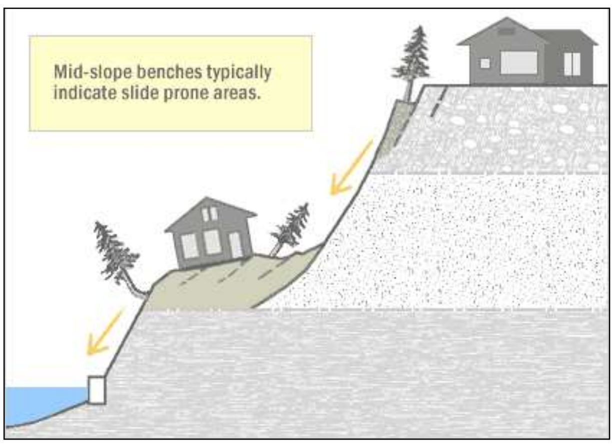


FIGURE 7-4. BENCH SLIDE

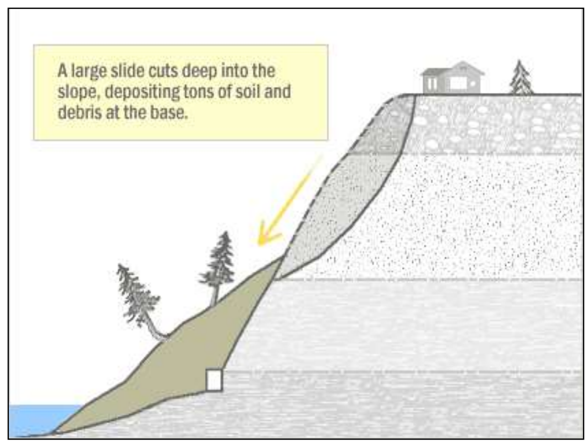


FIGURE 7-5. LARGE SLIDE

All current landslide models — those in practical applications and those more recently developed — use simplified hypothetical descriptions of mass movement to simulate the complex behavior of actual flow. The models attempt to reproduce the general features of the moving mass of material through measurable factors, such as base shear, that define a system and determine its behavior. Because of the lack of experimental data and the limited current knowledge about the behavior of the moving flows, landslide models use simplified parameters to account for complex aspects that may not be defined. These simplified parameters are not related to specific physical processes that can be directly measured, and there is a great deal of uncertainty in their definition. Some, but not all, models provide estimates of the level of uncertainty associated with the modeling approach.

Run-out modeling is complicated because the movement of materials may change over the course of a landslide event, depending on the initial composition, the extent of saturation by water, the ground shape of the path traveled, and whether additional material is incorporated during the event (Savage and Hutter 1991; Rickenmann 2000; Iverson et al. 2004).

7.1.2 Landslide Causes

Mass movements are caused by a combination of geological and climate conditions, as well as the encroaching influence of urbanization. Vulnerable natural conditions are affected by human residential, agricultural, commercial, and industrial development and the infrastructure that supports it. The following factors can contribute to landslide: change in slope of the terrain, increased load on the land, shocks and vibrations, change in water content, groundwater movement, frost action, weathering of rocks, and removing or changing the type of vegetation covering slopes.

Excavation and Grading

Slope excavation is common in development of home sites or roads on sloping terrain. Grading can result in some slopes that are steeper than the pre-existing natural slopes. Since slope steepness is a major factor in landslides, these steeper slopes can be at an increased risk for landslides. The added weight of fill on slopes can also result in an increased landslide hazard. Small landslides can be fairly common along roads, in either the road cut or the road fill. Landslides below new construction sites are indicators of the potential impacts stemming from excavation.

Drainage and Groundwater Alterations

Water flowing through or above ground is often the trigger for landslides. Any activity that augments the amount of water flowing into landslide-prone slopes can increase landslide hazards. Broken or leaking water or sewer lines can be especially problematic, as can water retention facilities that direct water onto slopes. However, even lawn irrigation and minor alterations to small streams in landslide-prone locations can result in damaging landslides. Ineffective stormwater management and excess runoff can also cause erosion and increase the risk of landslide hazards. Drainage can be affected naturally by the geology and topography of an area. Development that results in an increase in impervious surface impairs the ability of the land to absorb water and may redirect water to other areas. Channels, streams, flooding, and erosion on slopes all indicate potential slope problems.

Road and driveway drains, gutters, downspouts, and other constructed drainage facilities can concentrate and accelerate flow. Ground saturation and concentrated velocity flow are major causes of slope problems and may trigger landslides.

Changes in Vegetation

Removing vegetation from very steep slopes can increase landslide hazards. A study by the Oregon Department of Forestry found that landslide hazards in three out of four steeply sloped areas were highest for a period of roughly 10 years after timber harvesting (Oregon Department of Forestry 1999). Areas that have experienced wildfire and land clearing for development may experience long periods of increased landslide hazard. In addition, woody debris in stream channels (both natural and man-made from logging) may cause the impacts from debris flows to be more severe.

7.1.3 Landslide Management

While small landslides are frequently a result of human activity, the largest landslides are often naturally occurring phenomena with little or no human contribution. The sites of large landslides are typically areas of previous landslide movement that are periodically reactivated by significant precipitation or seismic events. These naturally occurring landslides can disrupt roadways and other infrastructure lifelines, destroy private property, and cause flooding, bank erosion, and rapid channel migration.

Landslides can create immediate, critical threats to public safety. Engineering solutions to protect structures on or adjacent to large active landslides are often extremely or prohibitively expensive.

In spite of their destructive potential, landslides can serve beneficial functions to the natural environment. They supply sediment and large wood to the channel network and can contribute to complexity and dynamic channel behavior critical for aquatic and riparian ecological diversity. Effective landslide management should include the following elements:

- Continuing investigation to identify natural landslides, understand their mechanics, assess their risk to public health and welfare, and understand their role in ecological systems
- Regulation of development in or near existing landslides or areas of natural instability through the San Mateo County Code and City ordinances.
- Preparation for emergency response to landslides to facilitate rapid, coordinated action among San Mateo County, local cities, and state and federal agencies, and to provide emergency assistance to affected or at-risk citizens
- Evaluation of options including landslide stabilization or structure relocation where landslides are identified that threaten critical public structures or infrastructure

7.2 Hazard Profile

7.2.1 Past Events

Landslides have occurred regularly within San Mateo County; one such event led to the deaths of three children in 1982, and several events (conjointly with coastal erosion) have required apartment evacuations along coastal bluffs. The table below lists known landslide events that have affected San Mateo County between 1980 and 2016. Two other landslides (outside of San Mateo County) were also recorded by the USGS in its "Did you see it?" archives. One occurred in 2012 and the other in 1970; both were about an hour's drive from the County but still near the Bay Area.

TABLE 7-1. LANDSLIDE EVENTS IN SAN MATEO COUNTY

Dates of Event	Event Type	FEMA Declaration Number	Location	Losses/Impacts
Various	Debris Flows	N/A	Tunitas Creek, San Gregorio, and Pescadero watersheds; Alpine Road, Crystal Springs, San Bruno Mountain, and Point San Pedro; Coastal sea cliffs	Damage from debris flows has particularly been incurred the southwestern portion of the County, including the Tunitas Creek, San Gregorio, and Pescadero watersheds. Debris flows are widespread on the natural slopes west of Skyline Ridge; they are present but rare on natural slopes east of Skyline Ridge; and they have been observed in Alpine Road, Crystal Springs, San Bruno Mountain, and Point San Pedro, as well as the County's coastal sea cliffs.
January 4, 1982	Landslides, Severe Storm	N/A	San Mateo County (Pacifica and Various)	Hundreds of small to major landslides resulted from an intense storm saturating the County. Many of the landslides occurred in steep sections of the western and northern portions of the County, mostly in areas of low population density. In Pacifica, three children died after a strip of hillside behind their homes slid hundreds of feet and destroyed two homes. The County recorded millions of dollars in property damage from the landslides.
1995	Landslide	N/A	Highway 1 by Devils Slide	Highway 1 has been closed by landslides multiple times at Devils Slide. In 1995 and 2006, landslides led to extended closures. The new Tom Lantos Tunnel, opened in March 2013, allows the highway to bypass Devils Slide and reduce vulnerability.
February 1995	Late Winter Storms (Severe Winter Storms, Flood, Landslide, Mudflows)	1046-DR-CA	San Mateo County	All 57 counties excepting Del Norte were included in this declaration, where more than 100 stations recorded their greatest ever 1-day rainfall total. In total, the state recorded 17 deaths; $190.6 million in public property damages, $122.4 million in individual damages, $46.9 million in business damages, $79 million in highway damages, and $651.6 million in agricultural damages; and significant damage to homes, with 1,322 recording major damage, 267 listed as destroyed, and 2,299 recording minor damage.

TABLE 7-1. LANDSLIDE EVENTS IN SAN MATEO COUNTY

Dates of Event	Event Type	FEMA Declaration Number	Location	Losses/Impacts
February 1998	Landslides	N/A	San Mateo County	These landslides are most likely associated with the El Niño damages described in more detail immediately below. The main slide in La Honda began moving continuously since at least February 11, and movement accelerated after a period of rain. Three houses at the head of the slide were red tagged, as were five other houses on or adjacent to it. San Mateo County drilled three wells in a road crossing the slide and began pumping wells on February 26. The County also dug plastic-lined trenches to facilitate drainage. Residents of seven homes on Esplanade Drive in Pacifica evacuated on February 22 after landslides and cliff erosion. The 30-foot cliff had retreated 10 feet to the rear edge of the homes in a 2-week period. Eventually cliff erosion, soil fall, and rock falls slowed; however, water continued seeping from the face. Plans began for sea wall and other mitigation measures.
February 2, 1998	El Niño (Flood and Landslides)	DR-1203	San Mateo County (Various Cities)	More than 11,000 people were evacuated because of 80 mph winds and floods. Record flooding was declared in San Mateo and Santa Clara Counties. Severe and widespread landslides in San Mateo County, four other counties, and 13 cities were triggered by intense rain all winter. In total, the region recorded 17 deaths and damage estimates of $550 million. San Mateo County recorded a minimum of $55 million in damages to public and private properties from landslides resulting from the 1998 winter storms. La Honda, Moss Beach, Pacifica, Daly City, and Portola Valley listed $38 million in damages. Hundreds of hillside slope failures occurred, particularly during the week of February 2. The most common types of damaging failures were earthflows and earth slumps, and the pre-existing Polhemus landslide (earth slump) reactivated. Shoreline retreat in Daly City, Pacifica, Tunitas Creek, and Moss Beach were included in this assessment.

TABLE 7-1. LANDSLIDE EVENTS IN SAN MATEO COUNTY

Dates of Event	Event Type	FEMA Declaration Number	Location	Losses/Impacts
December 17, 2005 – January 12, 2006	Winter Storms (Severe Storms, Flood, Mudslides, Landslides)	DR-1628	San Mateo County	Damage estimates for the region exceeded $100 million. Storms were blamed for two deaths from falling trees, around 50 businesses declared damaged, and three homes were nearly wiped out by mudslides. Event included severe storms, flooding, mudslides, and landslides.
March 29 – April 1, 2006	Spring Storms (Severe Storms, Flood, Landslides, Mudslides)	DR-1646	San Mateo County	Damages not available.
April 1, 2006	Debris Flow	N/A	San Francisco Peninsula Coast	Well above normal and persistent rainfall caused several mudslides across the area through the month of April. The hardest hit areas were water-soaked hillsides in Brisbane, Broadmoor, and El Granada. In total, 83 damage sites were documented throughout San Mateo County. One slide caused Highway 1 at Devil's Slide to be closed for an estimated period of several months.
April 4, 2006	Debris Flow	N/A	Santa Cruz Mountains (Zone)	Heavy and persistent rains in the Santa Cruz mountains during the first half of April caused many landslides. Damage was estimated at nearly $13 million, with at least $6 million charged to county road damages.
April 22, 2006	Landslide	N/A	Half Moon Bay	Landslide downed fiber optic phone lines on Saturday evening, leading to phone services outages in several San Mateo County coastal cities. The landslide occurred in a coastal mountainous area near state Highway 92 in an area not accessible by vehicle.
December 2009	Coastal Erosion (with associated landslides)	N/A	Pacifica	A breakaway bluff significantly eroded, forcing evacuations in several apartments on Esplanade Avenue. The evacuation order was triggered by a 30-foot land mass falling from the cliff.
December 6, 2014	Landslide	N/A	CA-84 East, between Old La Honda Rd., and Highway 35/Skyline Blvd.	A landslide led to a traffic alert for motorists on CA-84 East, where only one lane was open for traffic. Motorists were advised to expect delays and to avoid the area, if possible.

TABLE 7-1. LANDSLIDE EVENTS IN SAN MATEO COUNTY

Dates of Event	Event Type	FEMA Declaration Number	Location	Losses/Impacts
January/February 2016	Coastal Erosion (with associated landslides and sinkholes)	N/A	Pacifica	Residents with apartments along coastal bluffs have been forced to evacuate after significant erosion has led to dangers of building collapse. Further south, Beach Boulevard has suffered notable infrastructure damage from erosion.

Source: ABAG Local Hazard Mitigation Plan 2012, San Mateo County Sheriff 2015, USGS 1998, SFGate 2006, CBS Local 2014, NOAA Severe Storms Database 2016, ABC News 2009, NBC News 2016, KRON 4 2016

Note: For more information on the impacts of coastal erosion, refer to the Flood Hazard Profile. Coastal erosion events have been included here based on the speed and magnitude of the occurrences, and the possibility of joint landslide incidents.

7.2.2 Location

The entire U.S. experiences landslides, with 36 states having moderate to highly severe landslide hazards. Expansion of urban and recreational developments into hillside areas exposes more people to the threat of landslides each year. According to the USGS, San Mateo County has a high to very high landslide potential. For a figure displaying the landslide potential of the conterminous United States, please refer to http://pubs.usgs.gov/fs/2005/3156/2005-3156.pdf (USGS 2005).

The California Landslide Hazard Identification Act directs the State Geologist to identify and map hazardous landslide areas for use by municipalities in planning and decision-making on grading and building permits. Three factors that characterize landslide hazard areas include significant slope, weak rocks, and heavy rains. This program focuses on urban areas and growth areas that exhibit these characteristics. Although the California Geological Survey (CGS) provides access to many of these maps through its California Landslide Inventory, it does not offer them at the County level for San Mateo County (CGS 2016).

The Association of Bay Area Governments (ABAG) Resilience Program provides more detailed mapping for the Bay Area through use of USGS *Summary of Distribution of Slides and Earth Flows* (1997) and *Map Showing Principal Debris-Flow Source Areas* (1997). The County of San Mateo overlayed these data with its jurisdictional boundaries to develop Figure 7-1 below. Based on these data, the majority of the County is vulnerable to some type of landsliding, with the southern half of the County having a higher rate of landslides (San Mateo County 2016). The County also notes that more than 92 percent of the areas vulnerable to landslides are located within unincorporated areas; 7.53 percent of acres vulnerable to landslides are in incorporated areas of the County (San Mateo Sheriff 2015).

Landslide hazard areas and steep slopes within the planning area are shown on Figure 7-6. The landslide areas presented are provided by ABAG.

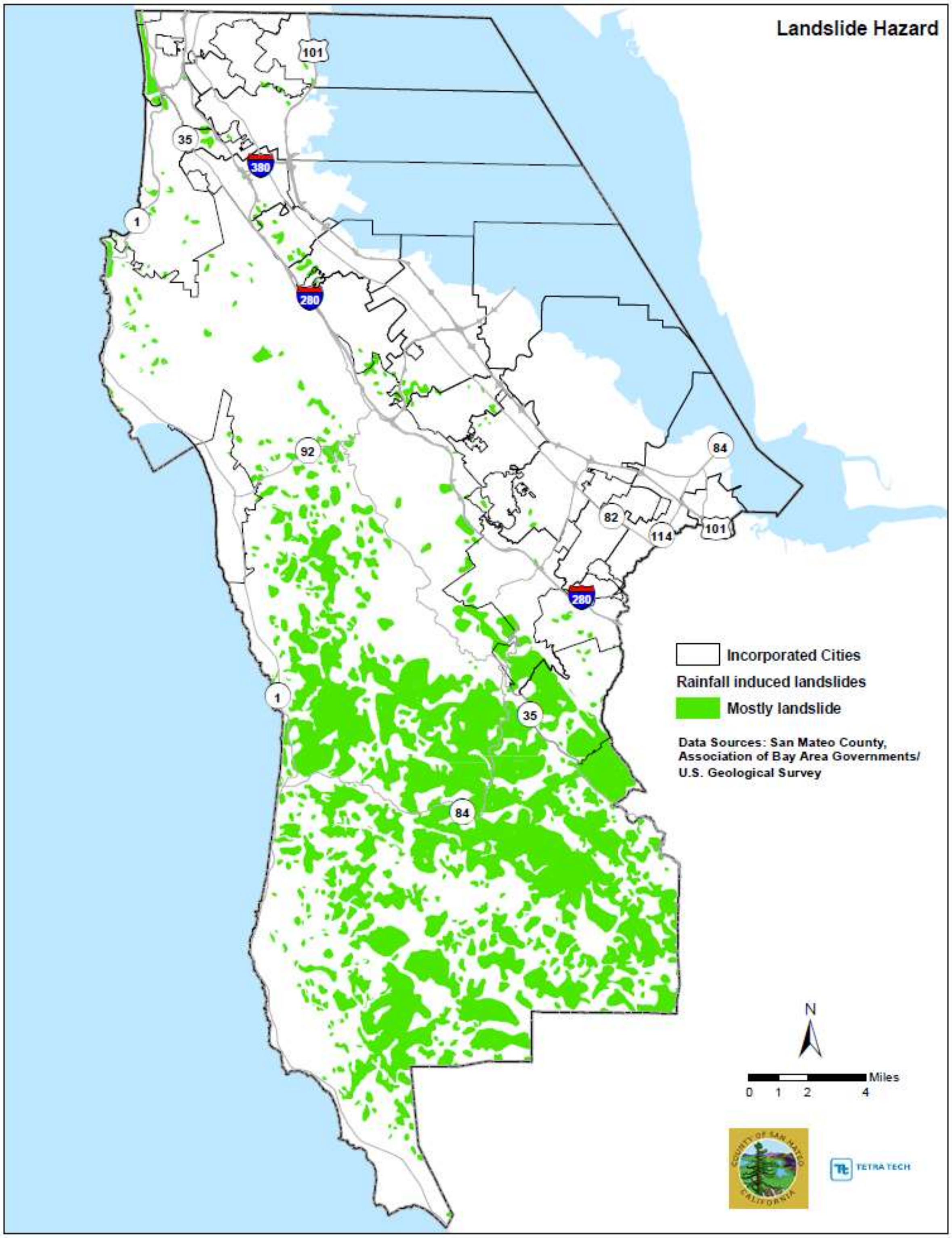


FIGURE 7-6. LANDSLIDE HAZARD AREAS

7.2.3 Frequency

Landslides are often triggered by other natural hazards such as earthquakes, heavy rain, floods (and associated coastal erosion), or wildfires, so the frequency of landslides is related to the frequency of these other hazards. In San Mateo County, landslides are most likely to occur during and after major storms.

Based on risk factors for the County and past occurrences, it is highly likely that landslides will continue to occur in San Mateo County. Landslide probabilities are largely a function of surface geology, but are also influenced by both weather and human activities.

7.2.4 Severity

Landslides destroy property and infrastructure and can take the lives of people. Slope failures in the United States result in an average of 25 lives lost per year and an annual cost of about $1.5 billion. Landslides can also create travel delays and other side effects.

The affected areas need to be identified and the probability that the landslide will occur within some time period needs to be evaluated to assess the magnitude or extent of a landslide hazard. Natural variables that contribute to the overall extent of potential landslide activity in any particular area include soil properties, topographic position and slope, and historical incidence. Predicting a landslide is difficult, even under ideal conditions and with reliable information. As a result, the landslide hazard is often represented by landslide incidence or susceptibility, as defined below:

- Landslide incidence is the number of landslides that have occurred in a given geographic area. High incidence means greater than 15 percent of a given area has been involved in landsliding; medium incidence means that 1.5 to 15 percent of an area has been involved; and low incidence means that less than 1.5 percent of an area has been involved (State of Alabama Date Unknown).
- Landslide susceptibility is defined as the probable degree of response of geologic formations to natural or artificial cutting, to loading of slopes, or to unusually high precipitation. It can be assumed that unusually high precipitation or changes in existing conditions can initiate landslide movement in areas where rocks and soils have experienced numerous landslides in the past. Landslide susceptibility depends on slope angle and the geologic material underlying the slope. Landslide susceptibility identifies only areas potentially affected and does not imply a time frame when a landslide might occur. High, medium, and low susceptibility are delimited by the same percentages used for classifying the incidence of landsliding (State of Alabama Date Unknown).

7.2.5 Warning Time

Mass movements can occur suddenly or slowly. The velocity of movement may range from a slow creep of inches per year to many feet per second, depending on slope angle, material, and water content. Generally accepted warning signs for landslide activity include the following:

- Springs, seeps, or saturated ground in areas that have not typically been wet before
- New cracks or unusual bulges in the ground, street pavements, or sidewalks

- Soil moving away from foundations
- Ancillary structures such as decks and patios tilting or moving relative to the main house
- Tilting or cracking of concrete floors and foundations
- Broken water lines and other underground utilities
- Leaning telephone poles, trees, retaining walls or fences
- Offset fence lines
- Sunken or down-dropped road beds
- Rapid increase in creek water levels, possibly accompanied by increased turbidity (soil content)
- Sudden decrease in creek water levels though rain is still falling or just recently stopped
- Sticking doors and windows and visible open spaces indicating frames out of plumb
- A faint rumbling sound that increases in volume as the landslide nears
- Unusual sounds, such as trees cracking or boulders knocking together.

Some methods used to monitor mass movements can provide an idea of the type of movement and the amount of time prior to failure. Assessing the geology, vegetation, and amount of predicted precipitation for an area can help in predictions of what areas are at risk during general time periods. Currently, there is no practical warning system for individual landslides, however. The standard operating procedure is to monitor situations on a case-by-case basis and respond after an event has occurred.

7.3 Secondary Hazards

Landslides can cause several types of secondary effects, such as blocking access to roads, which can isolate residents and businesses and delay emergency response or commercial, public, and private transportation. This blocked access could result in economic losses for businesses. Other potential problems resulting from landslides are power and communication failures. Utility poles on slopes can be knocked over, resulting in losses to power and communication lines. Landslides also have the potential to destabilize the foundation of structures, which may result in monetary loss for residents. They also can damage rivers or streams, potentially harming water quality, fisheries, and spawning habitat.

7.4 Exposure

7.4.1 Population

Population could not be examined by landslide hazard area because census block group areas do not coincide with the hazard areas. Population was estimated using the structure count of buildings within the landslide hazard areas and multiplying the estimated population for each jurisdiction by the percent of the residential structures in the jurisdiction exposed to the landslide hazard. Using this approach, the estimated population living in the landslide risk area is 20,570 or 2.7 percent of the total planning area population. This estimate includes only populations within defined landslide risk areas; it does not include persons who may be affected by landslide runout. Table 7-2 shows the estimated population exposure by city.

TABLE 7-2. ESTIMATED POPULATION RESIDING IN LANDSLIDE RISK AREAS

	Population Exposed	% of Total Population
Atherton	0	0.0%
Belmont	868	3.2%
Brisbane	0	0.0%
Burlingame	1,046	3.5%
Colma	0	0.0%
Daly City	4,742	4.5%
East Palo Alto	0	0.0%
Foster City	0	0.0%
Half Moon Bay	0	0.0%
Hillsborough	106	0.9%
Menlo Park	0	0.0%
Millbrae	1,739	7.6%
Pacifica	922	2.4%
Portola Valley	791	17.5%
Redwood City	177	0.2%
San Bruno	81	0.2%
San Carlos	163	0.6%
San Mateo	1,462	1.4%
South San Francisco	3,323	5.0%
Woodside	514	9.3%
Unincorporated	4,637	7.2%
Total	**20,570**	**2.7%**

Note: Values shown are accurate only for comparison among results in this plan. See Section 2, Chapter 1 for a discussion of data limitations.

7.4.2 Property

Table 7-3 shows the number and replacement value of structures exposed to the landslide risk. Table 7-4 shows the types of structures in landslide hazard areas. There are an estimated 5,652 structures located in the landslide risk areas, with an estimated value of $5.69 billion. This number represents 1.8 percent of the total replacement value for the planning area. More than 95 percent of the exposed structures are estimated to be residential. Table 7-5 shows the general land use of parcels exposed to landslides in San Mateo County.

TABLE 7-3. EXPOSURE AND VALUE OF STRUCTURES IN LANDSLIDE RISK AREAS

	Buildings Exposed	Value Exposed			% of Total Replacement Value
		Structure	Contents	Total	
Atherton	0	$0	$0	$0	0.0%
Belmont	246	$128,514,301	$91,688,832	$220,203,133	2.1%
Brisbane	1	$263,145	$394,718	$657,863	0.0%
Burlingame	274	$112,569,905	$66,851,882	$179,421,787	0.8%

TABLE 7-3. EXPOSURE AND VALUE OF STRUCTURES IN LANDSLIDE RISK AREAS

	Buildings Exposed	Value Exposed			% of Total Replacement Value
		Structure	Contents	Total	
Colma	0	$0	$0	$0	0.0%
Daly City	1,029	$311,386,628	$218,376,516	$529,763,144	2.1%
East Palo Alto	0	$0	$0	$0	0.0%
Foster City	0	$0	$0	$0	0.0%
Half Moon Bay	1	$4,044,240	$4,044,240	$8,088,480	0.1%
Hillsborough	36	$18,627,015	$9,313,508	$27,940,523	0.6%
Menlo Park	0	$0	$0	$0	0.0%
Millbrae	496	$176,554,277	$97,619,450	$274,173,727	2.8%
Pacifica	284	$104,425,677	$75,092,863	$179,518,540	1.6%
Portola Valley	273	$176,362,023	$126,643,111	$303,005,134	11.1%
Redwood City	42	$34,471,736	$25,899,988	$60,371,723	0.2%
San Bruno	22	$5,916,554	$2,958,277	$8,874,832	0.1%
San Carlos	55	$15,886,974	$7,943,487	$23,830,460	0.1%
San Mateo	390	$154,245,073	$95,259,137	$249,504,210	0.6%
South San Francisco	824	$311,300,934	$199,042,380	$510,343,314	1.6%
Woodside	186	$106,567,081	$71,289,972	$177,857,053	6.1%
Unincorporated	1,493	$1,559,578,176	$1,375,305,107	$2,934,883,283	9.1%
Total	5,652	$**3,220,713,739**	$**2,467,723,468**	$**5,688,437,206**	**1.8%**

Note: Values shown are accurate only for comparison among results in this plan. See Section 2, Chapter 1 for a discussion of data limitations.

TABLE 7-4. PRESENT LAND USE IN LANDSLIDE HAZARD AREAS

	Number of Structures in Landslide Hazard Areas							
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Atherton	0	0	0	0	0	0	0	0
Belmont	241	5	0	0	0	0	0	246
Brisbane	0	0	1	0	0	0	0	1
Burlingame	272	1	0	0	0	0	0	273
Colma	0	0	0	0	0	0	0	0
Daly City	1,019	6	0	0	3	0	1	1,029
East Palo Alto	0	0	0	0	0	0	0	0
Foster City	0	0	0	0	0	0	0	0
Half Moon Bay	0	0	0	1	0	0	0	1
Hillsborough	36	0	0	0	0	0	0	36
Menlo Park	0	0	0	0	0	0	0	0
Millbrae	494	2	0	0	0	0	0	496
Pacifica	281	2	0	0	0	0	1	284

TABLE 7-4. PRESENT LAND USE IN LANDSLIDE HAZARD AREAS

	Number of Structures in Landslide Hazard Areas							
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Portola Valley	267	4	0	0	2	0	0	273
Redwood City	41	1	0	0	0	0	0	42
San Bruno	22	0	0	0	0	0	0	22
San Carlos	55	0	0	0	0	0	0	55
San Mateo	387	2	0	0	1	0	0	390
South San Francisco	817	6	0	0	0	0	1	824
Woodside	183	3	0	0	0	0	0	186
Unincorporated	1,307	49	0	130	2	3	2	1,493
Total	**5,422**	**81**	**1**	**131**	**8**	**3**	**5**	**5,651**

7.4.3 Critical Facilities and Infrastructure

Facilities

Table 7-5 summarizes the critical facilities exposed to the landslide hazard. 45 of the planning area's critical facilities are located within mapped landslide risk areas.

TABLE 7-5. CRITICAL FACILITIES IN LANDSLIDE HAZARD AREAS IN SAN MATEO COUNTY

	Medical and Health Services	Emergency Services	Government	Utilities	Transportation Infrastructure	Hazardous Materials	Community Economic Facilities	Other Assets	Total
Atherton	0	0	0	0	0	0	0	0	**0**
Belmont	0	0	0	2	0	0	0	0	**2**
Brisbane	0	0	0	0	1	0	0	0	**1**
Burlingame	0	0	0	0	0	0	0	0	**0**
Colma	0	0	0	0	0	0	0	0	**0**
Daly City	0	0	0	0	0	0	0	1	**1**
East Palo Alto	0	0	0	0	0	0	0	0	**0**
Foster City	0	0	0	0	0	0	0	0	**0**
Half Moon Bay	0	0	0	0	0	0	0	0	**0**
Hillsborough	0	0	0	0	0	0	0	0	**0**
Menlo Park	0	0	0	0	0	0	0	0	**0**
Millbrae	0	0	0	0	0	0	0	0	**0**
Pacifica	0	0	0	2	1	0	0	1	**4**
Portola Valley	0	0	0	0	0	0	0	0	**0**
Redwood City	0	0	0	0	0	0	0	0	**0**

TABLE 7-5. CRITICAL FACILITIES IN LANDSLIDE HAZARD AREAS IN SAN MATEO COUNTY

	Medical and Health Services	Emergency Services	Government	Utilities	Transportation Infrastructure	Hazardous Materials	Community Economic Facilities	Other Assets	Total
San Bruno	0	0	0	0	1	0	0	0	**1**
San Carlos	0	0	0	0	0	0	0	0	**0**
San Mateo	0	0	0	1	0	0	0	0	**1**
South San Francisco	0	0	0	5	0	0	0	0	**5**
Woodside	0	0	0	0	3	0	0	0	**3**
Unincorporated	0	1	0	3	20	0	0	3	**27**
Total	**0**	**1**	**0**	**13**	**26**	**0**	**0**	**5**	**45**

Roads and Bridges

A significant amount of infrastructure (roads, bridges, and utilities) can be exposed to mass movements. Access to major roads is crucial to life-safety after a disaster and can help to provide resilience during response and recovery operations. Landslides have the potential to block roads, isolating all or part of the County. Roadway blockages caused by landslides can create traffic problems, resulting in delays for emergency vehicles and public and private transportation. These blockages could result in economic losses for businesses. The following major roads intersect mapped landslide hazard areas:

- State Highway 1
- State Highway 92
- Interstate 380
- State Highway 84
- State Highway 82
- US Highway 101
- Interstate 280

Landslide events can significantly damage bridges. They can knock out bridge abutments or significantly weaken the soil supporting a bridge, obstructing the bridge or making it hazardous for use. Bridges in areas of high landslide risk often provide the only ingress and egress to large areas and in some cases to isolated areas. There are 26 bridges within San Mateo County that are believed to be exposed to the landslide hazard. Additionally, bridges outside the County could close off vital access routes. Facilities outside of the County have not been inventoried for this assessment.

Power Lines

Other potential problems resulting from landslides are power and communication failures creating problems for vulnerable populations or businesses and potential loss of life in emergencies. Power lines are generally elevated above steep slopes, but the towers supporting them can be subject to landslides. A landslide could cause the soil underneath a tower to fail, causing it to collapse, and ripping down the lines. An inventory of these types of facilities was not available for this assessment.

7.4.4 Environment

Landslides that fall into streams may significantly damage fish and wildlife habitat, as well as affecting water quality. Hillsides that provide wildlife habitat can be lost for prolonged periods through landslides. Topography may shift and sediment accumulation downslope can block waterways and roadways, impairing the quality of streams and other water bodies. However, landslides also provide resources for many ecosystems.

7.5 Vulnerability

7.5.1 Population

Because of the nature of census block group data, it is difficult to estimate populations vulnerable to landslides. In general, all of the estimated 20,570 persons exposed to the landslide hazard are considered vulnerable. Increasing population, and the fact that many homes are built on view property atop or below bluffs and on steep slopes subject to mass movement, increases the number of lives endangered by this hazard. In addition, people may be affected if transportation corridors are disrupted by the landslide hazard.

7.5.2 Property

Loss estimates for the landslide hazard are not based on modeling using damage functions, because no such damage functions have been generated. Instead, loss estimates were developed representing 10 percent, 30 percent, and 50 percent of the total replacement value of exposed structures. This approach allows emergency managers to evaluate a range of potential economic impacts based on an estimate of the percent of damage to the building stock. Damage in excess of 50 percent is considered substantial by most building codes and typically requires total reconstruction of the structure. Table 7-6 lists loss estimates to the general building stock in landslide hazard areas. It is highly unlikely that all landslide-prone areas would slide at the same time.

TABLE 7-6. LOSS POTENTIAL FOR LANDSLIDE

		Estimated Loss Potential from Landslide		
	Exposed Value	10% Damage	30% Damage	50% Damage
Atherton	$0	$0	$0	$0
Belmont	$220,203,133	$22,020,313	$66,060,940	$110,101,567
Brisbane	$657,863	$65,786	$197,359	$328,932
Burlingame	$179,421,787	$17,942,179	$53,826,536	$89,710,894
Colma	$0	$0	$0	$0
Daly City	$529,763,144	$52,976,314	$158,928,943	$264,881,572
East Palo Alto	$0	$0	$0	$0
Foster City	$0	$0	$0	$0
Half Moon Bay	$8,088,480	$808,848	$2,426,544	$4,044,240
Hillsborough	$27,940,523	$2,794,052	$8,382,157	$13,970,261
Menlo Park	$0	$0	$0	$0

TABLE 7-6. LOSS POTENTIAL FOR LANDSLIDE

	Exposed Value	Estimated Loss Potential from Landslide		
		10% Damage	30% Damage	50% Damage
Millbrae	$274,173,727	$27,417,373	$82,252,118	$137,086,863
Pacifica	$179,518,540	$17,951,854	$53,855,562	$89,759,270
Portola Valley	$303,005,134	$30,300,513	$90,901,540	$151,502,567
Redwood City	$60,371,723	$6,037,172	$18,111,517	$30,185,862
San Bruno	$8,874,832	$887,483	$2,662,450	$4,437,416
San Carlos	$23,830,460	$2,383,046	$7,149,138	$11,915,230
San Mateo	$249,504,210	$24,950,421	$74,851,263	$124,752,105
South San Francisco	$510,343,314	$51,034,331	$153,102,994	$255,171,657
Woodside	$177,857,053	$17,785,705	$53,357,116	$88,928,527
Unincorporated	$2,934,883,283	$293,488,328	$880,464,985	$1,467,441,642
Total	**$5,688,437,206**	**$568,843,718**	**$1,706,531,162**	**$2,844,218,605**

Note: Values shown are accurate only for comparison among results in this plan. See Section 2, Chapter 1 for a discussion of data limitations.

7.5.3 Critical Facilities and Infrastructure

There are 45 critical facilities exposed to the landslide hazard to some degree. A more in-depth analysis of mitigation measures taken by these facilities should be completed to evaluate whether they could withstand impacts of a mass movement. No loss estimates were developed as a result of the lack of established damage functions for the landslide hazard.

7.5.4 Environment

The environment vulnerable to landslide hazard is the same as the environment exposed to the hazard. A landslide alters the landscape. In addition to changes in topography, vegetation and wildlife habitats may be damaged or destroyed, and soil and sediment runoff will accumulate downslope, potentially blocking waterways and roadways and impairing the quality of streams and other water bodies.

7.5.5 Economic Impact

The economic impact of a landslide or similar geologic event depends on the severity and location of the landslide. Minor landslides may not lead to any economic impact if they occur in the woods or in non-populated areas. Minor landslides in more populated areas can have a hidden economic impact, however. Landslides that lead to temporary road closures isolate neighborhoods and delay traffic for public and private transportation. This delay can result in losses for businesses if employees are unable to make it to work or if customers choose not to shop at a store because of logistical difficulties.

Landslide economic losses can ultimately be categorized in several ways. Direct impacts include the costs of replacement, repair, rebuilding, and maintenance resulting from landslide damage to property. Indirect costs include reduced real estate values in areas threatened by landslides; loss of tax revenues on properties devalued by landslides; loss of industrial, agricultural, and forest productivity, and of tourist revenues; loss of human or domestic animal productivity because of death, injury, and psychological trauma; and costs of mitigation and prevention to reduce landslide risks. Economic impact can also be evaluated by private and public costs. Private costs are mainly incurred as damage to land and structures, such as private property or industrial facilities. Public costs are those borne by government agencies. The largest public cost is the repair or relocation of highways/roads and accessory structures (sidewalks and storm drains) after an event (USGS 2001).

The potential for greater economic impact as a result of landslides is growing; it results when the built environment expands into unstable hillside areas to accommodate growing populations. Human activities and development exacerbate already unstable areas, increasing the potential for slope failures (USGS 2001).

7.6 Future Trends in Development

The County and its planning partners are equipped to handle future growth within landslide hazard areas, although the large range of landslide hazard areas in the County make vigilance toward growth and development even more important.

Additionally, the State of California has adopted the International Building Code (IBC) by reference in its California Building Standards Code. The IBC includes provisions for geotechnical analyses in steep slope areas that have soil types considered susceptible to landslide hazards. These provisions assure that new construction is built to standards that reduce the vulnerability to landslide risk.

TABLE 7-7. FUTURE LAND USE EXPOSURE TO THE LANDSLIDE HAZARD

Jurisdiction	Agriculture/Resource Extraction		Commercial		Education		Industrial		Mixed Use		Other/Unknown		Parks/Open Space		Residential		Water		Total
	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)
ATHERTON		0		0		0	0.0	0		0		0		0		0	0.0	0	**0.0**
BELMONT	0.0	0.00%	4.9	6.42%	1.5	1.90%	0.0	0.00%	0.0	0.00%	6.1	7.91%	0.7	0.91%	63.6	82.86%	0.0	0.00%	**76.8**
BRISBANE	0.0	0.00%	10.5	24.79%	0.0	0.00%	0.0	0.00%	0.0	0.00%	29.1	68.87%	2.6	6.13%	0.1	0.21%	0.0	0.00%	**42.3**
BURLINGAME	0.0	0.00%	0.0	0.00%	6.4	5.84%	0.0	0.00%	0.0	0.00%	20.7	18.77%	6.4	5.82%	76.8	69.57%	0.0	0.00%	**110.5**
COLMA		0		0		0	0.0	0		0		0		0		0	0.0	0	**0.0**
DALY CITY	0.0	0.00%	10.9	2.84%	18.1	4.69%	0.0	0.00%	0.0	0.00%	41.8	10.84%	185.5	48.14%	129.1	33.49%	0.0	0.00%	**385.4**
EAST PALO ALTO		0		0		0	0.0	0		0		0		0		0	0.0	0	**0.0**
FOSTER CITY		0		0		0	0.0	0		0		0		0		0	0.0	0	**0.0**
HALF MOON BAY	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	2.5	7.16%	32.4	92.84%	0.0	0.00%	0.0	0.00%	**34.9**
HILLSBOROUGH	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	3.8	8.73%	0.0	0.00%	40.0	91.27%	0.0	0.00%	**43.8**
MENLO PARK		0		0		0	0.0	0		0		0		0		0	0.0	0	**0.0**
MILLBRAE	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	1.7	1.06%	16.7	10.07%	147.0	88.88%	0.0	0.00%	**165.5**
PACIFICA	0.0	0.00%	4.5	1.74%	9.9	3.80%	0.0	0.00%	0.0	0.00%	132.9	51.17%	10.2	3.94%	102.2	39.35%	0.0	0.00%	**259.7**
PORTOLA VALLEY	0.0	0.00%	0.0	0.00%	1.6	0.07%	0.0	0.00%	0.0	0.00%	35.7	1.58%	380.5	16.88%	1,836.1	81.47%	0.0	0.00%	**2,253.9**
REDWOOD CITY	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	6.1	9.76%	41.5	66.93%	14.5	23.32%	0.0	0.00%	**62.0**
SAN BRUNO	0.0	0.00%	0.0	0.00%	0.0	0.03%	0.0	0.00%	0.0	0.00%	1.8	3.97%	39.1	87.79%	3.7	8.21%	0.0	0.00%	**44.6**
SAN CARLOS	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.3	1.92%	2.0	14.62%	11.7	83.47%	0.0	0.00%	**14.0**
SAN MATEO	0.0	0.00%	0.0	0.00%	1.3	0.70%	0.0	0.00%	0.0	0.00%	2.3	1.24%	100.4	53.87%	82.4	44.19%	0.0	0.00%	**186.4**
SOUTH SAN FRANCISCO	0.0	0.00%	11.9	8.24%	2.5	1.70%	0.0	0.00%	5.5	3.76%	28.7	19.81%	19.8	13.67%	76.5	52.81%	0.0	0.00%	**144.8**
WOODSIDE	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	37.7	3.57%	995.6	94.38%	21.6	2.05%	0.0	0.00%	**1,054.9**
UNINCORPORATED	30,634.9	49.98%	8.3	0.01%	14.9	0.02%	0.0	0.00%	96.0	0.16%	273.8	0.45%	29,444.7	48.04%	824.7	1.35%	0.0	0.00%	**61,297.3**
Total	**30,634.9**	**46.29%**	**51.1**	**0.08%**	**56.2**	**0.08%**	**0.0**	**0.00%**	**101.5**	**0.15%**	**624.9**	**0.94%**	**31,278.1**	**47.26%**	**3,430.0**	**5.18%**	**0.0**	**0.00%**	**66,176.7**

7.7 Scenario

Major landslides in San Mateo County most typically occur as a result of soil conditions affected by severe storms, groundwater, or human development. The worst-case scenario for landslide hazards in the planning area would generally correspond to a severe storm with heavy rain that caused flooding. Landslides are more likely during the late winter when the water table is high. After heavy rains from November to December, soils become saturated with water. As water seeps downward through upper soils that may consist of permeable sands and gravels and as it accumulates on impermeable silt, it will weaken and destabilize the slope. A short intense storm could cause saturated soil to move, resulting in landslides. As rains continue, the groundwater table rises, adding to the weakening of the slope. Gravity, poor drainage, a rising groundwater table, and poor soil exacerbate hazardous conditions.

Mass movements are becoming a greater concern as development moves outside of city centers and into areas with less developed infrastructure. Most mass movements would be isolated events affecting specific areas. It is probable that private and public property, including infrastructure, would be affected. Mass movements could affect bridges that pass over landslide-prone ravines and knock out rail service through the County. Road obstructions caused by mass movements would create isolation problems for residents and businesses in sparsely developed areas. Property owners exposed to steep slopes may suffer damage to property or structures. Landslides carrying vegetation such as shrubs and trees may cause a break in utility lines, cutting off power and communications to residents.

Continued heavy rains and flooding would complicate the problem further. As emergency response resources are applied to problems with flooding, it is possible they will be unavailable to assist with landslides across San Mateo County.

7.8 Issues

Important issues associated with landslide hazards in San Mateo County include but are not limited to the following:

- The data and science regarding mapping and assessing landslide hazards are constantly evolving. As new data and science become available, assessments of landslide risk should be re-evaluated.
- The impact of climate change on landslides is uncertain. If climate change affects atmospheric conditions, the exposure to landslide risks in San Mateo County could increase.
- There are existing homes in landslide risk areas throughout the County. The degree of vulnerability of these structures depends on the codes and standards applied in constructing the structures.
- Future development could lead to more homes in landslide risk areas.
- Landslides may cause negative environmental consequences, including water quality degradation.
- The risk associated with the landslide hazard overlaps the risk associated with other hazards, including earthquake, flooding, and wildfire. The County has an opportunity to seek mitigation alternatives with multiple objectives that can reduce risk for multiple hazards.

Chapter 8. Severe Weather

8.1 General Background

Severe weather refers to any dangerous meteorological phenomena with the potential to cause damage, serious social disruption, or loss of human life. It includes thunderstorms, downbursts, tornadoes, waterspouts, snowstorms, ice storms, and dust storms, among other events.

Severe weather can be categorized into two groups: systems that form over wide geographic areas are classified as general severe weather; those with a more limited geographic area are classified as localized severe weather. Technically, severe weather is not the same as extreme weather, which refers to unusual weather events at the extremes of the historical distribution for a given area.

The most common severe weather events that impact the Planning Area are tornadoes, windstorms, fog, heavy rains, thunderstorms, and lightning. Tidal impacts, while a regular phenomenon and not a hazardous event, is also considered due to its impact on coastal erosion. In northern parts of California, winter weather (i.e., snowstorms, ice, and extreme cold) can be included in this category; however, winter weather does not notably impact the Planning Area. Flooding issues associated with severe weather are discussed in Chapter 6.

DEFINITIONS

Coastal Erosion—The process of the wearing away of coastal beaches and bluffs by large storms, flooding, strong wave action, sea level rise, and human activities. Erosion occurs when waves and currents remove sand from the beach system. The loss of sand causes the beach to become narrower and lower in elevation.

Severe Local Storm—Small atmospheric systems including tornadoes, thunderstorms, and windstorms. Typically, major impacts from a severe storm are on transportation infrastructure and utilities. These storms may cause a great deal of destruction and even death, but their impact is generally confined to a small area.

Thunderstorm—Typically 15 miles in diameter and lasting about 30 minutes, thunderstorms are underrated hazards. Lightning, which occurs with all thunderstorms, is a serious threat to human life. Heavy rains over a small area in a short time can lead to flash flooding. Strong winds, hail, and tornadoes are also dangers associated with thunderstorms.

Tornado—Tornadoes are funnel clouds of varying sizes that generate winds more than 300 miles per hour. A tornado is formed by the turbulent mixing of layers of air with contrasting temperature, moisture, density, and wind flow. The mixing layers of air account for most of the tornadoes occurring in April, May, and June, when cold, dry air meets warm, moister air moving up from the south. They can affect an area up to one mile wide, with a path of varying length. Tornadoes can come from lines of cumulonimbus clouds or from a single storm cloud. They are measured using the Enhanced Fujita Scale ranging from EF0 to EF5.

Windstorm—A storm featuring violent winds. Southwesterly winds are associated with strong storms moving onto the coast from the Pacific Ocean. Southern winds parallel to the coastal mountains are the strongest and most destructive winds. Windstorms tend to damage ridgelines that face into the winds.

8.1.1 Tornadoes

A tornado is a violently rotating column of air extending between, and in contact with, a cloud and the surface of the earth. Tornadoes are often (but not always) visible as a funnel cloud. On a local-scale, tornadoes are the most intense of all atmospheric circulations and wind can reach destructive speeds of more than 300 miles per hour (mph). A tornado's vortex is typically a few hundred meters in diameter, and damage paths can be up to 1 mile wide and 50 miles long. Figure 8-1, as adopted from Federal Emergency Management Agency (FEMA), illustrates the potential impacts and damage from tornadoes of different magnitude. Tornadoes can occur throughout the year at any time of day but are most frequent in the spring during the late afternoon. As shown in Figure 8-2, California has a relatively low risk compared to states in the midwestern and southern United States.

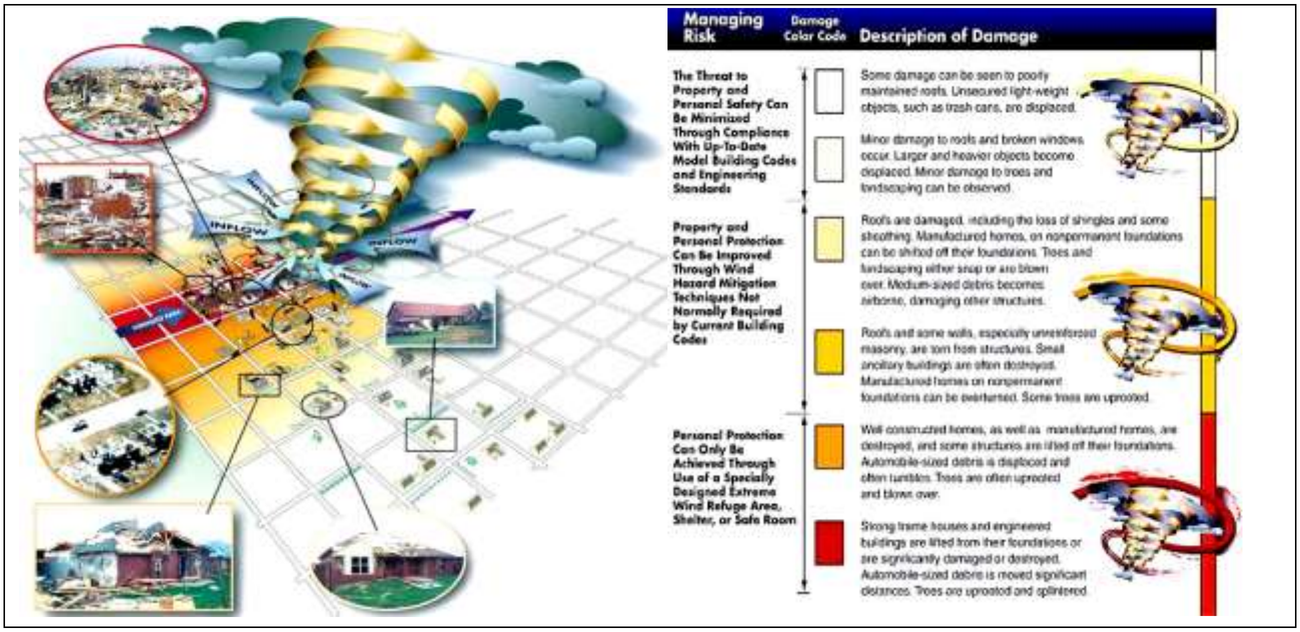


FIGURE 8-1. POTENTIAL IMPACT AND DAMAGE FROM A TORNADO

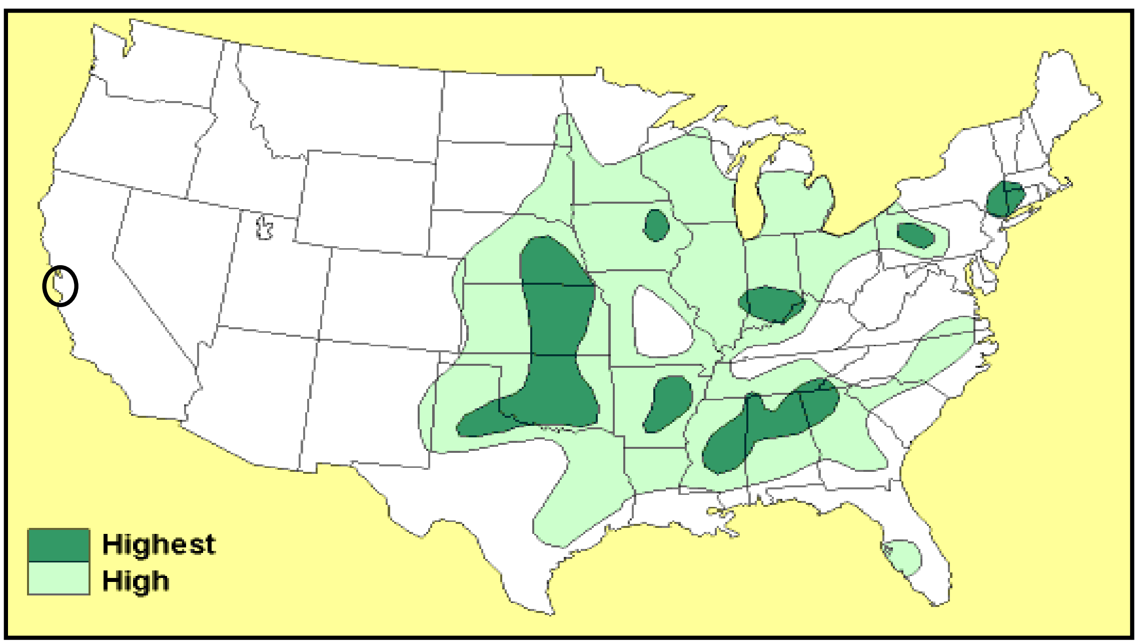


FIGURE 8-2. TORNADO RISK AREAS IN THE COTERMINOUS UNITED STATES

Note: The approximate location of San Mateo County is indicated by the black circle.

8.1.2 Windstorms

Windstorms are generally short-duration events involving straight-line winds or gusts of over 50–60 mph, strong enough to cause property damage. Damage from such winds accounts for half of all severe weather reports in the lower 48 states. Wind speeds can reach up to 100 mph and can produce a damage path extending for hundreds of miles. There are seven types of damaging winds:

- **Straight-line winds**—Any thunderstorm wind that is not associated with rotation; this term is used mainly to differentiate from tornado winds. Most thunderstorms produce some straight-line winds as a result of outflow generated by the thunderstorm downdraft.
- **Downdraft**—A small-scale column of air that rapidly sinks toward the ground.
- **Downburst**—A strong downdraft with horizontal dimensions larger than 2.5 miles resulting in an outward burst or damaging winds on or near the ground. Downburst winds may begin as a microburst and spread out over a wider area, sometimes producing damage similar to a strong tornado. Although usually associated with thunderstorms, downbursts can occur with showers too weak to produce thunder.
- **Microbursts**—Microbursts are small concentrated downbursts that produce an outward burst of damaging winds at the surface. Microbursts are generally less than 2.5 miles across and short-lived, lasting only 5 to 10 minutes, with maximum wind speeds up to 168 mph. There are two kinds of microbursts: wet and dry. A wet microburst is accompanied by heavy precipitation at the surface. Dry microbursts, common in places like the high plains and the intermountain west, occur with little or no precipitation reaching the ground.
- **Gust front**—The leading edge of rain-cooled air that clashes with warmer thunderstorm inflow. Gust fronts are characterized by a wind shift, temperature drop, and gusty winds out ahead of a thunderstorm. Sometimes the winds push air above them, forming a shelf cloud or detached roll cloud.
- **Derecho**—A widespread thunderstorm wind caused when new thunderstorms form along the leading edge of an outflow boundary (the boundary formed by horizontal spreading of thunderstorm-cooled air). The word “derecho” is of Spanish origin and means “straight ahead.” Thunderstorms feed on the boundary and continue to reproduce. Derechos typically occur in summer when complexes of thunderstorms form over plains, producing heavy rain and severe wind. The damaging winds can last a long time and cover a large area.
- **Bow Echo**—A linear wind front bent outward in a bow shape. Damaging straight-line winds often occur near the center of a bow echo. Bow echoes can be 200 miles long, last for several hours, and produce extensive wind damage at the ground.

Windstorms can result in collapsed or damaged buildings, damaged or blocked roads and bridges, damaged traffic signals, streetlights, and parks, and other damage. Wind speeds as low as 32 mph can cause structural damage, and winds of 100 mph can destroy wood-frame structures (Seattle Office of Emergency Management 2014). They can also cause direct losses to buildings, people, and vital equipment. There are direct consequences to the local economy resulting from windstorms and the associated physical damage and interrupted services.

Wind pressure can create a direct and frontal assault on a structure, pushing walls, doors, and windows inward. Conversely, passing currents can create lift and suction forces that act to pull building components and surfaces outward. As positive and negative forces impact a building's doors, windows, and walls, the result can be roof or building component failures and considerable structural damage. The effects of winds are magnified in the upper levels of multi-story structures.

Debris carried along by extreme winds can contribute directly to loss of life and indirectly to the failure of protective building envelopes. Falling trees and branches can damage buildings, power lines, and other property and infrastructure. Tree limbs breaking in winds of only 45 mph can be thrown over 75 feet, so overhead power lines can be damaged even in relatively minor windstorm events. During wet winters, saturated soils cause trees to become less stable and more vulnerable to uprooting from high winds. Utility lines brought down by summer thunderstorms have also been known to cause fires, which start in dry roadside vegetation. Electric power lines falling down to the pavement create the possibility of lethal electric shock.

Downed trees and power lines, and damaged property also can be major hindrances to emergency response and disaster recovery. Emergency response operations can be complicated when roads are blocked or when power supplies are interrupted. Industry and commerce can suffer losses from interruptions in electric service and from extended road closures.

8.1.3 Fog

Fog is a cloud near the ground. Fog forms when air close to the ground can no longer hold all the moisture it contains. This occurs either when air is cooled to its dew point or the amount of moisture in the air increases. Heavy fog is particularly hazardous because it can restrict surface visibility. Severe fog incidents can close roads, cause vehicle accidents and airport delays, and impair the effectiveness of emergency response. Financial losses associated with transportation delays caused by fog have not been calculated in the United States, but it is known to be substantial. Fog can occur almost anywhere during any season and is classified based on how it forms, which is related to where it forms. Certain seasons are more likely to have foggy days or nights based on a number of factors, including topography.

Fog in the Bay Area and San Mateo County has different origins depending on the time of year. In the summer, the area is characterized by cool marine air and persistent coastal stratus and fog. In winter, fog typically originates from the Great Valley. Radiation (ground) fog forms in the moist regions of the Sacramento River Delta and arrives to the region via Suisun and San Pablo Bays and San Francisco Bays on cool easterly drainage winds. While this type of fog is less frequent than summer fogs, it is typically denser and more likely to lead to significantly reduced visibility (Golden Gate Weather Services 2009). Although fog seems like a minor hazard, it can have significant impacts. The California Highway Patrol (CHP) alone has records of at least four officers whose deaths were indirectly caused by or exacerbated by dense fog and poor visibility (CHP 2016).

8.1.4 Heavy Rains, Thunderstorms, and Lightning

Most severe storms in San Mateo County consist of either heavy rains or thunderstorms. Heavy rain, also known as heavy precipitation, refers to events where the amount of rain exceeds normal levels. The amount of precipitation needed to qualify an event as heavy rain will vary by location and season. Heavy rain is distinct from climate change analyses on increasing precipitation. It does not mean that the total amount of precipitation at a location has increased, just that the rain is occurring in a more intense event. More frequent heavy rain events, however, can serve as an indicator in changing precipitation levels. Heavy rain is most frequently measured by tracking frequency of events, analyzing the mean return period (MRP), and measuring the amount of precipitation in a certain period (most typically inches of rain falling within a 24-hour period) (EPA 2015).

A thunderstorm is a rain event that includes thunder and lightning. A thunderstorm is classified as “severe” when it contains one or more of the following: hail with a diameter of three-quarter inch or greater, winds gusting in excess of 50 knots (57.5 mph), or a tornado. Approximately 10 percent of the 100,000 thunderstorms that occur nationally every year are classified as severe (National Oceanic and Atmospheric Administration [NOAA] 2014).

Three factors cause thunderstorms to form: moisture, rising unstable air (air that keeps rising when disturbed), and a lifting mechanism to provide the disturbance. The sun heats the surface of the earth, which warms the air above it. If this warm surface air is forced to rise (hills or mountains can cause rising motion, as can the interaction of warm air and cold air or wet air and dry air) it will continue to rise as long as it weighs less and stays warmer than the air around it. As the air rises, it transfers heat from the surface of the earth to the upper levels of the atmosphere (the process of convection). The water vapor it contains begins to cool and it condenses into a cloud. The cloud eventually grows upward into areas where the temperature is below freezing. Some of the water vapor turns to ice and some of it turns into water droplets. Both have electrical charges. Ice particles usually have positive charges, and rain droplets usually have negative charges. When the charges build up enough, they are discharged in a bolt of lightning, which causes the sound waves we hear as thunder. Thunderstorms have three stages (see Figure 8-3):

- The *developing stage* of a thunderstorm is marked by a cumulus cloud that is being pushed upward by a rising column of air (updraft). The cumulus cloud soon looks like a tower (called towering cumulus) as the updraft continues to develop. There is little to no rain during this stage but occasional lightning. The developing stage lasts about 10 minutes.
- The thunderstorm enters the *mature stage* when the updraft continues to feed the storm, but precipitation begins to fall out of the storm, and a downdraft begins (a column of air pushing downward). When the downdraft and rain-cooled air spread out along the ground, they form a gust front, or a line of gusty winds. The mature stage is the most likely time for hail, heavy rain, frequent lightning, strong winds, and tornadoes. The storm occasionally has a black or dark green appearance.
- Eventually, a large amount of precipitation is produced and the updraft is overcome by the downdraft beginning the *dissipating stage*. At the ground, the gust front moves out a long distance

from the storm and cuts off the warm moist air that was feeding the thunderstorm. Rainfall decreases in intensity, but lightning remains a danger.

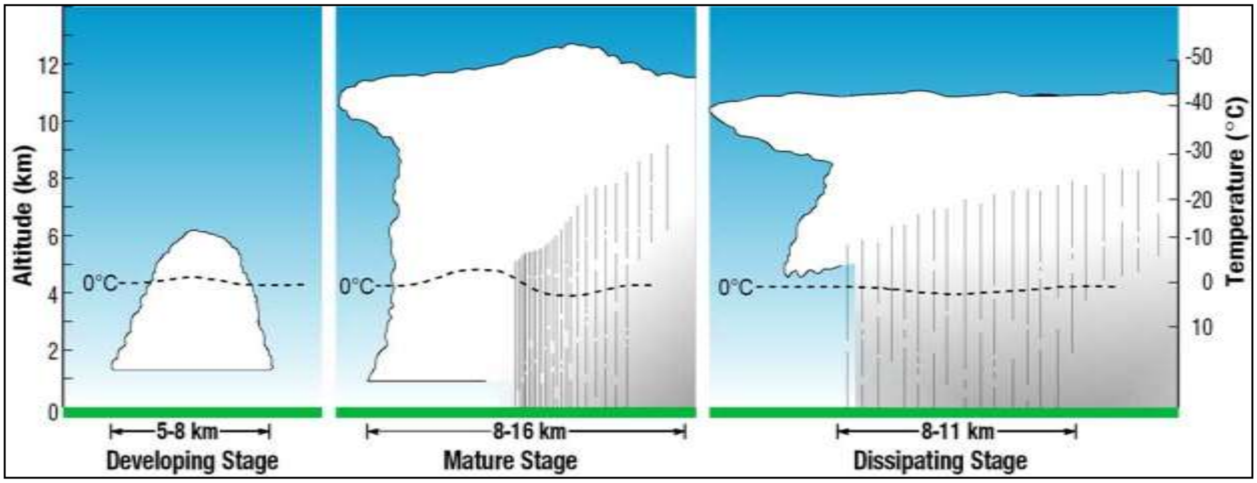


FIGURE 8-3. THE THUNDERSTORM LIFE CYCLE

There are four types of thunderstorms:

- **Single-Cell Thunderstorms**—Single-cell thunderstorms usually last 20 to 30 minutes. A true single-cell storm is rare, because the gust front of one cell often triggers the growth of another. Most single-cell storms are not usually severe, but a single-cell storm can produce a brief severe weather event. When this happens, it is called a pulse severe storm.
- **Multi-Cell Cluster Storm**—A multi-cell cluster is the most common type of thunderstorm. The multi-cell cluster consists of a group of cells, moving as one unit, with each cell in a different phase of the thunderstorm life cycle. Mature cells are usually found at the center of the cluster and dissipating cells at the downwind edge. Multi-cell cluster storms can produce moderate-size hail, flash floods, and weak tornadoes. Each cell in a multi-cell cluster lasts only about 20 minutes; the multi-cell cluster itself may persist for several hours. This type of storm is usually more intense than a single cell storm.
- **Multi-Cell Squall Line**—A multi-cell line storm, or squall line, consists of a long line of storms with a continuous well-developed gust front at the leading edge. The line of storms can be solid, or there can be gaps and breaks in the line. Squall lines can produce hail up to golf-ball size, heavy rainfall, and weak tornadoes, but they are best known as the producers of strong downdrafts. Occasionally, a strong downburst will accelerate a portion of the squall line ahead of the rest of the line. This produces what is called a bow echo. Bow echoes can develop with isolated cells as well as squall lines. Bow echoes are easily detected on radar but are difficult to observe visually.
- **Super-Cell Storm**—A super-cell is a highly organized thunderstorm that poses a high threat to life and property. It is similar to a single-cell storm in that it has one main updraft, but the updraft is extremely strong, reaching speeds of 150 to 175 miles per hour. Super-cells are rare. The main characteristic that sets them apart from other thunderstorms is the presence of rotation. The rotating updraft of a super-cell (called a mesocyclone when visible on radar) helps the super-cell to

produce extreme weather events, such as giant hail (more than 2 inches in diameter), strong downbursts of 80 miles an hour or more, and strong to violent tornadoes.

Lightning occurs in all thunderstorms. There are two main types of lightning: intra-cloud lightning and cloud-to-ground lightning (National Weather Service, 2014). Lightning is an electrical discharge that results from the buildup of positive and negative charges within a thunderstorm. When the buildup becomes strong enough, lightning appears as a "bolt." This flash of light usually occurs within the clouds or between the clouds and the ground. A bolt of lightning reaches temperatures approaching 50,000 degrees Fahrenheit (ºF) instantaneously. The rapid heating and cooling of air near the lightning causes thunder. Lightning is a major threat during a thunderstorm. In the United States, between 75 and 100 Americans are struck and killed by lightning each year. Lightning also causes forest and brush fires and deaths and injuries to livestock and other animals. According to the National Lightning Safety Institute, lightning causes more than 26,000 fires in the United States each year. The institute estimates property damage, increased operating costs, production delays, and lost revenue from lightning and secondary effects to be in excess of $6 billion per year. Impacts can be direct or indirect.

Ice, snow, and freezing rain storms are not part of the climate pattern in San Mateo County and the Bay Area. Wintertime temperatures typically range from 45ºF to 60ºF, and there have only been 10 documented instances of snowfall during a 143-year period. Snow may also occur in trace amounts or at higher elevations. As noted at the beginning of this section, although ice storms, snow, and freezing rains are a significant natural hazard, the extremely remote possibility of their occurrence in San Mateo County precludes any further discussion in this analysis.

8.1.5 Tides and Coastal Erosion

Tides consist of long-period waves moving through the ocean as a result of pressures exerted by the moon and sun. Tides originate in oceans and move towards the coast. They are more visible as the rise and fall of the sea level surface closer to the coastline. High tide occurs when the highest part of the wave (the crest) reaches the location in question, while low tide occurs when the lowest part of the wave (the trough) reaches the location in question. The tidal range consists of the difference in height between high and low tide. Tides, water levels, and tidal currents are monitored for a variety of reasons, including their relationship to weather, their impact on local biology and the environment, their importance to the economy, and their potential impact on new development, especially as climate change and sea level rise become better understood (NOAA no date [n.d.]).

The County of San Mateo and City of Pacifica have an additional reason to monitor the impacts and effects of tides along their coastlines. Over time, tides reshape coastlines and alter shoreline morphology, sometimes resulting in coastal erosion. Particularly in the City of Pacifica, coastal erosion has led to significant and visible impacts as local cliffs are worn away by the regular motion of the tides. Portions of the City built along the edge of the cliffs have gradually come closer to being "beachfront" property as the cliffs wear away. In fact, buildings and infrastructure have fallen into the Pacific Ocean when the cliff and rocks beneath them have crumbled from erosion. Refer to the Landslide Hazard Profile (Chapter 7) for more details on specific damages and losses to the City of Pacifica. While storm surge, severe storm events, and coastal flooding exacerbate the undercutting of the cliffs, it is the regular motion of the tides which present the greatest threat due to tidal action being a sustained phenomenon. The 1997–1998 El Niño System led to the crest of the Pacifica cliff retreating 13 meters (m) landward while the toe of the cliff retreated about 10 m. In contrast, the average long-term erosion rate for the cliffs in general is roughly 0.2 m per year. Land along the cliff also does not erode evenly, leading to more difficulties in prediction (U.S. Geological Survey [USGS] 2013). Therefore, while significant storms should be monitored due to their ability to cause a surge in erosion rates along the Pacifica cliffs, regular tidal erosion must also be monitored and mitigated to the greatest extent possible.

8.1.6 El Niño Effects on Severe Weather

El Niño is a type of natural climactic event which dramatically illustrates the impact of climate change on the frequency and intensity of severe storms, geologic hazard events, droughts, and fires. El Niño consists of oceanic and atmospheric phenomena related to unusually high temperatures on the surface of the eastern equatorial Pacific Ocean. These conditions occur once every few years and most likely start from a random, slight reduction in trade winds. Their exacerbation of severe weather is thought to be brought about by the release of greater amounts of heat in the atmosphere, which comes from an increase in water evaporating from the ocean (Keller 2008). NOAA operates a network of buoys to measure temperature, currents, and winds in the equatorial band of the Pacific Ocean. This allows researchers to determine the occurrence and strength of El Niño events. The strength of an event is determined by the Oceanic Niño Index (ONI), the three-month running mean of sea surface temperature departures from average in the Niño 3.4 region (NOAA 2015).

The 1997–1998 El Niño event gained national recognition for its contribution to hurricanes, floods, landslides, droughts, and fires that killed substantial numbers of people and caused billions of dollars in damages. Australia, Indonesia, and the Americas were particularly impacted by the 1997–1998 El Niño. La Niña is another type of weather phenomena, and it could be considered the opposite of an El Niño. It leads to cooler Pacific Ocean waters (Keller 2008). The next noteworthy El Niño event occurred over 2015–2016. The most recent event gained significant attention, particularly in California, since the State has already been dealing with the devastating impacts of a long-term drought (NOAA 2015). The 2015–2016 El Niño is currently considered one of the strongest three on record, going back to 1950. The 2015–2016 ONI values tied with the 1997–1998 event for severity, but other types of measurements indicate that the 1997–1998 event had greater impact (Climate.gov 2016).

8.2 Hazard Profile

8.2.1 Past Events

Table 8-1 summarizes past severe weather events in San Mateo County as recorded by NOAA since 1950. Although 86 events were reported to NOAA, only tornadoes, dense fog, thunderstorms with wind speeds over 50 knots, and windstorms with winds over 50 knots are listed below.

TABLE 8-1. SEVERE WEATHER EVENTS IN SAN MATEO COUNTY SINCE 1950

Date	Type	Deaths or Injuries	Property Damage
April 1, 1958	**Tornado**	**0**	**$825,030**
A tornado with a 0.2 mile length and 67 yard width impacted San Mateo County. This tornado does not have an associated magnitude.			
March 10, 1986	**Tornado**	**0**	**$30**
A F0 tornado with a 0.2 mile length and 50 yard width impacted San Mateo County. The small waterspout moved ashore from the Pacific Ocean, flipped a car, and did minor property damage at a seaside restaurant at Moss Beach.			
March 4, 1996	**Heavy Rain**	**0**	**$0**
1.48 inches of rain fell in Redwood City. The rain accumulated on the roof of Office Depot causing it to collapse.			
January 2, 1998	**Heavy Rain**	**12 Injuries**	**$0**
Rain-slick roads caused several car accidents.			
January 11, 1998	**Heavy Rain**	**1 Death**	**$0**
Heavy rain contributed to a car accident. One fatality was recorded as a result of this event.			
February 7, 1998	**Tornado**	**0**	**$0**
A F0 tornado with a 0.2-mile length and 50-yard width impacted San Mateo County. The weak tornado ripped up some trees. It appears to have begun as a waterspout and moved onshore.			
February 13, 2000	**Heavy Rain**	**0**	**$2,000,000**
Widespread rain with 24-hour accumulations of more than 5 inches occurred over the area on Feb 13th into February 14th. Urban and small stream flooding occurred in most counties of the area. Many roads including Highway 1 and Highway 116 were closed. Twenty-nine people were evacuated in Pescadero due to high waters. A number of houses in Daly City were abandoned and eventually destroyed due to mudslides which were a result of the consecutive years of above average rain. The roof of a Home Depot collapsed due to the accumulation of heavy rain, flooding the interior of the store with 6 inches of rain and exposing the interior to continuing rain.			
December 15, 2002	**Heavy Rain**	**0**	**$0**
December turned out to be one of the wettest on record at many locations throughout the area. 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 mainstream flooding as well.			
October 19, 2004	**Thunderstorm Wind**	**0**	**$50,000**
A thunderstorm produced a 60 mph wind gust that snapped two large trees, with one falling on a house.			
March 20, 2005	**Tornado**	**0**	**$800,000**

TABLE 8-1. SEVERE WEATHER EVENTS IN SAN MATEO COUNTY SINCE 1950

Date	Type	Deaths or Injuries	Property Damage
A F1 tornado with a 3-mile length and 30-yard width impacted San Mateo County. The tornado damaged approximately 60 structures.			
December 1, 2005	**High Wind**	**0**	**$0**
A strong winter storm brought a 64 mph gust to San Francisco Airport.			
December 18, 2005	**High Wind**	**0**	**$0**
A wind gust reached 71 mph at Angel Island during a winter storm.			
December 31, 2005	**High Wind**	**0**	**$0**
A wind gust measured 58 mph at San Francisco Airport during a strong winter storm.			
February 27, 2006	**High Wind**	**1 Death**	**$0**
A storm system produced winds of varying levels throughout the region. In Half Moon Bay, wind gusts of 59 mph were recorded. In Daly City, wind gusts of 63 mph were recorded. San Francisco Airport recorded gusts of 60 to 71 mph, Point San Pablo had 66 mph gusts, and Pillar Point recorded gusts of 73 mph. One fatality was recorded: a 73 year old woman was killed in Boulder Creek when wind gusts estimated at 70 mph tore the top off a redwood tree and hurled it into her yard, where she was walking her dog.			
January 4, 2008	**High Wind**	**0**	**$0**
A very strong cyclone slammed into the San Francisco and Monterey Bay areas bringing flooding rains, high winds, record high surf and coastal flooding. Hundreds of thousands of residences and businesses were without power, some for several days due to high winds toppling power lines. Property damage in the millions was reported due to falling trees hitting cars and structures as well as damage to roads due to heavy rain. Winds gusted to 66 mph at Pigeon Point, 67 mph at San Francisco Airport, 58 mph and 81 mph at Pillar Point, 58 mph at Oakland Airport, and 72 mph in Daly City.			
February 15, 2009	**High Wind**	**0**	**$25,000**
An approaching eastern Pacific storm produced strong wind and heavy rain behind the warm front as it moved through the San Francisco Bay Area. Over 61,000 Bay Area customers lost power between 3 a.m. and 4 p.m. The Pigeon Point observation station reported a peak wind gust to 58 mph at 3:09 a.m. High wind knocked down numerous trees in the Santa Cruz Mountains causing Highway 9 at Highway 236 to close at 6:30 a.m. and knocked down power lines closing Thurber Lane at Twelfth Avenue during the morning. Trees and branches slowed traffic along Highway 17, Bear Creek Road and Middle Ellen Road.			
April 14, 2009	**High Wind**	**0**	**$80,000**
High winds wreak havoc along the San Francisco Bay Area shoreline causing numerous power outages, downed trees and forcing a big-rig onto its side. At 5:35 p.m. PST a big-rig blew over in the westbound lane of the San Mateo Bridge closing the entire bridge for more than an hour. Shortly afterwards a seventy foot fishing vessel was blown into the bridge after losing power. At 4:54 p.m. PST the Redwood City Mesonet observation site reported a gust to 50 knots.			
May 2, 2009	**Dense Fog**	**0**	**$25,000**
Dense fog along with a slippery road surface caused eight traffic collisions along Highway 17 in the Santa Cruz County mountains. No major injuries were reported.			

TABLE 8-1. SEVERE WEATHER EVENTS IN SAN MATEO COUNTY SINCE 1950

Date	Type	Deaths or Injuries	Property Damage
October 13, 2009	**High Wind**	**0**	**$3,400,000**
A strong low pressure system made its way through Northern and Central California accompanied by deep tropical moisture and very strong winds. Heavy rain combined with the wind to cause numerous trees, tree limbs, and power and telephone poles to fall. Pacific Gas and Electric reported over 277,000 customers had lost power in the San Francisco and Monterey Bay areas with a cost of over thirteen million dollars in damages. The record breaking heavy rain also led to flooding and debris flows. The Los Gatos RAWS reported a wind gust to 68 mph at 8:32 a.m. Also, fierce winds downed trees on Rapley Ranch Road near State Route 35, on State Route 35 near Mountain House Restaurant in Kings Mountain, and along State Route 84 at the junction of State Route 35. A huge oak tree crushed a house in Redwood City and brought down power lines. Also in Redwood City, dozens of trees were toppled, including at least two that hit houses or parked cars. Within San Mateo County, at least 47 trees and 31 sets of power lines were knocked over. In Pescadero, a large tree was blown onto North Street at Pescadero Road, blocking both lanes of traffic. Wind also caused power outages all across San Mateo County. About 58,000 residents lost power during the storm.			
October 13, 2009	**Heavy Rain**	**3 Injuries, 1 Death**	**$100,000**
This powerful rainstorm overwhelmed pipes and manholes in San Mateo, San Carlos, and Millbrae causing over 127,000 gallons of untreated sewage to flow into the streets and creeks. Over 55,000 gallons of raw sewage spilled into to San Francisco Bay. At 7:47 a.m. the California Highway Patrol responded to a three car collision on Highway 1 at Devil's Slide. Heavy rain and strong winds were a contributing factor of the crash. A 74-year-old woman lost her life in the accident.			
January 18, 2010	**Thunderstorm Wind**	**0**	**$0**
Squall line thunderstorms moved across the San Francisco International Airport producing wind gusts to 59 mph. Numerous power lines and trees were knocked down when strong wind combined with saturated soil.			
January 18, 2010	**High Wind**	**0**	**$230,000**
High wind knocked over power poles along San Mateo County's coast causing 12,000 customers to lose power. Downed power lines were reported in Half Moon Bay, at the intersection of Cedar and Acacia Avenues, along the 700 block on Main Street, and at Park Avenue in Moss Beach; and in Pacifica. The wind also caused damage to fixtures on the roof at the Half Moon Bay City Hall, and it dislodged a patio roof behind Sam's Chowder House, damaging solar panels used to power the restaurant. The Half Moon Airport Mesonet site reported a wind gust of 69 mph at 10:00 a.m. PST. At least 12,000 customers lost power in San Mateo County.			
January 19, 2010	**High Wind**	**0**	**$40,000**

TABLE 8-1. SEVERE WEATHER EVENTS IN SAN MATEO COUNTY SINCE 1950

Date	Type	Deaths or Injuries	Property Damage
High wind blew an oak tree down onto a car while a woman was driving it along Old La Honda Road near Woodside. The woman was unhurt and the car sustained minor damage. In Woodside, State Route 84 was closed at Grandview Drive due to downed trees. The ASOS at the San Francisco International Airport reported a peak wind gust of 62 mph at 6:09 a.m. PST. And, the Bay Area Air Quality Management District's Point San Pablo Mesonet site reported a peak wind gust of 59 mph at 6:00 a.m. PST. The Spring Valley RAWS site reported a peak wind gust of 73 mph at 6:00 a.m. PST. And, the Pigeon Point automated site reported a peak wind gust of 62 mph at 5:00 a.m. PST. Power outages occurred throughout the area forcing Canada College in Redwood City, the College of San Mateo and Stanford University to cancel classes.			
January 20, 2010	**High Wind**	**0**	**$260,000**
Strong winds brought trees and power lines down across the San Francisco Bay Area. In Menlo Park, a driver was injured when the top of a Redwood tree came crashing through his windshield as he was driving on Santa Cruz Avenue near Hillview Middle School. Strong wind brought trees and power lines down onto State Route 1 just north of the Santa Cruz and San Mateo County line. The road was closed for two hours.			
January 20, 2010	**Thunderstorm Wind**	**1 Injury**	**$0**
The third in a series of significant storms brought strong winds and heavy rain to the San Francisco and Monterey Bay areas. This storm, the strongest of the week, developed over the Pacific Ocean with a strong parent low pressure based in the Gulf of Alaska. Around 159,000 customers lost power across the San Francisco Bay area with nearly 22,000 customers without power in the Monterey Bay area. Numerous power lines and trees were knocked down when strong wind combined with saturated soil. Also, areas of flooding occurred causing mainly problems for vehicles. A RAWS site at Spring Valley reported a wind gust to 64 mph at 9:19 a.m. PST.			
February 16, 2010	**Dense Fog**	**N/A**	**N/A**
The NWS issued a dense fog advisory for the Bay Area, with notice of visibility being less than a quarter-mile in many areas.			
December 28, 2010	**High Wind**	**0**	**$15,000**
Damaging wind brought a tree down onto State Route 9 causing its closure from one mile south to 2.9 miles south of the south Junction of State Route 236. The Highway was closed from 6:20 p.m. to 10:29 p.m. PST.			
February 15, 2011	**High Wind**	**0**	**$150,000**
Strong and gusty wind developed ahead of a long wave trough. Southwesterly to westerly winds began to increase late in the afternoon and peaked in the late evening. A mesonet automated weather reporting system measured a wind gust of 60 mph at midnight. Other automated observation systems around the area above 1,000 feet in elevation reported gusts up to 83 mph. The wind caused large trees and power lines to fall. Also, road closures occurred due to the downed trees and power lines. Overall, more than 6,500 customers lost power in the San Francisco Bay Area.			
November 27, 2011	**Dense Fog**	**N/A**	**N/A**
Dense fog advisories were issued for multiple bridges around the Bay Area, including the San Mateo Bridge, the Dumbarton Bridge, the Benicia Bridge and the Carquinez Bridge. Inland roads were expected to have heavy fog and poor visibility until mid-afternoon.			
November 29, 2011	**Dense Fog**	**N/A**	**N/A**

TABLE 8-1. SEVERE WEATHER EVENTS IN SAN MATEO COUNTY SINCE 1950

Date	Type	Deaths or Injuries	Property Damage
Dense fog advisories were issued for Bay Area bridges, including the San Mateo and Bay Bridges. Overall visibility for the region ranged between a half-mile to 300 feet.			
March 14, 2012	**Heavy Rain**	**5 Injuries**	**$50,000**
Two accidents shut down Highway 1 for brief periods. One occurred on March 14 which was a head-on crash just south of Devil's Slide. Two sedans were involved with minor injuries to the two drivers. The other occurred on March 16 when two trucks collided at 10:45 am west of the turnoff for Ox Mountain landfill. Three riders suffered minor cuts and bruises.			
November 28, 2012	**High Wind**	**0**	**$1,000**
A wind gust of 61 mph was measured at Spring Valley RAWS, at elevation of 1,075 feet, causing numerous downed trees and some power outages. A wind gust of 75 mph was measured at Los Gatos RAWS, at elevation 1,842 feet, causing numerous downed trees and some power outages.			
December 21, 2012	**Heavy Rain**	**0**	**$0**
A series of storm systems, part of a large Atmospheric River type of pattern, impacted the area during late December 2012. From December 21 through 26, heavy rain, gusty winds, flooding, and mudslides occurred across the Bay Area in these consecutive events. Downed trees, powerlines, and flooded roadways impacted residents over the Christmas holiday season.			
April 8, 2013	**Heavy Rain**	**0**	**$1,000**
High winds impacted operations at San Francisco International Airport overnight with wind gusts measured at 60 mph. High winds blew out the front window of a house in Daly City.			
February 28, 2014	**Heavy Rain**	**0**	**$0**
A Pacific storm system moved across the Bay Area on February 28. It dropped several inches of rainfall and brought gusty winds to the area. This resulted in flooding of urban areas, small streams and creeks, and damage to power lines and trees, and a few localized mud and rockslides.			
November 10, 2014	**Dense Fog**	**N/A**	**N/A**
Dense fog surrounded the San Francisco Bay Area, including San Mateo County.			
November 28, 2014	**Dense Fog**	**N/A**	**N/A**
The California Highway Patrol issued dense fog advisories for a number of Bay Area bridges, including San Mateo Bridge, and on U.S. Highway 101. Patchy, thick fog and poor visibility was reported and estimated to last until 9 a.m.			
December 11, 2014	**Heavy Rain**	**0**	**$0**
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.			
February 9, 2015	**Heavy Rain**	**0**	**$0**
A strong winter storm finally impacted California following nearly a month and a half of no rain and the driest January on record. The storm brought heavy rain, gusty winds, and damage to trees and power lines along with some minor flooding of urban areas. A 72 hour rainfall total of 5.43 inches was measured from Emerald Lake Hills at elevation 472 feet. This was the highest storm total in San Mateo County.			

TABLE 8-1. SEVERE WEATHER EVENTS IN SAN MATEO COUNTY SINCE 1950

Date	Type	Deaths or Injuries	Property Damage
March 10, 2015	**Dense Fog**	**N/A**	**N/A**
The NWS issued dense fog advisories for all valleys and coastal locations in the San Francisco and Monterey Bay areas. Visibility reports were estimated to be a quarter-mile or less, and officials noted that visibility could drop to zero in parts of the San Francisco Bay Area.			

Source: NOAA 2016; San Francisco CBS Local 2014; Patch.Com 2011, 2015, Banjo.com 2014, ABC30.com 2011; Inside the Bay Area 2010
Note: San Mateo County has not experienced any lightning events unrelated to storm events, per NOAA records.
Notes: ASOS Automated Surface Observing Systems; F# Fujita Scale, followed by magnitude of tornado; mph miles per hour; N/A Not Applicable; NWS National Weather Service; PST Pacific Standard Time; RAWS Remote Automatic Weather Stations

8.2.2 Location

Severe weather events have the potential to happen anywhere in San Mateo County. Communities in low-lying areas next to streams or lakes are more susceptible to flooding. Regions near San Francisco Bay are more likely to experience fog. Wind events are most damaging to areas that are heavily wooded.

Tornadoes

Tornadoes have been documented in every state in the United States, and on every continent with the exception of Antarctica. Approximately 1,200 tornadoes occur in the United States each year, with the central portion of the country experiencing the most. Tornadoes can occur at any time of the year, with peak seasons at different times for different states (National Severe Storms Laboratory [NSSL] 2015). As noted earlier, the State of California and San Mateo County have a lower risk for tornados than elsewhere in the country. Tornado risk within the County is fairly equal across the region; historical tornado events have been documented on both the bayside and coastal region of the County. Residents near the Pacific Ocean or the San Francisco Bay (as opposed to the central area of the County) may be at a slightly higher risk for tornados; however, historical data is not sufficiently exhaustive enough to confirm this potential trend. Tornadoes are usually localized; however, severe thunderstorms can result in conditions favorable to the formation of numerous or long-lived tornadoes.

Windstorms

All of San Mateo County is subject to high winds from thunderstorms, tornadoes, and other severe weather events. According to the FEMA Winds Zones of the United States map (Figure 8-4), San Mateo County is located in Wind Zone I, where wind speeds can reach up to 130 mph. Figure 8-4 indicates the strength of windstorms in the United States, and the general location of the most wind activity. This is based on 40 years of tornado data and 100 years of hurricane data, collected by FEMA.

FIGURE 8-4. WIND ZONES IN THE UNITED STATES

Source: FEMA 2010 Note: The black oval indicates the approximate location of San Mateo County.

Fog

The Pacific, Atlantic Canada, and New England coastlines, along with the valleys and hills in the Appalachian Mountains, are the areas most prone to fog on the North American continent (Keller 2008). San Mateo County, therefore, is more likely to experience fog than many other parts of the country.

Additionally, the Bay Area, including San Mateo County, has a unique topography that when combined with the California climate and nearby bay/maritime resources, creates multiple microclimates. Microclimates are small but distinct climates within a larger area. Temperature differences of as much as 10 to 20ºF can be found only miles apart in the Bay Area, and those differences can grow significantly from one end of the region to another. In spring 2001, Half Moon Bay documented temperatures in the 50s while Antioch in Contra Costa County had temperatures of around 100ºF (SF Gate 2001).

Microclimates are significant in the case of fog events because certain cities in the County may experience fog, while only a few miles away, clear skies predominate. Western breezes may bring fog from the ocean, but it will be blocked from passing certain points by mountainous ridges. Even the type of fog in microclimates may vary; some regions are more prone to experience radiation fog, while others only receive a canopy of high fog. This is usually based on the proximity of the location to mountains, ridges, fault lines, and water sources, among other factors.

Heavy Rains, Thunderstorms, and Lightning

The frequency of heavy rain events remained fairly consistent between 1910 and the 1980s; however, it has risen substantially since then (EPA 2015). Certain locations have noted more significant increases in heavy precipitation events (including snow) than others. Most notably, the Northeast and Midwest have experienced the greatest changes, although the Southeast, Great Plains, Northwest, Alaska, and Southwest have also noted increases (Tompkins 2014). Although San Mateo County experiences heavy rain events, it is at a reduced level compared to other parts of the country.

Thunderstorms affect relatively small localized areas, rather than large regions like winter storms and extreme temperature events. Thunderstorms can strike in all regions of the United States; however, they are most common in the central and southern states. The atmospheric conditions in these regions of the country are ideal for generating these powerful storms. It is estimated that there are as many as 40,000 thunderstorms each day worldwide. The most thunderstorms are seen in the southeast United States, with Florida having the highest incidences (80 to over 100 thunderstorm days each year). San Mateo County can experience an average of 10 thunderstorm days each year (NWS 2010).

The entire extent of San Mateo County is exposed to some degree of lightning hazard, though exposed points of high elevation have significantly higher frequency of occurrence. As noted earlier, lightning instances in the County have only been associated with other storm events and not as a standalone hazard.

8.2.3 Frequency

Predicting the frequency of severe weather events in a constantly changing climate is a difficult task. The Planning Area can expect to experience exposure to and adverse impacts from some type of severe weather event at least annually.

8.2.4 Severity

The most common problems associated with severe storms are immobility and loss of utilities. Fatalities are uncommon, but can occur. Roads may become impassable due to flooding, downed trees, or a landslide. Power lines may be downed due to high winds, and services such as water or phone may not be able to operate without power. Lightning can cause severe damage and injury. Physical damage to homes and facilities can be caused by wind or flooding.

Windstorms can be a frequent problem in the Planning Area and have been known to cause damage to utilities. The predicted wind speed given in wind warnings issued by the National Weather Service (NWS) is for a one-minute average; gusts may be 25 to 30 percent higher. Lower wind speeds typical in the lower valleys are still high enough to knock down trees and power lines and cause other property damage. Higher elevations in the County can experience much higher winds under more varied conditions.

Tornadoes are potentially the most dangerous of local storms, but they are not common in the Planning Area. If a major tornado were to strike within the populated areas of the County, damage could be widespread. Businesses could be forced to close for an extended period or permanently, fatalities could be high, many people could be homeless for an extended period, and routine services such as telephone or power could be disrupted. Buildings may be damaged or destroyed. Because the County has never experienced a tornado more severe than an EF1, however, such severity is unlikely.

Heavy precipitation, which in the County almost always takes the form of rain, can have significant impacts, including crop damage, soil erosion, and increased risk of flood. Stormwater runoff from heavy rains can also impair water quality by washing pollutants into water bodies (EPA 2015). Soil erosion, particularly along the coast, is a significant concern for San Mateo County, and is further explored in the landslide and flood hazard profiles. Thunderstorms carry the same risks as heavy precipitation events, and depending on the type of storm, they can also serve as breeding grounds for tornados, lightning, and heavy winds, increasing risk of injury and property damage (Keller 2008).

Lightning severity is typically investigated for both property damage and life safety (injuries and fatalities). The number of reported injuries from lightning is likely to be low, and County infrastructure losses can equate to up to thousands of dollars each year. The relationship of lighting to wildfire ignitions in the County increases the significance of this hazard. There are no recorded instances of lightning appearing alone (without a storm) in San Mateo County, and any lightning damage is likely to be compounded by other storm damage.

8.2.5 Warning Time

Meteorologists can often predict the likelihood of a severe storm or other severe weather event. This can give several days of warning time. However, meteorologists cannot predict the exact time of onset or severity of the storm. Some storms may come on more quickly and have only a few hours of warning time. The San Francisco Bay Area Weather Forecast Office of the NWS monitors weather stations and issue watches and warnings when appropriate to alert government agencies and the public of possible or impending weather events. The watches and warnings are broadcast over NOAA weather radio and are forwarded to the local media for retransmission using the Emergency Alert System.

8.3 Secondary Hazards

The most significant secondary hazards associated with severe local storms are floods, falling and downed trees, landslides, and downed power lines. Stormwater from heavy rain can overwhelm both natural and man-made drainage systems, causing overflow and property destruction. Landslides occur when the soil on slopes becomes oversaturated and fails. Storms can also exacerbate existing areas of vulnerability, such as increasing the frequency of erosion and landslide along coastal cliffs in San Mateo County. Fires (both structural and wild), along with power outages, can occur as a result of lightning strikes.

8.4 Exposure

8.4.1 Population

A lack of data separating severe weather damage from flooding and landslide damage prevented a detailed analysis for exposure and vulnerability. However, it can be assumed that the entire County is exposed to some extent to severe weather events. Certain areas are more exposed due to geographic location and localized weather patterns. Populations living at higher elevations with large stands of trees or power lines may be more susceptible to wind damage and black out, while populations living in low lying areas are at risk for flooding.

8.4.2 Property

All of the buildings in the Planning Area are considered to be exposed to the severe weather hazard, but structures in poor condition or in particularly vulnerable locations (located on hilltops or exposed open areas) may risk the most damage. The frequency and degree of damage will depend on specific locations.

8.4.3 Critical Facilities and Infrastructure

All critical facilities exposed to flooding (see Chapter 6) are also likely exposed to severe weather. Facilities on higher ground may also be exposed to wind damage or damage from falling trees. The most common problems associated with severe weather are loss of utilities. Downed power lines can cause blackouts, leaving large areas isolated. Phone, water and sewer systems may not function. Roads may become impassable from a secondary hazard such as landslides.

8.4.4 Environment

Severe storm events can drastically affect the physical environment, changing natural landscapes. Natural habitats such as streams and trees are exposed to the elements during a severe storm and risk major damage and destruction. Prolonged rains can saturate soils and lead to slope failure. Flooding caused by severe weather can cause stream channel migration.

8.5 Vulnerability

There are currently no loss estimation tools with uniform damage functions for severe weather events. This can be attributed to the variety of impacts that severe weather events generate. Also, the severity of severe weather events varies by location. Since secondary effects of severe weather events include flooding, landslides or even wildfires in drier climates, the vulnerability assessments under those hazards can provide emergency managers a gage of the economic impact of severe weather events.

8.5.1 Population

Vulnerable populations are the elderly, low income, or linguistically isolated populations, people with life-threatening illnesses, and residents living in areas that are isolated from major roads. Power outages can be life-threatening to those dependent on electricity for life support. Isolation of these populations is a significant concern. These populations face isolation and exposure during severe weather events and could suffer more secondary effects of the hazard.

Nationally, lighting is one of the leading causes of weather-related fatalities (Centers for Disease Control [CDC] 2013). The majority of injuries and deaths associated with lighting strikes occur when people are outdoors; however, almost one-third of lightning related injuries occur indoors. Males are five times more likely than females to be struck by lightning, and people between the ages of 15 and 34 account for 41 percent of all lightning strike victims (CDC 2013).

8.5.2 Property

All property is vulnerable during severe weather events, but structures in poor condition or constructed to low building code standards risk the most damage. Those in higher elevations and on ridges may be more prone to wind damage. Those that are located under or near overhead lines or near large trees may be damaged in the event of a collapse.

Loss estimations for the severe weather hazard are not based on modeling utilizing damage functions, because no such damage functions have been generated. Instead, loss estimates were developed representing 10 percent, 30 percent and 50 percent of the replacement value of exposed structures. This allows emergency managers to select a range of potential economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure. Table 8-2 lists the estimates of potential loss to the general building stock.

TABLE 8-2. LOSS POTENTIAL FOR SEVERE WEATHER

	Total Replacement Value	Estimated Loss Potential from Severe Weather		
		10% Damage	30% Damage	50% Damage
Atherton	$3,895,740,346	$389,574,035	$1,168,722,104	$1,947,870,173
Belmont	$10,308,416,428	$1,030,841,643	$3,092,524,928	$5,154,208,214
Brisbane	$4,240,552,559	$424,055,256	$1,272,165,768	$2,120,276,279
Burlingame	$21,380,649,949	$2,138,064,995	$6,414,194,985	$10,690,324,975

TABLE 8-2. LOSS POTENTIAL FOR SEVERE WEATHER

	Total Replacement Value	Estimated Loss Potential from Severe Weather		
		10% Damage	30% Damage	50% Damage
Colma	$2,326,464,412	$232,646,441	$697,939,324	$1,163,232,206
Daly City	$24,938,831,232	$2,493,883,123	$7,481,649,370	$12,469,415,616
East Palo Alto	$5,857,698,432	$585,769,843	$1,757,309,529	$2,928,849,216
Foster City	$8,218,878,256	$821,887,826	$2,465,663,477	$4,109,439,128
Half Moon Bay	$7,849,930,382	$784,993,038	$2,354,979,115	$3,924,965,191
Hillsborough	$4,700,710,511	$470,071,051	$1,410,213,153	$2,350,355,256
Menlo Park	$18,505,489,077	$1,850,548,908	$5,551,646,723	$9,252,744,538
Millbrae	$9,769,920,735	$976,992,074	$2,930,976,221	$4,884,960,368
Pacifica	$11,068,838,243	$1,106,883,824	$3,320,651,473	$5,534,419,121
Portola Valley	$2,722,951,324	$272,295,132	$816,885,397	$1,361,475,662
Redwood City	$36,012,737,585	$3,601,273,759	$10,803,821,276	$18,006,368,793
San Bruno	$17,413,414,915	$1,741,341,491	$5,224,024,474	$8,706,707,457
San Carlos	$20,194,621,859	$2,019,462,186	$6,058,386,558	$10,097,310,929
San Mateo	$43,325,264,111	$4,332,526,411	$12,997,579,233	$21,662,632,056
South San Francisco	$32,013,427,549	$3,201,342,755	$9,604,028,265	$16,006,713,774
Woodside	$2,915,455,082	$291,545,508	$874,636,525	$1,457,727,541
Unincorporated	$32,208,641,175	$3,220,864,117	$9,662,592,352	$16,104,320,587
Total	**$319,868,634,162**	**$31,986,863,416**	**$95,960,590,250**	**$159,934,317,080**

Note: Values shown are accurate only for comparison among results in this plan. See Section X for a discussion of data limitations.

8.5.3 Critical Facilities and Infrastructure

Incapacity and loss of roads are the primary transportation failures, most of which are associated with secondary hazards. Landslides that block roads are caused by heavy prolonged rains. High winds can cause significant damage to trees and power lines, with obstructing debris blocking roads, incapacitating transportation, isolating population, and disrupting ingress and egress. Of particular concern are roads providing access to isolated areas and to the elderly.

Severe windstorms, downed trees, and stormwater can create serious impacts on power and aboveground communication lines. Loss of electricity and phone connection could result in isolation because some residents would be unable to call for assistance.

8.5.4 Environment

The vulnerability of the environment to severe weather is the same as the exposure.

8.5.5 Economic Impact

Economic impact will be largely associated with disrupted services as a result of downed debris blocking transportation infrastructure and potential disruption of energy resources. Prolonged obstruction of major routes due to landslides, debris, or floodwaters can disrupt the shipment of goods and other commerce. Large and prolonged storms can have negative economic impacts for an entire region.

8.6 Future Trends in Development

Many of the impacts associated with severe weather hazards can be addressed through proactive planning and utilization of best available information in making land use decisions. San Mateo County has and will achieve this goal through the implementation of its Shared Vision, while its jurisdictions will be able to incorporate these concerns into their General Plans. The General Plan serves as a long-term policy guide for the physical, economic, and environmental growth of a city and includes a statement of the community's vision of its ultimate physical growth. The County's Shared Vision shares similar purposes. Implementation of these guidelines and goals, along with other programs such as Building Code enforcement, public information, and early warning will help San Mateo County to manage the probable impacts of severe weather hazards as the County expands and grows.

8.7 Scenario

Impacts of severe weather can be significant, particularly when secondary hazards of flood and landslide occur. A worst-case event would involve prolonged high winds accompanied by thunderstorms. Such an event would have both short-term and longer-term effects. Initially, schools and roads would be closed due to power outages caused by high winds and downed tree obstructions. In more rural areas, some subdivisions could experience limited ingress and egress. Prolonged rain could produce flooding, overtopped culverts with ponded water on roads, and landslides on steep slopes. Significant erosion and landslides along the coast may occur, further increasing the vulnerability of residents living right on the edge of coastal cliffs. Flooding and landslides could obstruct roads and bridges, isolating residents. Fog after the storm, resulting from the heavy moisture still in the area, could increase traffic accidents as visibility worsens.

8.8 Issues

Severe local storms are probably the most common widespread hazard. They affect large numbers of people in the Planning Area when they occur. Severe storms can quickly overwhelm city and county resources. Citizens should be prepared for these types of storms: family plans should be developed, disaster kits should be put in homes, workplaces, schools and cars, and every family member should be taught how to shut off household utilities. Initiating early dismissal from schools and business is an effective mitigation measure and should be encouraged.

Severe weather cannot be prevented, but measures can be taken to mitigate the effects. Critical infrastructure and utilities can be hardened to prevent damage during an event. The secondary effect of flooding can be addressed through decreasing runoff and water velocity. Important issues associated with severe weather in the San Mateo County Planning Area include the following:

- Redundancy of power supply throughout the Planning Area must be evaluated to better understand what areas may be vulnerable.

- Although primarily thought of as an urban area, the County has a larger physical land mass containing rural communities and must also consider the needs of these residents (as well as their possible isolation during storm events).
- Public education on dealing with the impacts of severe weather needs to continue to be provided so that citizens can be better informed and prepared for severe weather events. In particular, fog should be considered, since fog may be downplayed despite its potential for transportation accidents.
- Debris management (downed trees, etc.) must be addressed, because debris can impact the severity of severe weather events, requires coordination efforts, and may require additional funding.
- The effects of climate change may result in an increase of heavy rain or more intense storm events, and will likely lead to increased temperatures and changes in overall precipitation amounts.
- Older building stock in the Planning Area is built to low code standards or none at all. These structures could be highly vulnerable to severe winter weather effects.
- Urban forest management programs should be evaluated to help reduce impacts from forest-related damages.

Chapter 9. Tsunami

9.1 General Background

A tsunami consists of a series of high-energy waves that radiate outward like ripples in a pond from an area where a generating event occurs. The waves arrive at the shore over an extended period.

DEFINITIONS

Tsunami—A series of traveling ocean waves of extremely long wavelength, usually caused by displacement of the ocean floor and typically generated by seismic or volcanic activity or by underwater landslides.

Seiches— A standing wave/oscillation in an enclosed or partially enclosed body of water that varies in period from a few minutes to several hours.

Tsunamis are typically classified as local or distant. The warning time for a locally generated tsunamis is minimal, leaving few options except to seek high ground. They may be accompanied by damage from the triggering earthquake caused by ground shaking, surface faulting, liquefaction, or landslides. Distant tsunamis may travel for hours before they strike a coastline, giving a community a longer chance to implement evacuation plans.

In the open ocean, a tsunami may be only a few inches or a few feet high, but it can travel with speeds approaching 500 miles per hour. As a tsunami enters the shoaling waters near a coastline, its speed diminishes, its wavelength decreases, and its height increases greatly. The first wave usually is not the largest. Several larger and more destructive waves often follow the first one. As tsunamis reach the shoreline, they may take the form of a fast-rising tide, a cresting wave, or a bore (a large, turbulent wall-like wave). The bore phenomenon resembles a step-like change in the water level that advances rapidly (from 10 to 60 miles per hour).

The configuration of the coastline, the shape of the ocean floor, and the characteristics of advancing waves play important roles in the destructiveness of the waves. Offshore canyons can focus tsunami wave energy, and islands can filter the energy. The orientation of the coastline determines whether the waves strike head-on or are refracted from other parts of the coastline. A wave may be small at one point on a coast and much larger at other points. Bays, sounds, inlets, rivers, streams, offshore canyons, islands, and flood control channels may cause various effects that alter the level of damage. It has been estimated, for example, that a tsunami wave entering a flood control channel could reach a mile or more inland, especially if it enters at high tide.

The first visible indication of an approaching tsunami may be recession of water (drawdown) caused by the trough preceding the advancing, large inbound wave crest. Rapid drawdown can create strong currents in harbor inlets and channels that can severely damage coastal structures through erosive scour around piers and pilings. As the water's surface drops, piers can be damaged by boats or ships straining at or breaking their mooring lines. The vessels can overturn or sink because of the strong currents, collisions with other objects, or impact with the harbor bottom.

Conversely, the first indication of a tsunami may be a rise in water level. The advancing tsunami may initially resemble a strong surge that increases the sea level like the rising tide, but the tsunami surge rises faster and often does not break as a normal wave. Additionally, this surge of water does not stop at the shoreline and pushes above normal sea level tidal reach. This phenomenon is called “run-up” (see Figure 9-1).

Even if the run up appears to be small — 3 to 6 feet, for example – the strength of the accompanying surge can be deadly. Waist-high surges can cause strong currents that float cars, small structures, and other debris. Boats and debris are often carried inland by the surge and left stranded when the water recedes.

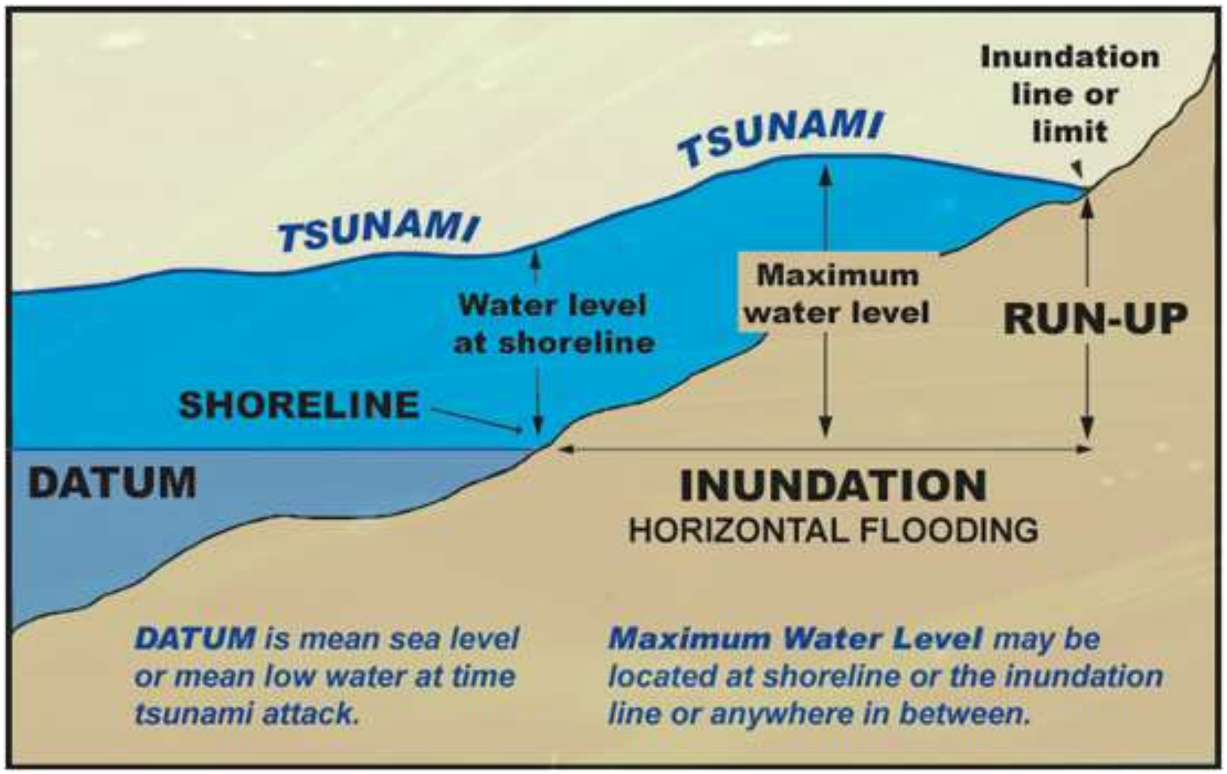


FIGURE 9-1. RUN-UP DISTANCE AND HEIGHT IN RELATION TO THE DATUM AND SHORELINE

Source: UNESCO, n.d.

The advancing turbulent front will be the most destructive part of the tsunami at some locations. In other situations, the greatest damage will be caused by the outflow of water back to the sea between crests, sweeping all before it and undermining roads, buildings, bulkheads, and other structures. This outflow action can carry enormous amounts of highly damaging debris, resulting in further destruction. Ships and boats, unless moved away from shore, may be dashed against breakwaters, wharves, and other craft, or be washed ashore and left grounded after the seawater withdraws.

Typical signs of a tsunami hazard are earthquakes and a sudden and unexpected rise or fall in coastal water. The large waves are often preceded by coastal flooding and followed by a quick recession of the water. Tsunamis are difficult to detect in the open ocean because waves are often less than 3 feet high. The tsunami’s size and speed, as well as the coastal area’s form and depth, affect the impact of a tsunami; wave heights of 50 feet are not uncommon. In general, scientists believe it requires an earthquake of at least a magnitude 7 to produce a tsunami.

9.2 Hazard Profile

9.2.1 Past Events

More than 80 tsunamis have been recorded or observed in California, according to state records; however, many of these events were small and led to little or no damage. All tsunamis from the past century have been distant, not local. That is, they have all resulted from earthquakes far across the Pacific basin (as opposed to earthquakes near the American coastline). The most noteworthy tsunamis in California include:

- **January 26, 1700 (Local Tsunami)** – An estimated M-9 earthquake ruptured the entire length of the Cascadia Subduction Zone, causing tsunami waves up to 50 feet in parts of northern California. Scientists have reconstructed the event from geologic evidence and oral Native American histories, as well as Japanese documents describing a tsunami that hit Japan's coastline that same day.
- **December 21, 1812 (Local Tsunami)** – A tsunami struck the Santa Barbara and Ventura coastlines not long after an earthquake was felt in the area. The tsunami inundated lowland areas and damaged local ships. Some debate exists as to whether the tsunami was earthquake-induced or the result of a submarine landslide triggered by the earthquake.
- **April 1, 1946 (Distant Tsunami)** – An M-8.8 earthquake in the Aleutian Islands generated a tsunami that caused damage along the coast of California, including flooding more than 1,000 feet inland in Half Moon Bay.
- **March 28, 1964 (Distant Tsunami)** – An M-9.2 earthquake in Anchorage, Alaska, generated a tsunami that struck the Pacific Northwest and northern California. Twelve people were killed in California, and a surge approximately 20-feet high flooded 29 city blocks of Crescent City.
- **March 11, 2011 (Distant Tsunami)** – An M-9.0 earthquake in Tohuku, Japan generated a moderate tsunami in California. While the tsunami did not cause significant flooding, it did lead to one death and more than $100 million in damages to 27 harbors statewide. The most significant damage occurred in Crescent City and Santa Cruz.

While the list above includes only major tsunamis in California, San Mateo County has been struck by minor tsunamis as well. The table below lists known tsunami events that have struck the County or one of its jurisdictions since 1859. The California Department of Conservation maintains a list of tsunamis in the state, including San Francisco or other Bay Area entities. Some tsunamis have struck San Francisco or other parts of the Bay Area but not San Mateo County; those events were not identified in the list below.

TABLE 9-1. TSUNAMI EVENTS IN SAN MATEO COUNTY

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	San Mateo County Designated?	Description
September 24, 1859	Local Tsunami	N/A	N/A	A tsunami originating in Northern California hit Half Moon Bay, with a waves 4.6 meters high.
April 1, 1946	Distant Tsunami	N/A	N/A	An M-7.3 earthquake in the East Aleutian Islands (Alaska) triggered a tsunami that struck California. Wave heights of 2.6 meters were recorded in Half Moon Bay.
May 22, 1960	Distant Tsunami	N/A	N/A	An M-9.5 earthquake in Central Chile triggered a tsunami that reached San Mateo County. Wave heights of 1.2 meters were recorded in Pacifica.
March 28, 1964	Distant Tsunami	N/A	N/A	An M-9.2 earthquake off the Gulf of Alaska triggered a tsunami that reached San Mateo County. Wave heights of 1.4 meters were recorded in Pacifica. The tsunami arrived in San Francisco 5 hours and 6 minutes after the triggering event.
February 27, 2010	Distant Tsunami	N/A	N/A	An M-8.8 earthquake in Central Chile triggered a tsunami that reached San Mateo County. Wave heights of 0.6 meter were recorded in Half Moon Bay.
March 11, 2011	Distant Tsunami	DR-1968	No	At 10:46 p.m. on March 10, 2011, a magnitude 8.9 earthquake struck near the coast of Honshu, Japan. The earthquake generated a tsunami significantly affecting California on March 11, 2011. Wave heights of 0.7 meter were recorded in Half Moon Bay, 1 meter in Pacifica, and 0.12 meter in Redwood City. A preliminary damage assessment was conducted during the response, but no physical damage reported. Ultimately, however, the tsunami damaged six boat slips, three docks, and snapped a wooden piling at the Berkeley Marina.

Sources: FEMA 2016, NOAA NDCD 2016, California Department of Conservation 2016

9.2.2 Location

The earth's surface is made up of a number of crustal plates that contain large sections of the continents and ocean basins. These plates may pull apart from, slide past, override, or under-ride ("subduct") one another. Plate boundaries coincide with faults that produce earthquakes as stress accumulated from the relative movement of the plates is relieved. The earthquakes, in turn, may produce displacements of the sea floor that can set the overlying column of water in motion, initiating a tsunami. However, not all submarine earthquakes produce tsunamis. It depends on the magnitude of the earthquake and type of faulting that has occurred.

The most active plate boundaries rim the Pacific Ocean and the Caribbean Sea. Consequently, these areas are where most tsunami activity is expected. Most tsunamis originate in the Pacific "Ring of Fire," which is the most active seismic region on earth. An estimated 489 cities in Alaska, California, Hawaii, Oregon, and Washington are susceptible to tsunamis. As many as 900,000 residents of these cities could be inundated by a 50-foot tsunami. In addition, millions of tourist that visit these regions each year could be affected by tsunami events along the Pacific coast.

Tsunamis affecting San Mateo County may be induced by geologic events of local origin or earthquakes at considerable distances, such as in Alaska or South America. Most tsunamis originate in the Pacific Ocean, where tsunami waves triggered by seismic activity can travel at up to 500 miles per hour, striking distant coastal areas in a matter of hours (see Figure 9-22).

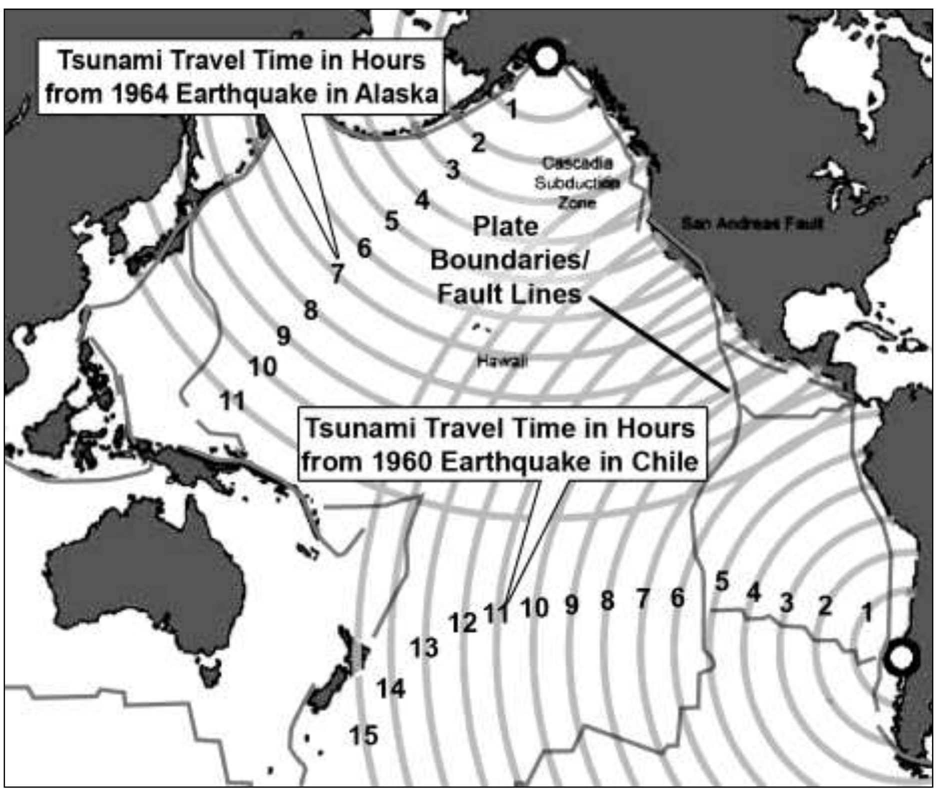


FIGURE 9-2. POTENTIAL TSUNAMI TRAVEL TIMES IN THE PACIFIC OCEAN

According to a document titled *U.S. States and Territories National Tsunami Hazard Assessment: Historical Record and Sources for Waves—Update*, California as a whole is classified as a "Very High" hazard area according to run-up height, run-up frequency, and qualitative tsunami hazard assessments based on historical record. Additionally, California has experienced more tsunami-caused fatalities than either Oregon or Washington, although it is not the state or territory with the highest number of tsunami-caused fatalities in the country (Dunbar and Weaver 2015).

The California Department of Conservation maintains detailed tsunami inundation maps for San Mateo County and other parts of the State. Maps for relevant communities are available on their website at: http://www.conservation.ca.gov/cgs/geologic_hazards/Tsunami/Inundation_Maps/SanMateo. These maps are generated through computer modeling of the areas most likely to be affected by a tsunami event and serve as an important preparedness tool. The tsunami hazard areas identified in the mapping are based on a suite of tsunami sources, both local and distant, and does not, therefore, represent risk from a single sources event. Tsunami risk areas are shown in Figure 9-3.

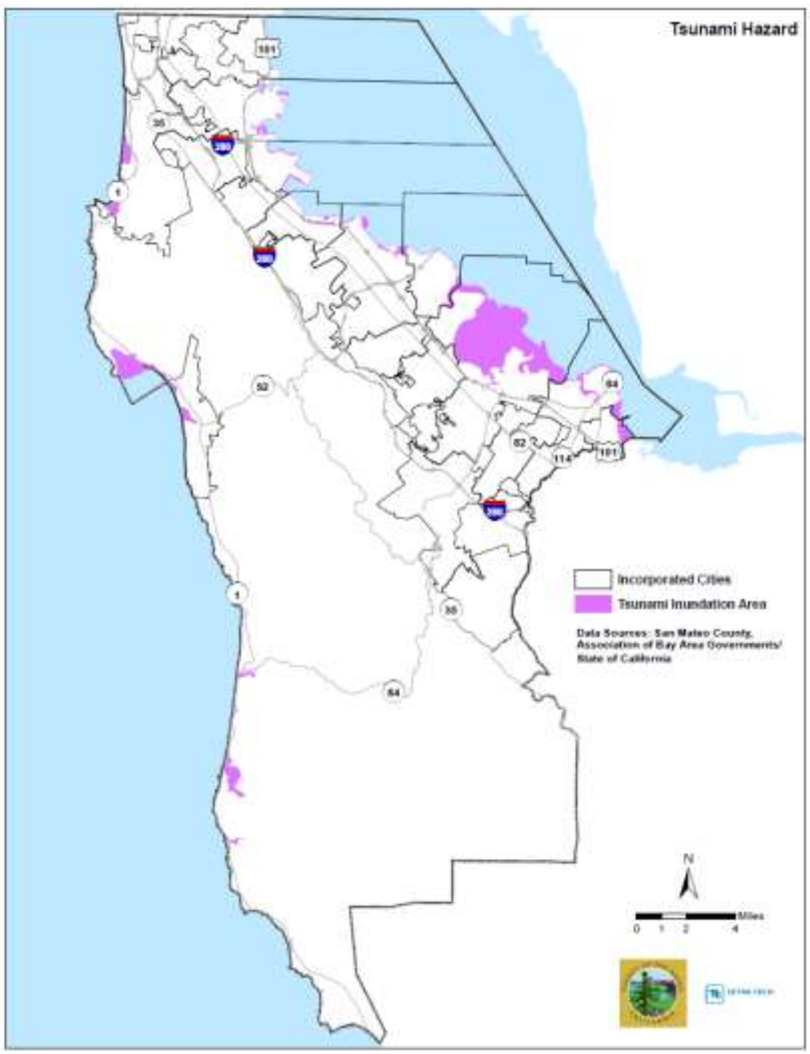


FIGURE 9-3. TSUNAMI RISK AREAS FOR SAN MATEO COUNTY

9.2.3 Frequency

The frequency of tsunamis is related to the frequency of the events that cause them, so it is similar to the frequency of seismic or volcanic activities or landslides. Generally, four or five tsunamis occur every year in the Pacific Basin, and those that are most damaging are generated in the Pacific waters off South America rather than in the northern Pacific.

Based on risk factors for the County and past occurrences, it is highly likely that tsunamis will continue to strike the coastline in San Mateo County. Tsunami probabilities are tied to earthquake and other geologic events; however, not all earthquakes or submarine landslides will trigger a tsunami.

9.2.4 Severity

The National Oceanic and Atmospheric Administration (NOAA) issues tsunami warnings in the United States and has two Tsunami Warning Centers: the West Coast and Alaska Tsunami Warning Center (WC/ATWC) located in Palmer, Alaska and the Pacific Tsunami Warning Center (PTWC) located in Ewa Beach, Hawaii. WC/ATWC issues information to all states except Hawaii, U.S. territories in the Caribbean, and Canada. PTWC is responsible for Hawaii, U.S. territories in the Pacific, and international recipients in the Pacific and Indian Oceans, and the Caribbean Sea.

The warning centers monitor a worldwide network of seismic and sea level stations, providing the basis for tsunami warnings, advisories, watches, and information statements. There are four types of tsunami messages issued by the warning centers and are as follows:

- Warnings are initially based solely on seismic data and are issued as quickly as possible indicating that a significant inundation may occur. They can be cancelled or downgraded to an advisory.
- Advisories indicate potential beach and harbor danger caused by strong currents; however, significant widespread inundation is not expected.
- Watches indicate that a potentially dangerous distant event has occurred and the area needs to be alert for more information (NOAA 2016)

9.2.5 Warning Time

The Pacific Tsunami Warning System evolved from a program initiated in 1946. It is a cooperative effort involving 26 countries along with numerous seismic stations, water level stations, and information distribution centers. Both the WC/ATWC and PTWC participate in the warning system, along with the Ewa Beach Center, which serves as an administrative hub for the Pacific Tsunami Warning System.

The warning system begins to function only when a Pacific basin earthquake of magnitude 6.5 or greater triggers an earthquake alarm. When this earthquake is registered, the following sequence of actions occurs:

- Data are interpolated to identify the epicenter and magnitude of the event.
- If the event is magnitude 7.5 or greater and located at sea, a TSUNAMI WATCH is issued.

- Participating tide stations in the earthquake area are requested to monitor their gages. If unusual tide levels are noted, the tsunami watch is upgraded to a TSUNAMI WARNING.
- Tsunami travel times are calculated, and the warning is transmitted to the disseminating agencies and thus relayed to the public.
- The Ewa Beach center will cancel the watch or warning if reports from the stations indicate that no tsunami was generated or that the tsunami was inconsequential.

This system is not considered effective for communities located close to the tsunami because the first wave would arrive before the data were processed and analyzed. In this case, strong ground shaking would provide the first warning of a potential tsunami.

In addition, NOAA, as part of the U.S. National Tsunami Hazard Mitigation Program, implemented the Deep-ocean Assessment and Reporting of Tsunami (DART) project to ensure detection of tsunamis and to acquire data critical to real-time forecasts. DART systems consist of an anchored seafloor bottom pressure recorder (BPR) and a companion moored surface buoy for real-time communications. An acoustic link transmits data from the BPR on the seafloor to the surface buoy. The surface buoy then delivers data to the national Weather Service Telecommunications Gateway that then distributes the data in real-time to the Tsunami Warning Centers. Figure 9-4 depicts the operation of the DART System (NOAA 2011).

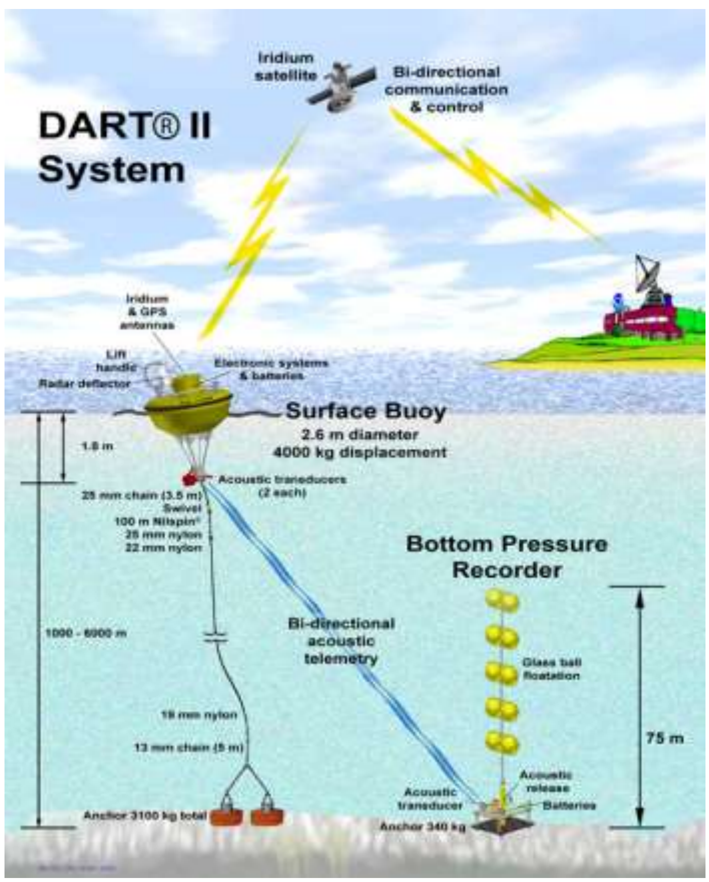


FIGURE 9-4. DART II SYSTEM

9.3 Secondary Hazards

Floating debris carried by a tsunami can endanger human lives and batter inland structures. Ships moored at piers and in harbors often are swamped and sunk or are left battered and stranded high on the shore. Breakwaters and piers collapse, sometimes because of scouring actions that sweep away their foundation material and sometimes because of the sheer impact of the waves.

Port facilities, naval facilities, fishing fleets, and public utilities are often the backbone of the economy of the affected areas, and these resources generally receive the most severe damage. Until debris can be cleared, wharves and piers rebuilt, utilities restored, and fishing fleets reconstituted, communities may find themselves without fuel, food, and employment. Wherever water transport is a vital means of supply, disruption of coastal systems caused by tsunamis can have far-reaching economic effects.

Another potential secondary hazard from tsunamis includes seiches. Seiches are standing waves oscillating in a body of water, and they can form in any enclosed or semi-enclosed body of water, including the San Francisco Bay. They typically result from strong winds and rapid changes in atmosphere pressure, which push the water from one end of the enclosure to the other. When the wind stops, the water rebounds to the other side and then continues to oscillate for hours or days. Tsunamis, earthquakes, and severe storm fronts can also cause seiches. The destructive potential associated with seiches is exemplified through one from 1844, where a 22-foot seiche in Lake Erie breached a 14-foot sea wall, killed 78 people, and dammed the ice to the extent that the Niagara Falls temporarily stopped flowing (NOAA 2015). While seiches are not as common in the San Francisco Bay as they are in the Great Lakes, bayside communities should still be mindful of this potential hazard and recommend residents avoid close proximity to the bay for several days after a tsunami.

Run-up is another secondary hazard that should be monitored by bayside and oceanside residents after a tsunami. Discussed earlier in this profile, the force associated with run-up can move cars, small structures, and debris, presenting risks to both life safety and property.

9.4 Exposure

The Level 2 (user-defined) HAZUS-MH protocol was used to assess the risk and vulnerability to tsunamis in the planning area. The model used census data at the block level and State of California tsunami inundation mapping, which has a level of accuracy acceptable for planning purposes. Where possible, the HAZUS-MH default data were enhanced using local geographic information system (GIS) data from county, state, and federal sources. It should be noted that the tsunami mapping used as the basis for this assessment combines risk from a variety of sources and is not representative of a single scenario event. It is unlikely that all areas shown as at risk would be inundated from any single tsunami event.

9.4.1 Population

The population living in tsunami hazard areas was estimated using the percent of residential buildings within the tsunami hazard area for each jurisdiction multiplied by the total estimated population for the jurisdiction. Using this approach, the estimated resident population living in tsunami hazard areas is 4,282 or less than 1 percent of the population. The populations that would be most exposed to this type of hazard are those along beaches, low-lying coastal areas, tidal flats, and stream deltas that empty into ocean-going waters. People recreating in these areas would also be exposed. Table 9-2 shows the estimated population exposure by jurisdiction.

TABLE 9-2. ESTIMATED POPULATION EXPOSURE FOR TSUNAMI HAZARD AREAS

	Population Exposed	Percent of Population
Atherton	0	0.0%
Belmont	0	0.0%
Brisbane	0	0.0%
Burlingame	4	0.0%
Colma	0	0.0%
Daly City	0	0.0%
East Palo Alto	0	0.0%
Foster City	0	0.0%
Half Moon Bay	908	7.5%
Hillsborough	0	0.0%
Menlo Park	0	0.0%
Millbrae	0	0.0%
Pacifica	2,453	6.4%
Portola Valley	0	0.0%
Redwood City	0	0.0%
San Bruno	0	0.0%
San Carlos	0	0.0%
San Mateo	0	0.0%
South San Francisco	8	0.0%
Woodside	0	0.0%
Unincorporated	908	1.4%
Total	**4,282**	**0.6%**

9.4.2 Property

Present Land Use in the Tsunami Hazard Area

Table 6-53 summarizes present land use based on structure type in the tsunami hazard area by jurisdiction. Spatial analysis concluded that there are 1,469 structures within the hazard areas and that 88 percent of these structures (1,287) are thought to be residential.

TABLE 9-3. STRUCTURE TYPE IN TSUNAMI HAZARD AREAS[b]

	Number of Structures[a]							
	Residential	Commercial	Industrial	Agriculture/ Forestry	Religion	Government	Education	Total
Atherton	0	0	0	0	0	0	0	0
Belmont	0	0	0	0	0	0	0	0
Brisbane	0	0	0	0	0	0	0	0
Burlingame	1	2	0	0	0	0	0	3
Colma	0	0	0	0	0	0	0	0
Daly City	0	0	0	0	0	0	0	0
East Palo Alto	0	2	0	0	0	0	0	2
Foster City	0	0	0	0	0	0	0	0
Half Moon Bay	280	2	0	0	0	0	0	282
Hillsborough	0	0	0	0	0	0	0	0
Menlo Park	0	0	0	0	0	0	0	0
Millbrae	0	0	0	0	0	0	0	0
Pacifica	748	43	0	0	0	0	1	792
Portola Valley	0	0	0	0	0	0	0	0
Redwood City	0	3	1	0	0	0	0	4
San Bruno	0	0	0	0	0	0	0	0
San Carlos	0	0	0	0	0	0	0	0
San Mateo	0	1	0	0	0	0	0	1
South San Francisco	2	3	3	0	0	0	0	8
Woodside	0	0	0	0	0	0	0	0
Unincorporated	256	100	20	0	0	1	0	377
Total	**1,287**	**156**	**24**	**0**	**0**	**1**	**1**	**1,469**

a. Structure type assigned to best fit HAZUS occupancy classes based on present use classifications provided by San Mateo County assessor's data. Where conflicting information was present in the available data, parcels were assumed to be improved.

Exposed Value

Table 6-64 summarizes the estimated value of exposed buildings to the tsunami hazard in the planning area. This methodology estimated $5.7 billion worth of building-and-contents exposed to the tsunami hazard, representing 1.8 percent of the total replacement value of the planning area.

TABLE 9-4. VALUE OF STRUCTURES IN THE TSUNAMI HAZARD AREA

	Value Exposed			% of Total Replacement value
	Structure	Contents	Total	
Atherton	$0	$0	$0	0.0%
Belmont	$0	$0	$0	0.0%
Brisbane	$0	$0	$0	0.0%
Burlingame	$82,504,201	$50,594,412	$133,098,612	0.6%
Colma	$0	$0	$0	0.0%
Daly City	$0	$0	$0	0.0%
East Palo Alto	$18,684,623	$18,684,623	$37,369,245	0.6%
Foster City	$0	$0	$0	0.0%
Half Moon Bay	$1,458,177,273	$738,037,040	$2,196,214,313	28.0%
Hillsborough	$0	$0	$0	0.0%
Menlo Park	$0	$0	$0	0.0%
Millbrae	$0	$0	$0	0.0%
Pacifica	$594,836,756	$485,014,320	$1,079,851,076	9.8%
Portola Valley	$0	$0	$0	0.0%
Redwood City	$30,428,355	$36,015,938	$66,444,293	0.2%
San Bruno	$0	$0	$0	0.0%
San Carlos	$0	$0	$0	0.0%
San Mateo	$3,814,080	$3,814,080	$7,628,160	0.0%
South San Francisco	$281,424,550	$361,756,531	$643,181,081	2.0%
Woodside	$0	$0	$0	0.0%
Unincorporated	$837,935,571	$772,564,676	$1,610,500,248	5.0%
Total	**$3,307,805,409**	**$2,466,481,620**	**$5,774,287,028**	**1.8%**

Note: Values shown are accurate only for comparison among results in this plan. See Section 2, Chapter 1 for a discussion of data limitations.

9.4.3 Critical Facilities

Critical facilities in the tsunami hazard areas are summarized in Table 9-5 Details are provided in the following sections.

TABLE 9-5. CRITICAL FACILITIES IN TSUNAMI HAZARD AREAS

	Medical and Health Services	Emergency Services	Government	Utilities	Transportation Infrastructure	Hazardous Materials	Community Economic Facilities	Other Assets	Total
Atherton	0	0	0	0	0	0	0	0	**0**
Belmont	0	0	0	0	0	0	0	0	**0**

TABLE 9-5. CRITICAL FACILITIES IN TSUNAMI HAZARD AREAS

	Medical and Health Services	Emergency Services	Government	Utilities	Transportation Infrastructure	Hazardous Materials	Community Economic Facilities	Other Assets	Total
Brisbane	0	0	0	0	0	0	0	0	**0**
Burlingame	0	0	0	0	1	0	0	0	**1**
Colma	0	0	0	0	0	0	0	0	**0**
Daly City	0	0	0	0	0	0	0	0	**0**
East Palo Alto	0	0	0	0	0	0	0	0	**0**
Foster City	0	0	0	0	1	0	0	0	**1**
Half Moon Bay	0	0	0	0	0	0	0	0	**0**
Hillsborough	0	0	0	0	0	0	0	0	**0**
Menlo Park	0	0	0	0	1	0	0	0	**1**
Millbrae	0	0	0	0	0	0	0	0	**0**
Pacifica	0	0	0	8	1	0	0	0	**9**
Portola Valley	0	0	0	0	0	0	0	0	**0**
Redwood City	0	0	0	2	5	0	0	0	**7**
San Bruno	0	0	0	0	0	0	0	0	**0**
San Carlos	0	0	0	0	0	0	0	0	**0**
San Mateo	0	0	0	3	2	0	0	0	**5**
South San Francisco	0	0	0	0	1	2	0	0	**3**
Woodside	0	0	0	0	0	0	0	0	**0**
Unincorporated	0	1	0	0	4	0	0	0	**5**
Total	**0**	**1**	**0**	**13**	**16**	**2**	**0**	**0**	**32**

Hazardous Material Facilities

The planning area includes 2 structures in the tsunami hazard areas that contain hazardous materials. Containers holding these materials can rupture and leak into the surrounding area during a tsunami event, having a disastrous effect on the environment as well as residents.

Roads

Roads that are blocked or damaged can prevent access throughout the planning area and can isolate residents and emergency service providers needing to reach vulnerable populations or to make repairs. Roads are an important component in the management of tsunami-related emergencies in that they act is the primary resource for evacuation to higher ground before and during a tsunami event. Roads often act as flood control facilities in low-depth, low-velocity flood events by acting as levees or berms and diverting or containing flood flows. Geospatial analysis indicates the following major roads pass through the tsunami inundation areas and may be exposed to the tsunami hazard:

- State Highway 1
- State Highway 92
- US Highway 101

This list of roads should not be misinterpreted as possible evacuation routes for tsunami events. Evacuation routes are identified in emergency response plans.

Bridges

Bridges exposed to tsunami events can be extremely vulnerable because of the forces transmitted by the wave run-up and by the impact of debris carried by the wave action. Geospatial analysis identified 11 bridges that would be exposed to the tsunami hazard.

Water/Sewer/Utilities

Water and sewer systems can be affected by the flooding associated with tsunami events. Floodwaters can back up drainage systems, causing localized flooding. Culverts can be blocked by debris from flood events, also causing localized urban flooding. Floodwaters can enter drinking water supplies, causing contamination. Sewer systems can be backed up, causing wastes to spill into homes, neighborhoods, rivers and streams. The forces of tsunami waves can damage aboveground utilities by knocking down power lines and radio/cellular communication towers. Power generation facilities can be severely impaired by both the impact of the wave action and the inundation of floodwaters.

9.5 Vulnerability

9.5.1 Population

The populations most vulnerable to the tsunami hazard are the elderly, disabled, and very young who reside or recreate near beaches, low-lying coastal areas, tidal flats, and stream or river deltas that empty into ocean-going waters. In addition, visitors recreating in or around inundation areas would also be vulnerable, as they may not be as familiar with residents or appropriate responses to a tsunami or ways to reach higher ground. There would be little warning time in the event of a local tsunami generated in or near San Mateo County or the Bay Area (as opposed to a Cascadia earthquake-induced tsunami), so more of the population would be vulnerable. The degree of vulnerability of the population exposed to the tsunami hazard event is based on a number of factors:

- Is there a warning system?
- What is the lead time of the warning?
- What is the method of warning dissemination?
- Will the people evacuate when warned?

Table 9-6 summarizes estimated impacts on persons in the planning area for a tsunami event.

TABLE 9-6. ESTIMATED TSUNAMI IMPACT ON PERSONS[a]

	Displaced Persons[a]	Persons Requiring Short-Term Shelter[b]
Atherton	0	0
Belmont	0	0
Brisbane	0	0
Burlingame	0	0
Colma	0	0
Daly City	0	0
East Palo Alto	0	0
Foster City	0	0
Half Moon Bay	**231**	**193**
Hillsborough	0	0
Menlo Park	0	0
Millbrae	0	0
Pacifica	**1,369**	**1,307**
Portola Valley	0	0
Redwood City	0	0
San Bruno	0	0
San Carlos	0	0
San Mateo	0	0
South San Francisco	**4**	**3**
Woodside	0	0
Unincorporated	**352**	**298**
Total	**1,955**	**1,800**

a. HAZUS-MH results in this table are not intended to be precise estimates of damage after a hazard event. They represent generalized estimates of damage that may occur as the result of the modeled scenario, based on the available data.
b. Calculated using a census block level, general building stock analysis and adjusted to reflect the estimated population

9.5.2 Property

Structural and Non-Structural Loss

All structures along beaches, low-lying coastal areas, tidal flats, and stream or river deltas would be vulnerable to a tsunami, especially in an event with little or no warning time. The impact of the waves and the scouring associated with debris that may be carried in the water could be damaging to structures in the tsunami's path. Those that would be most vulnerable are located in the front line of tsunami impact and those that are not structurally sound.

HAZUS-MH was modified to calculate tsunami losses to structures based on flooding depth and structure type. It is estimated that there could be more than $879 million of loss from the tsunami hazard in the planning area. This amount represents 15 percent of the total exposure to the tsunami hazard and less than 1 percent of the total replacement value for the planning area. The analysis is summarized in Table 9-7.

TABLE 9-7. LOSS ESTIMATES FOR TSUNAMI HAZARD

	Structures Impacted[b]	Estimated Loss Associated with Tsunami[a]			% of Total Replacement value
		Structure	Contents	Total	
Atherton	0	$0	$0	$0	0.0%
Belmont	0	$0	$0	$0	0.0%
Brisbane	0	$0	$0	$0	0.0%
Burlingame	1	$132,028	$660,140	$792,168	0.0%
Colma	0	$0	$0	$0	0.0%
Daly City	0	$0	$0	$0	0.0%
East Palo Alto	0	$0	$0	$0	0.0%
Foster City	0	$0	$0	$0	0.0%
Half Moon Bay	20	$466,803	$207,389	$674,192	0.0%
Hillsborough	0	$0	$0	$0	0.0%
Menlo Park	0	$0	$0	$0	0.0%
Millbrae	0	$0	$0	$0	0.0%
Pacifica	463	$56,672,824	$93,672,876	$150,345,700	1.4%
Portola Valley	0	$0	$0	$0	0.0%
Redwood City	3	$3,152,737	$7,537,518	$10,690,255	0.0%
San Bruno	0	$0	$0	$0	0.0%
San Carlos	0	$0	$0	$0	0.0%
San Mateo	0	$0	$0	$0	0.0%
South San Francisco	3	$3,178,171	$12,264,155	$15,442,326	0.0%
Woodside	0	$0	$0	$0	0.0%
Unincorporated	296	$231,448,972	$470,097,426	$701,546,399	2.2%
Total	**786**	**$295,051,535**	**$584,439,504**	**$879,491,040**	**0.3%**

a. The hazard risk areas are derived from several potential source events. It is not likely that all areas would be inundated by any single tsunami event.

b. Impacted structures are those structures with finished floor elevations below the tsunami water surface elevation. These structures are the most likely to receive significant damage in a tsunami event

Note: Values shown are accurate only for comparison among results in this plan. See Section 2, Chapter 1 for a discussion of data limitations.

Tsunami-Caused Debris

The HAZUS-MH analysis estimated the amount of tsunami-caused debris in the planning area for the tsunami hazard, as summarized in Table 9-8.

TABLE 9-8. ESTIMATED TSUNAMI-CAUSED DEBRIS[a]

	Debris to Be Removed (tons)[b]	Estimated Number of Truckloads [c]
Atherton	0	0
Belmont	0	0
Brisbane	0	0
Burlingame	0	0
Colma	0	0
Daly City	1,066	43
East Palo Alto	205	8
Foster City	59	2
Half Moon Bay	57,598	2,304
Hillsborough	0	0
Menlo Park	0	0
Millbrae	0	0
Pacifica	15,544	622
Portola Valley	0	0
Redwood City	3,189	128
San Bruno	0	0
San Carlos	0	0
San Mateo	85	3
South San Francisco	1,227	49
Woodside	0	0
Unincorporated	134,061	5,362
Total	**213,033**	**8,521**

a. The hazard risk areas are derived from several potential source events. It is not likely that all areas would be inundated by any single tsunami event.
b. Debris generation estimates were based on updated general building stock dataset at a Census Block analysis level.
c. HAZUS-MH assumes 25 tons/trucks

Note: Values shown are accurate only for comparison among results in this plan. See Section Section 2, Chapter 1 for a discussion of data limitations.

9.5.3 Critical Facilities

HAZUS-MH was used to estimate potential tsunami damage to critical facilities exposed to the tsunami hazard. Using depth/damage function curves to estimate the percent of damage to the building and contents of critical facilities, HAZUS-MH correlates these estimates into an estimate of functional down-time (the estimated time it will take to restore a facility to 100 percent of its functionality). This estimate helps to gauge how long the usage of facilities deemed critical to response and recovery would be limited in the planning area. The HAZUS critical facility results are shown in Table 9-**Error! Reference source not found.**9. On average, critical facilities would receive 3.71 percent damage to the structure and 0 percent damage to the contents.

TABLE 9-9. ESTIMATED DAMAGE TO CRITICAL FACILITIES AND INFRASTRUCTURE FROM THE TSUNAMI HAZARD[a]

	Number of Facilities Affected	Average % of Total Value Damaged		Days to 100% Functionality
		Building	Content	
Medical and Health Services	0	N/A	N/A	N/A
Emergency Services	1	0.0	0.0	480
Government	0	N/A	N/A	N/A
Utilities	13	0.0	N/A	N/A
Transportation Infrastructure	16	1.31	N/A	N/A
Hazardous Materials	2	16.33	N/A	N/A
Community Economic Facilities	0	N/A	N/A	N/A
Other Assets	0	N/A	N/A	N/A
Total	**32**	**3.71**	**0.0**	**480**

a. The hazard risk areas are derived from several potential source events. It is not likely that all areas would be inundated by any single tsunami event.

9.5.4 Environment

The environment vulnerable to the tsunami hazard is the same as the environment exposed to the hazard. A tsunami event has the potential to alter the shoreline, depending on the force of the run-up. In addition to these changes, vegetation and wildlife habitats may be damaged or destroyed, and soil and sediment runoff will accumulate downslope, potentially blocking waterways and roadways and impairing the quality of streams and other water bodies.

Most environmental and ecological impacts from tsunamis derive from direct damage from the waves, which can physically remove vegetation and wildlife, increase sediment load, and smother vegetation that isn't physically carried away. While not a concern in San Mateo County, tsunami destruction of coral reefs can be a concern. The specific physical damage from waves frequently depends on the local topography and hydrology.

Other environmental impacts from tsunamis include chemical changes from saltwater intruding into freshwater sources; eutrophication (enrichment) of water from increased runoff; raw sewage; and decomposition of vegetation, wildlife, rotting property (boats or buildings) and unrecovered remains. Non-biodegradable waste, such as plastics, can also lead to a buildup in marine debris, and toxic wastes, if previously inadequately stored, may be released into the environment. Lastly, exotic wildlife may be introduced or may escape into the local ecosystem.

9.5.5 Economic Impact

Economic impact will be largely associated with the location where the tsunami occurred. In such areas, commercial buildings may be destroyed or severely damaged, disrupting associated services.

9.6 Future Trends in Development

The County and its planning partners are equipped to handle future growth within tsunami inundation areas. The inundation maps provided by the California Department of Conservation offer jurisdictions a way to guide development away from tsunami-prone areas. Additionally, all partners have committed to integrating their general plans to this hazard mitigation plan. By coordinating their general plans, municipalities and the County will be better able to make wise land use decisions as future growth impacts tsunami hazard areas.

TABLE 9-10. FUTURE LAND USE EXPOSED TO THE TSUNAMI HAZARD

	Agriculture/Resource Extraction		Commercial		Education		Industrial		Mixed Use		Other/Unknown		Parks/Open Space		Residential		Water		Total
Jurisdiction	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)
ATHERTON	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
BELMONT	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
BRISBANE	0.0	0.00%	4.4	13.70%	0.0	0.00%	0.0	0.00%	0.0	0.00%	27.4	86.27%	0.0	0.00%	0.0	0.00%	0.0	0.04%	**31.8**
BURLINGAME	0.0	0.00%	19.0	17.24%	0.0	0.00%	0.0	0.00%	0.0	0.00%	25.3	22.98%	65.8	59.77%	0.0	0.00%	0.0	0.00%	**110.1**
COLMA	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
DALY CITY	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	9.6	25.05%	28.7	74.95%	0.0	0.00%	0.0	0.00%	**38.2**
EAST PALO ALTO	0.0	0.01%	0.0	0.00%	0.0	0.00%	2.0	0.85%	0.0	0.00%	8.6	3.68%	218.6	94.14%	3.0	1.31%	0.0	0.00%	**232.2**
FOSTER CITY	0.0	0.00%	41.7	16.90%	0.0	0.00%	0.0	0.00%	0.0	0.00%	46.7	18.92%	144.8	58.64%	13.7	5.54%	0.0	0.00%	**246.9**
HALF MOON BAY	0.0	0.00%	15.9	4.72%	7.1	2.09%	0.0	0.00%	0.0	0.00%	86.0	25.43%	180.7	53.45%	48.4	14.31%	0.0	0.00%	**338.0**
HILLSBOROUGH	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
MENLO PARK	161.9	38.07%	0.0	0.00%	0.0	0.00%	10.4	2.46%	0.0	0.00%	119.8	28.18%	123.0	28.93%	10.0	2.36%	0.0	0.00%	**425.2**
MILLBRAE	0.0	0.00%	0.0	0.00%	0.0	0.00%	7.4	62.12%	0.0	0.00%	1.3	10.61%	3.2	27.27%	0.0	0.00%	0.0	0.00%	**11.8**
PACIFICA	0.0	0.00%	51.8	11.49%	14.3	3.17%	0.0	0.00%	0.0	0.00%	133.0	29.47%	104.7	23.20%	132.6	29.38%	14.9	3.29%	**451.4**
PORTOLA VALLEY	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
REDWOOD CITY	0.0	0.00%	7.5	0.14%	0.2	0.00%	9.2	0.17%	10.4	0.20%	2,531.8	47.72%	2,734.7	51.55%	11.7	0.22%	0.0	0.00%	**5,305.5**
SAN BRUNO	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
SAN CARLOS	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.3	24.30%	1.0	75.70%	0.0	0.00%	0.0	0.00%	**1.3**
SAN MATEO	0.0	0.00%	3.4	1.75%	0.0	0.00%	0.0	0.00%	0.0	0.00%	50.4	26.06%	139.7	72.18%	0.0	0.01%	0.0	0.00%	**193.5**
SOUTH SAN FRANCISCO	0.0	0.00%	70.5	33.64%	0.0	0.00%	23.2	11.10%	1.3	0.64%	86.2	41.13%	28.3	13.50%	0.0	0.00%	0.0	0.00%	**209.5**
WOODSIDE	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
UNINCORPORATED	227.3	11.90%	44.7	2.34%	1.6	0.08%	79.6	4.17%	0.0	0.00%	845.7	44.27%	657.7	34.43%	53.9	2.82%	0.0	0.00%	**1,910.5**
Total	**389.3**	**4.09%**	**258.9**	**2.72%**	**23.2**	**0.24%**	**131.8**	**1.39%**	**11.7**	**0.12%**	**3,972.0**	**41.79%**	**4,430.8**	**46.61%**	**273.4**	**2.88%**	**14.9**	**0.16%**	**9,505.9**

9.7 Scenario

A tsunami in San Mateo County can be generated by either a nearby or distant earthquake or a submarine landslide. The worst-case scenario involves a local tsunami generated by an earthquake in the Cascadia subduction zone or by an earthquake or earthquake-induced landslide along the San Andreas Fault. A professor at the University of California Santa Cruz has developed a projection where the incoming waves of such a tsunami (in this case, originating from an earthquake in the Cascadia subduction zone) are more than 16 feet. In these simulations, the tsunami would flood outlying and low-lying portions of the Bay Area, spreading out through San Francisco Bay. Significant flooding, property damage, and potential injuries and fatalities would result. Such a tsunami would probably be very damaging, although its travel time should ensure residents would have several hours to prepare and follow local evacuation guides. Additionally, while a worst-case scenario, experts agree that it has an extremely low probability of occurrence (Varner 2015).

The most likely tsunami event to strike San Mateo County would be a distant earthquake near Alaska or Chile generating a tsunami with wave heights of 1 to 2 meters reaching Half Moon Bay or Pacifica.

9.8 Issues

The planning team has identified the following issues related to the tsunami hazard for the planning area:

- **Hazard Identification**—To truly measure and evaluate the probable impacts of tsunamis on planning, hazard mapping based on probabilistic scenarios must continue to be updated regularly. The science and technology in this field are emerging. Accurate probabilistic tsunami mapping will need to be a key component for tsunami hazard mitigation programs to be effective.
- **Building Code Revisions**—Present building codes and guidelines do not adequately address the impacts of tsunamis on structures. Planning partners, especially the Cities of Half Moon Bay and Pacifica, should review their building code and consider requirements for tsunami-resistant construction standards in vulnerable areas.
- **Enhancement of Current Capabilities**—As tsunami warning technologies evolve, the tsunami warning capability within the planning area will need to be enhanced to provide the highest degree of warning.
- **Vulnerable Populations Planning**—Special attention will need to be focused on the vulnerable communities in the tsunami zone and on hazard mitigation through public education, outreach, and warning capabilities. This issue may be especially important for visitors to San Mateo County.

Chapter 10. Wildfire

10.1 General Background

A wildfire is any uncontrolled fire occurring on undeveloped land that requires fire suppression. Wildfires can be ignited by lightning or by human activity such as smoking, campfires, equipment use, and arson.

Fire hazards present a considerable risk to vegetation and wildlife habitats throughout San Mateo County. Short-term loss caused by a wildfire can include destruction of timber, wildlife habitat, scenic vistas, and watersheds. Long-term effects include smaller timber harvests, reduced access to affected recreational areas, and destruction of cultural and economic resources and community infrastructure. Vulnerability to flooding increases through destruction of watersheds. The potential for significant damage to life and property exists in areas designated as wildland-urban interface (WUI) areas, where development is adjacent to densely vegetated areas.

DEFINITIONS

Conflagration—A fire that grows beyond its original source area to engulf adjoining regions. Wind, extremely dry or hazardous weather conditions, excessive fuel buildup, and explosions are usually the elements behind a wildfire conflagration.

Firestorm—A fire that expands to cover a large area, often more than a square mile. A firestorm usually occurs when many individual fires grow together into one. The area involved becomes so hot that all combustible materials ignite, even if they are not exposed to direct flame. Temperatures may exceed 1,000°C. Superheated air and hot gases of combustion rise over the fire zone, drawing surface winds in from all sides, often at velocities approaching 50 miles per hour. Although firestorms seldom spread because of the inward direction of the winds, once started, there is no known way of stopping them. Within the area of the fire, lethal concentrations of carbon monoxide are present; combined with the intense heat, this combination poses a serious life threat to responding fire forces. In very large events, the rising column of heated air and combustion gases carries enough soot and particulate matter into the upper atmosphere to cause cloud nucleation, creating a locally intense thunderstorm and the hazard of lightning strikes.

Interface Area—An area susceptible to wildfires and where wildland vegetation and urban or suburban development occur together. An example would be smaller urban areas and dispersed rural housing in forested areas.

Wildfire—Fires that result in uncontrolled destruction of forests, brush, field crops, grasslands, and real and personal property in non-urban areas. Because of their distance from firefighting resources, they can be difficult to contain and can cause a great deal of destruction.

10.1.1 Local Conditions Related to Wildfire

Because natural vegetation and dry-farmed grain areas are extremely flammable during late summer and fall, wildfire is a serious hazard in undeveloped areas and on large lot home sites with extensive areas of un-irrigated vegetation. Grassland fires are easily ignited, particularly in dry seasons. These fires are relatively easily controlled if they can be reached by fire equipment; the burned slopes, however, are highly subject to erosion and gullying.

While brush-lands are naturally adapted to frequent light fires, fire protection in recent decades has resulted in heavy fuel accumulation on the ground. Brush fires, particularly near the end of the dry season, tend to burn fast and very hot, threatening homes and leading to serious destruction of vegetative cover. A brush fire that spreads to a woodland can generate a destructive hot crown fire. No suitable management technique of moderate cost has been devised to reduce the risk of brush fires.

Peat fires represent a special hazard in that, once ignited, they are extremely difficult to extinguish. In some instances, islands have been flooded to extinguish peat fires. Any area lying landward of the mean high water line may be peaty because of the marshy origin of the soil.

10.1.2 Wildland-Urban Interface (WUI) and Structure Fires

WUI fires occur where combustible vegetation meets combustible structures, combining the hazards associated with wildfires and structure fires. These types of fires have increased dramatically in the last two decades as more and more people move to rural areas. Between 1970 and 1980, the rural population of the United States increased 23.4 percent, more than twice the gain of 11.4 percent for the nation as a whole. The hazard is bi-directional: wildfires can burn homes, and home fires can burn into wildlands, making this type of fire an important consideration in wildfire management.

WUI fires are increasing as more vacation homes are built and improved transportation systems allow more people to live outside city centers. The longer response times for these out-of-the-way locations gives the fire more time to burn out of control, making these fires difficult to fight. Most firefighters are trained to fight either wildfires or structure fires. WUI fires require both skills, and it is difficult to balance the two. When a WUI fire breaks out, the threat of extreme property and casualty losses often forces firefighters to focus their efforts on protecting homes and structures, sometimes at the expense of protecting wildland resources or working to slow the fire itself.

Structure fires are not typically considered an emergency, except when the fire can spread to adjoining structures. Older structures are often more vulnerable to fire (both where the structure fire starts first and where it is a secondary hazard event tied to a wildfire), because the older structures do not conform to modern building and fire codes and do not contain fire detection devices. These structures are also prone to faulty electrical, heating, and other utility systems because of their age and lack of proper maintenance. Many of these older structures were constructed close together, enabling fire to spread rapidly from one to another. These existing vulnerabilities can facilitate the spread of a wildfire to structures, or vice versa, as the structures are already more likely to catch fire. Additionally, it is likely that other defensive measures, such as fire-resistant vegetation and defensible space, are not in place, increasing the probability that structural fires for older buildings will spread to local vegetation and surrounding wildlands.

In contrast, newer residential structures are not as vulnerable to fire as are older structures. These structures include fire-resistant features that conform to modern fire and building codes, as well as fire detection or extinguishing systems. The likelihood that a major structural fire will expand into a wildland fire before it can be brought under control is therefore significantly reduced. Similarly, wildfires will be less able to burn these buildings because of the preventative measures in place.

The storage and use of hazardous materials by commercial and industrial occupancies not only increase the risk of fire but also pose a threat to firefighters and the community if they should become involved in a fire. Certain materials have been designated by the National Fire Protection Academy (NFPA) as flammable and combustible, such as propane or petroleum; if a wildfire infects a building or container with these materials, it would greatly exacerbate the severity and damage associated with the fire. Toxic chemicals could present public health hazards if a wildfire reaches an industrial sector or building, releasing to toxic fumes as clouds of smoke. In addition to the health concerns and impact to the community, hazardous materials-associated fires (whether initiated by a wildfire or as a structural fire that has spread into the wildland) can also introduce toxins and increase the damage to the local environment, destroying or altering important habitats.

Property owners of structures within the WUI can take preventative measures to reduce the risk of a wildfire creating a secondary structural fire. Fire-resistant plants, implementing 100-feet of defensible space, and additional hardening the property are some of protective measures recommended by the California Department of Forestry and Fire Protection (CAL FIRE) (CAL FIRE 2016).

10.1.3 Wildfire Protection Responsibility in California

Hundreds of agencies have fire protection responsibility for wildland and WUI fires in California. Local, state, tribal, and federal organizations have primary legal (and financial) responsibility for wildfire protection. In many instances, two fire organizations have dual primary responsibility on the same parcel of land —one for wildfire protection, and the other for structural or "improvement" fire protection. According to the *2013 California State Hazard Mitigation Plan*, this layering of responsibility and resulting dual policies, rules, practices, and legal ordinances can cause conflict or confusion. To address wildfire jurisdictional responsibilities, the California state legislature in 1981 adopted Public Resource Code Section 4291.5 and Health and Safety Code Section 13108.5 establishing the following responsibility areas:

- **Federal Responsibility Areas (FRAs)—**FRAs are fire-prone wildland areas that are owned or managed by a federal agency such as the U.S. Forest Service, National Park Service, Bureau of Land Management, U.S. Fish and Wildlife Service, or U.S. Department of Defense. Primary financial and rule-making jurisdictional authority rests with the federal land agency. In many instances, FRAs are interspersed with private land ownership or leases. Fire protection for developed private property is usually not the responsibility of the federal land management agency; structural protection responsibility is that of a local government agency.
- **State Responsibility Areas (SRAs)**—SRAs are lands in California where CAL FIRE has legal and financial responsibility for wildfire protection and where CAL FIRE administers fire hazard classifications and building standard regulations. SRAs are defined as lands that meet the following criteria:
- Are county unincorporated areas
- Are not federally owned
- Have wildland vegetation cover rather than agricultural or ornamental plants
- Have watershed or range/forage value
- Have housing densities not exceeding three units per acre.

- Where SRAs contain built environment or development, the responsibility for fire protection of those improvements (non-wildland) is that of a local government agency.
- **Local Responsibility Areas (LRAs)—**LRAs include land in cities, cultivated agriculture lands, and non-flammable areas in unincorporated areas, and lands that do not meet the criteria for SRA or FRA. LRA fire protection is typically provided by city fire departments, fire protection districts, and counties, or by CAL FIRE under contract to local governments. Four fire districts are participating in the San Mateo County Hazard Mitigation Plan (HMP) Update; they include Belmont Fire Protection District, Colma Fire Protection District, San Mateo County Fire Department, and Woodside Fire Protection District. LRAs may include flammable vegetation and WUI areas where the financial and jurisdictional responsibility for improvement and wildfire protection is that of a local government agency.

SRAs were originally mapped in 1985, while LRAs were originally mapped in 1996. During that time, many local governments made similar designations under their own authority. CAL FIRE recognized the need to remap both SRAs and LRAs with more recent data and technology to create more accurate zone designations. Updated SRA maps were released in May 2011 and again in August 2012. SRA and LRA maps, released in November 2007 and December 2008, are available at the county level for San Mateo County on CAL FIRE's Fire and Resource Assessment Program (FRAP) website.

FRAP not only contains maps showing high hazard fire zones in SRA and LRA, it offers a multitude of fire management prevention and planning tools. Other maps and geographic information system (GIS) information include bioregions, fire management environments, fire perimeters, fire threat, fuel rank, surface fuels, land cover, watersheds, historical and anticipated development, and more. FRAP also conducts a periodic assessment on state forests and rangelands to determine the amount and extent of these resources, analyze their conditions, and identify alternative management and policy guidelines. The assessment also enhances inter-agency collaboration between state and federal agencies on forest and rangeland resources. The 2015 assessment is still in production and not available on line; however, the 2010 and 2003 assessment can both be accessed through the FRAP website (http://frap.fire.ca.gov/assessment/).

Additionally, SB 1241 (adopted in fall 2012) requires local governments to update the safety elements in their general plan to recognize wildfire risks in SRAs and Very High Fire Hazard Severity Zones to enhance inter-agency coordination. SB 1241 correlates strongly with AB 2140, which requires local jurisdictions to adopt a federally approved HMP through reference in the safety element of their general plan. This bill also notes the requirement for the safety element to include information and policies on unreasonable risk from potential hazards, including fire. These bills are both designed to encourage integration intra-jurisdictionally and inter-jurisdictionally to enhance mitigation and prevention efforts. Information from a city or town's safety element should be considered with the development of an HMP, response procedures, evacuation planning, and long-term development.

10.2 Hazard Profile

The *2013 California State Hazard Mitigation Plan* provides the following description of wildfire hazard and risk:

> *"The diversity of WUI settings and disagreement about alternative mitigation strategies has led to confusion and different methods of defining and mapping WUI areas. One major disagreement has been caused by terms such as 'hazard' and 'risk' being used interchangeably. Hazard is the physical condition that can lead to damage to a particular asset or resource. The term 'fire hazard' is related to those physical conditions related to fire and its ability to cause damage, specifically how often a fire burns a given locale and what the fire is like when it burns (its fire behavior). Thus, fire hazard only refers to the potential characteristics of the fire itself.*
>
> *Risk is the likelihood of a fire occurring at a given site (burn probability) and the associated mechanisms of fire behavior that cause damage to assets and resources (fire behavior). This includes the impact of fire brands (embers) that may be blown some distance igniting fires well away from the main fire" (California 2013).*

10.2.1 Past Events

Fire is a normal part of most forest and range ecosystems in temperate regions of the world. Fires historically burn on a fairly regular cycle, recycling carbon and nutrients stored in the ecosystem and strongly affecting the species within the ecosystem. Annual acreage consumed by wildfires in the lower 48 states dropped from about 40 to 50 million acres per year in the 1930s to under 5 million acres by 1970. A western Washington study estimated that modern wildfires consume only about a tenth of the biomass each year that prehistoric fires burned.

While San Mateo County has a prolific fire history, few of its fires have caused sufficient damage to trigger a state or federal disaster declaration. According to the *2013 California State Hazard Mitigation Plan*, San Mateo County has been included in two state or federal declared fire emergencies between 1950 and December 2012. Specifics on which fire emergencies were not available through either the state HMP or the Federal Emergency Management Agency's (FEMA's) disaster list.

CAL FIRE maintains statistics on historical wildfire activity through its annual reporting (Redbooks). Wildfire statistics include state and county information, cause and size, acres burned, and dollar damage, among other details. The table below shows the wildfire activity for San Mateo County between 2000 and 2013, the most recent annual report available. CAL FIRE has Redbooks available for every year back through 1942. Although fire statistics are available for 2014, 2014, and 2016, a breakdown at the county level is not yet available.

TABLE 10-1. CAL FIRE WILDFIRE ACTIVITY STATISTICS FOR SAN MATEO COUNTY

Year	Total	Arson	Campfire	Debris Burning	Equipment Use	Lightning	Miscellaneous	Power Line/Electric Power	Playing With Fire (PWF)	Railroad	Smoking	Undetermined	Vehicle
2013	19	1	1	0	1	1	0	4	0	0	0	8	3
2012	15	2	2	0	2	1	2	3	0	0	0	3	0
2011	10	0	0	0	2	0	5	0	0	0	0	3	0
2010	15	0	0	0	1	0	5	2	0	0	1	6	0
2009	13	1	0	1	1	0	2	0	0	0	0	7	1
2008	21	0	0	1	3	0	5	1	0	0	1	9	1
2007	18	1	0	1	3	0	11	0	0	0	0	1	1
2006	12	0	0	0	3	0	1	0	0	0	0	5	3
2005	13	0	0	1	8	1	0	1	0	0	0	2	0
2004	28	0	2	1	10	0	0	2	0	0	0	7	6
2003	23	0	5	1	2	0	5	1	0	0	1	5	3
2002	40	2	1	3	8	0	2	1	0	0	1	11	11
2001	42	1	4	4	11	4	6	2	1	0	1	3	5
2000	28	0	2	1	9	0	2	4	0	0	0	7	3
Total	**297**	**8**	**17**	**14**	**64**	**7**	**46**	**21**	**1**	**0**	**5**	**77**	**37**

Note: Wildfire causes tracked by CAL FIRE include natural, human, and technological. More detailed information is available in each applicable Redbook. For instance, power line-caused fires may be a result of animals or vegetation disrupting or connecting with a power line, sparking a fire. They may also be the result of a technological issue or line down (causes not listed but could include storm events).

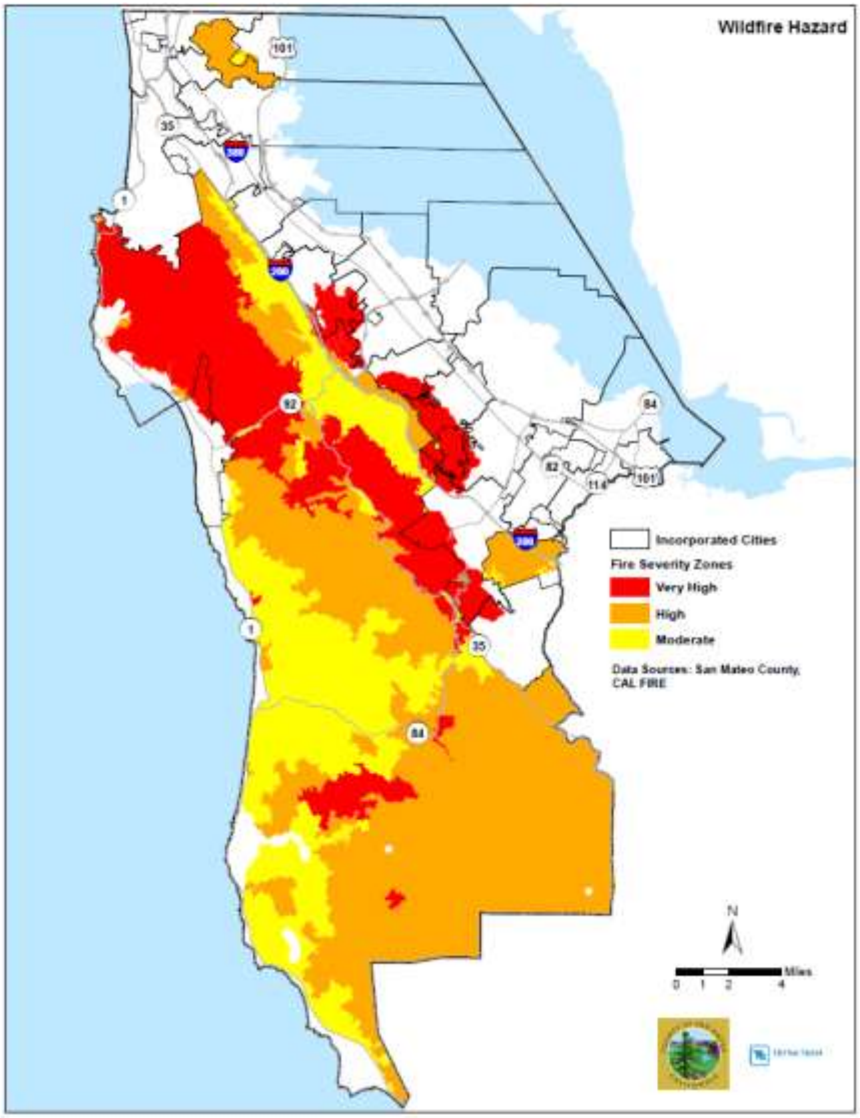
10.2.2 Location

CAL FIRE maps areas of significant fire hazards based on factors such as the following:

- **Fuel**—Fuel may include living and dead vegetation on the ground, along the surface as brush and small trees, and above the ground in tree canopies. Lighter fuels such as grasses, leaves, and needles quickly expel moisture and burn rapidly, while heavier fuels such as tree branches, logs, and trunks take longer to warm and ignite. Trees killed or defoliated by forest insects and diseases are more susceptible to wildfire.
- **Weather**—Relevant weather conditions include temperature, relative humidity, wind speed and direction, cloud cover, precipitation amount and duration, and the stability of the atmosphere. Of particular importance for wildfire activity are wind and thunderstorms:
- Strong, dry winds produce extreme fire conditions. Such winds generally reach peak velocities during the night and early morning hours.
- The thunderstorm season typically begins in June with wet storms and turns dry with little or no precipitation reaching the ground as the season progresses into July and August.
- **Terrain**—Topography includes slope and elevation. The topography of a region influences the amount and moisture of fuel; the impact of weather conditions such as temperature and wind;

potential barriers to fire spread, such as highways and lakes; and elevation and slope of land forms (fire spreads more easily uphill than downhill).

A fire hazard severity scale has been devised taking these factors into consideration that characterizes zones by the number of days of moderate, high and extreme fire hazard. These zones, referred to as Fire Hazard Severity Zones (FHSZ), define the application of various mitigation strategies to reduce risk associated



with wildfires.

Figure 10-1 shows the Very High Fire Hazard Severity Zone (VHFHSZ) and other severity zones for LRA and SRA for San Mateo County. These maps are the basis for this wildfire risk assessment. City-level VHFHSZ maps are also available on CAL FIRE's website for Belmont, Half Moon Bay, Hillsborough, Portola Valley, Redwood City, San Carlos, San Mateo, and Woodside.

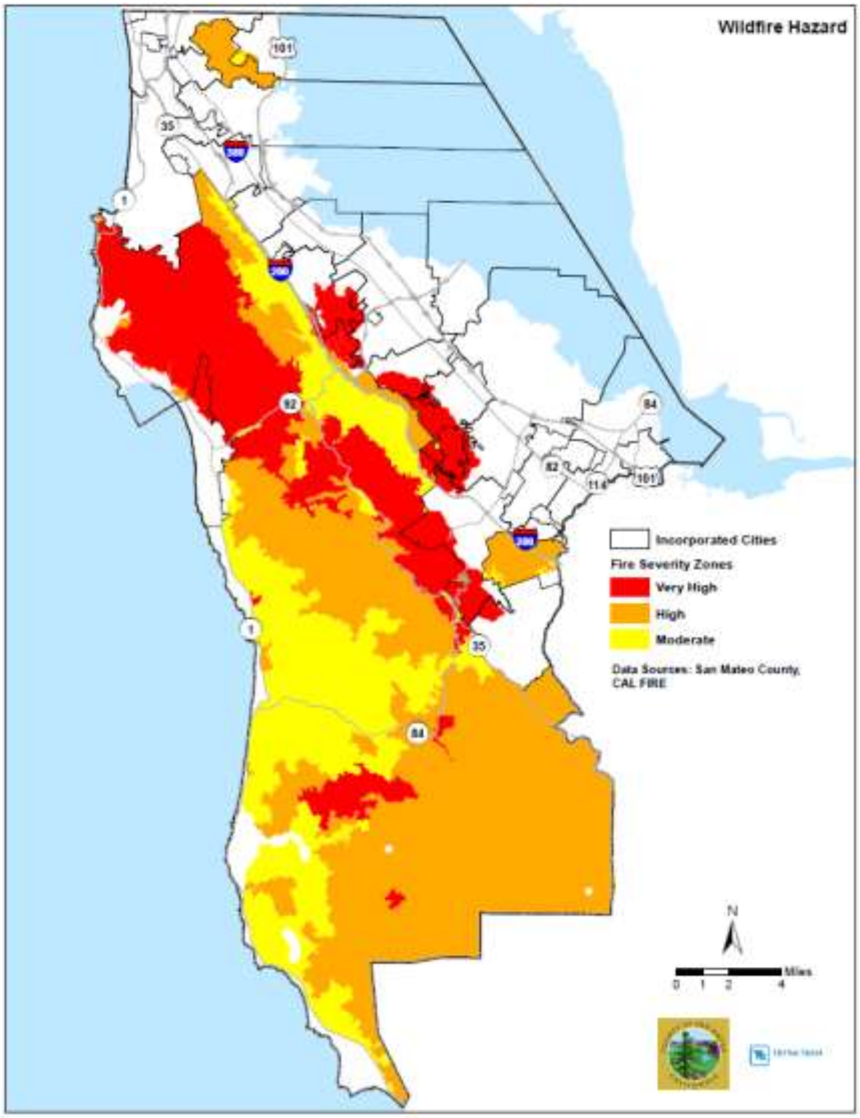


FIGURE 10-1. WILDFIRE SEVERITY IN SAN MATEO COUNTY

The FHSZ model is built from existing data and hazard constructs developed by CAL FIRE's Fire and Resource Assessment Program. The model refines the zones to characterize fire exposure mechanisms that cause ignitions to structures. The model characterizes potential fire behavior for vegetation fuels, which are by nature dynamic. Since model results are used to identify permanent engineering mitigations for structures, it is desirable that the model reflect changes in fire behavior over the length of time a structure is likely to be in place. Significant land-use changes need to be accommodated through period maintenance routines.

The model output of fire probability also is based on frequency of fire weather, ignition patterns, expected rate-of spread, and fire history. It also accounts for flying ember production and hazards based on the area of influence where embers are likely to land and cause ignitions. Embers are the principal driver of hazard in densely developed areas. A related concern in built-out areas is the relative density of vegetative fuels that can serve as sites for new spot fires within the urban core and spread to adjacent structures.

The geography, weather patterns, and vegetation in the Bay Area provide ideal conditions for recurring wildfires. Especially vulnerable are the SRA between Shelter Cove, Moss Beach, Half Moon Bay, Sky Londa, and Crystal Springs Lake. The southern half of the County is mostly rated as moderate or high, with some very high sections, including in La Honda. LRA rated as very high include land immediately west of Crystal Springs Lake, land near Woodside and Sky Londa, and land about halfway between Half Moon Bay and Moss Beach. Very high LRA are adjacent to very high risk SRA.

10.2.3 Frequency

Based on risk factors for the County and past occurrences, it is highly likely that wildfires will continue to occur in San Mateo County. Wildfires are influenced by both weather and human activities. Based on its history of past events, San Mateo County has a high chance of a wildfire in any given year. The most common causes of wildfires, based on past events, will be "undetermined," equipment use, miscellaneous, and power line/electric power.

10.2.4 Severity

Potential losses from wildfire include human life, structures and other improvements, and natural resources. Although no major noteworthy fires were listed in San Mateo County, a 2008 fire in neighboring Santa Clara County provides an example for how quickly a wildfire can turn destructive. In May 2008, a wildfire burned 10 homes, threatened an additional 50 homes, and spread across 3,000 acres in northern California. The wildfire began in Santa Clara County and moved south toward Santa Cruz County. It was fueled by dry brush and caused the evacuation of 190 people. At least 149 firefighters were needed to manage the blaze (CNN 2008).

CAL FIRE tracks the deadliest, largest, and most destructive wildfires that have occurred in the state, with the lists last updated in late January 2016. San Mateo County is not included in any of these lists; however, neighboring Alameda County is on these lists. While San Mateo County does not share contiguous wildlands with Alameda County, this fire demonstrates a worst-case scenario fire that could occur in counties in the Bay Area. The October 1991 Oakland/Berkeley Hills "Tunnel Fire" is listed as the most damaging fire and the second most deadly fire to occur in California. This WUI fire resulted in 25 lives lost, including a fire battalion chief and an Oakland police officer, 148 people injured, and 2,900 structures destroyed. The blaze started from a grass fire in the Berkeley Hills and burned 1,600 acres. The estimated private property loss was $1.7 billion at the time, according to the Insurance Information Institute. The only other relatively local fire to make one of CAL FIRE's top 20 lists is a September 1923 fire, also in Alameda County. This fire broke out as a result of powerlines in the City of Berkeley, burning 130, damaging 548 structures, but causing no deaths. It is ranked as the 11th most damaging fire in state history.

Given the immediate response times to reported fires, the likelihood of injuries and casualties is minimal. Smoke and air pollution from wildfires can be a health hazard, especially for sensitive populations, including children, the elderly, and those with respiratory and cardiovascular diseases. Wildfire may also threaten the health and safety of those fighting the fires. First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke. In addition, wildfire can lead to ancillary impacts such as landslides in steep ravine areas and flooding caused by the impacts of silt in local watersheds.

10.2.5 Warning Time

Wildfires are often caused by humans, intentionally or accidentally. There is no way to predict when one might break out. Since fireworks often cause brush fires, extra diligence is warranted around the Fourth of July, when the use of fireworks is highest. Dry seasons and droughts are factors that greatly increase the likelihood of fire, which has led to increased concern on fire management for the last several years in the County and state. Dry lightning may trigger wildfires. Severe weather can be predicted, so special attention can be paid during weather events that may include lightning. Reliable National Weather Service lightning warnings are available on average 24 to 48 hours before a significant electrical storm.

If a fire breaks out and spread rapidly, residents may need to evacuate within days or hours. A fire’s peak burning period generally is between 1 p.m. and 6 p.m. Once a fire has started, fire alerting is reasonably rapid in most cases. The rapid spread of cellular and two-way radio communications in recent years has further contributed to a significant improvement in warning time.

10.2.6 SECONDARY HAZARDS

Wildfires can generate a range of secondary effects, which in some cases may cause more widespread and prolonged damage than the fire itself. Fires can cause direct economic losses in the reduction of harvestable timber and indirect economic losses in reduced tourism. Wildfires contaminate reservoirs, destroy transmission lines, and contribute to flooding. They strip slopes of vegetation, exposing them to greater amounts of runoff, in turning weakening soils and causing failures on slopes. Major landslides can occur several years after a wildfire. Most wildfires burn hot and for long durations that can bake soils, especially those high in clay content, thus increasing the imperviousness of the ground, increasing the runoff generated by storm events, thus enhancing the chance of flooding.

10.2.7 EXPOSURE

Population

Exposed population for the wildfire risk areas (very high, high, and moderate fire severity zones) was estimated using the percentage of residential structures exposed multiplied by the estimated population for each jurisdiction. The results are shown in Table 10-2. Approximately 5 percent of the total County population lives in areas identified as very high severity zones, less than 1 percent of the total population lives in areas identified as high severity zones, and less than 1 percent of the population lives in moderate severity zones. In total, 5.8 percent of the County’s population lives in a wildfire risk area.

In addition to the populations living in wildfire risk areas, people working or recreating in resource lands, such as hikers, are exposed to the wildfire risk. Firefighting crews are exposed as they work to combat fires and to protect property. All county residents are potentially exposed to the health-related impacts of reduced air quality from wildland fires.

TABLE 10-2. POPULATION WITHIN WILDLAND FIRE SEVERITY ZONES

	Very High			High			Moderate		
		Population			Population			Population	
	Buildings	Number	% of Total	Buildings	Number	% of Total	Buildings	Number	% of Total
Atherton	0	0	0.0%	0	0	0.0%	0	0	0.0%
Belmont	1,098	3,915	14.6%	0	0	0.0%	0	0	0.0%
Brisbane	0	0	0.0%	0	0	0.0%	1	0	0.0%
Burlingame	0	0	0.0%	0	0	0.0%	0	0	0.0%
Colma	0	0	0.0%	0	0	0.0%	0	0	0.0%
Daly City	0	0	0.0%	0	0	0.0%	0	0	0.0%
East Palo Alto	0	0	0.0%	0	0	0.0%	0	0	0.0%
Foster City	0	0	0.0%	0	0	0.0%	0	0	0.0%
Half Moon Bay	12	26	0.2%	0	0	0.0%	0	0	0.0%
Hillsborough	1,270	3,701	32.4%	0	0	0.0%	0	0	0.0%
Menlo Park	0	0	0.0%	0	0	0.0%	0	0	0.0%
Millbrae	0	0	0.0%	0	0	0.0%	0	0	0.0%
Pacifica	0	0	0.0%	0	0	0.0%	0	0	0.0%
Portola Valley	145	412	9.1%	0	0	0.0%	0	0	0.0%
Redwood City	1,174	4,877	6.0%	0	0	0.0%	0	0	0.0%
San Bruno	0	0	0.0%	0	0	0.0%	0	0	0.0%
San Carlos	2,451	7,233	24.6%	0	0	0.0%	0	0	0.0%
San Mateo	552	1,987	2.0%	0	0	0.0%	0	0	0.0%
South San Francisco	0	0	0.0%	0	0	0.0%	0	0	0.0%
Woodside	700	1,916	34.6%	0	0	0.0%	0	0	0.0%
Unincorporated	4,404	15,130	23.4%	1,511	4,548	7.0%	741	1,987	3.1%
Total	**11,806**	**39,197**	**5.2%**	**1,511**	**4,548**	**0.6%**	**742**	**1,987**	**0.3%**

Property and Present Land Use

Table 10-3 and Table 10-4 show the number of structures in the planning area that are located in the fire hazard severity zones and their values. Approximately 4 percent of the total replacement value of the County is located in areas identified as very high severity zones, 1.4 percent of the total replacement value is located in areas identified as high severity zones, and less than 1 percent of the total replacement value is located in moderate severity zones. In total, 6.3 percent of the County's total replacement value is located in a wildfire risk area.

Table 10-5 shows the type of structures in wildfire risk areas in the County. The vast majority of these structures (83 percent) are located in the very high risk zone, 11 percent are located in high severity risk zones, and 6 percent are located in moderate risk zones. Approximately 95 percent of exposed structures are residential. (Table 10-6)

TABLE 10-3. EXPOSURE AND VALUE OF STRUCTURES IN VERY HIGH SEVERITY ZONES

Jurisdiction	Buildings Exposed	Value Exposed			% of Total Replacement value
		Structure	Contents	Total	
Atherton	0	$0	$0	$0	0.0%
Belmont	1,098	$762,754,194	$465,504,803	$1,228,258,997	11.9%
Brisbane	0	$0	$0	$0	0.0%
Burlingame	0	$0	$0	$0	0.0%
Colma	0	$0	$0	$0	0.0%
Daly City	0	$0	$0	$0	0.0%
East Palo Alto	0	$0	$0	$0	0.0%
Foster City	0	$0	$0	$0	0.0%
Half Moon Bay	12	$16,195,710	$15,110,703	$31,306,414	0.4%
Hillsborough	1,270	$914,396,471	$569,831,796	$1,484,228,267	31.6%
Menlo Park	0	$0	$0	$0	0.0%
Millbrae	0	$0	$0	$0	0.0%
Pacifica	0	$0	$0	$0	0.0%
Portola Valley	145	$119,106,592	$98,015,396	$217,121,988	8.0%
Redwood City	1,174	$997,667,995	$818,080,919	$1,815,748,914	5.0%
San Bruno	0	$0	$0	$0	0.0%
San Carlos	2,451	$1,022,568,572	$605,039,498	$1,627,608,070	8.1%
San Mateo	552	$502,506,168	$420,001,390	$922,507,559	2.1%
South San Francisco	0	$0	$0	$0	0.0%
Woodside	700	$536,928,806	$402,859,892	$939,788,698	32.2%
Unincorporated	4,404	$3,077,592,180	$2,382,782,133	$5,460,374,313	17.0%
Total	**11,806**	**$7,949,716,688.42**	**$5,777,226,530.55**	**$13,726,943,219**	**4.3%**

Note: Values shown are accurate only for comparison among results in this plan. See Section 1, Chapter 2 for a discussion of data limitations.

TABLE 10-4. EXPOSURE AND VALUE OF STRUCTURES IN HIGH SEVERITY ZONES

Jurisdiction	Buildings Exposed	Value Exposed			% of Total Replacement value
		Structure	Contents	Total	
Atherton	0	$0	$0	$0	0.0%
Belmont	0	$0	$0	$0	0.0%
Brisbane	0	$0	$0	$0	0.0%
Burlingame	0	$0	$0	$0	0.0%
Colma	0	$0	$0	$0	0.0%
Daly City	0	$0	$0	$0	0.0%
East Palo Alto	0	$0	$0	$0	0.0%
Foster City	0	$0	$0	$0	0.0%
Half Moon Bay	0	$0	$0	$0	0.0%

Table 10-4. Exposure and Value of Structures in High Severity Zones

Jurisdiction	Buildings Exposed	Value Exposed			% of Total Replacement value
		Structure	Contents	Total	
Hillsborough	0	$0	$0	$0	0.0%
Menlo Park	0	$0	$0	$0	0.0%
Millbrae	0	$0	$0	$0	0.0%
Pacifica	0	$0	$0	$0	0.0%
Portola Valley	0	$0	$0	$0	0.0%
Redwood City	0	$0	$0	$0	0.0%
San Bruno	0	$0	$0	$0	0.0%
San Carlos	0	$0	$0	$0	0.0%
San Mateo	0	$0	$0	$0	0.0%
South San Francisco	0	$0	$0	$0	0.0%
Woodside	0	$0	$0	$0	0.0%
Unincorporated	1,511	$2,274,917,161	$2,161,230,368	$4,436,147,528	13.8%
Total	1,511	**$2,274,917,161**	**$2,161,230,368**	**$4,436,147,528**	**1.4%**

Note: Values shown are accurate only for comparison among results in this plan. See Section 1, Chapter 2 for a discussion of data limitations

Table 10-5. Exposure and Value of Structures in Moderate Severity Zones

Jurisdiction	Buildings Exposed	Value Exposed			% of Total Replacement value
		Structure	Contents	Total	
Atherton	0	$0	$0	$0	0.0%
Belmont	0	$0	$0	$0	0.0%
Brisbane[a]	1	$11,175,165	$16,762,748	$27,937,913	0.7%
Burlingame	0	$0	$0	$0	0.0%
Colma	0	$0	$0	$0	0.0%
Daly City	0	$0	$0	$0	0.0%
East Palo Alto	0	$0	$0	$0	0.0%
Foster City	0	$0	$0	$0	0.0%
Half Moon Bay	0	$0	$0	$0	0.0%
Hillsborough	0	$0	$0	$0	0.0%
Menlo Park	0	$0	$0	$0	0.0%
Millbrae	0	$0	$0	$0	0.0%
Pacifica	0	$0	$0	$0	0.0%
Portola Valley	0	$0	$0	$0	0.0%
Redwood City	0	$0	$0	$0	0.0%
San Bruno	0	$0	$0	$0	0.0%
San Carlos	0	$0	$0	$0	0.0%

TABLE 10-5. EXPOSURE AND VALUE OF STRUCTURES IN MODERATE SEVERITY ZONES

Jurisdiction	Buildings Exposed	Value Exposed			% of Total Replacement value
		Structure	Contents	Total	
San Mateo	0	$0	$0	$0	0.0%
South San Francisco	0	$0	$0	$0	0.0%
Woodside	0	$0	$0	$0	0.0%
Unincorporated	741	$1,470,560,767	$1,385,559,244	$2,856,120,011	8.9%
Total	742	**$1,481,735,932**	**$1,402,321,992**	**$2,884,057,924**	**0.9%**

[a] The exposed structure for Brisbane is within Brisbane's sphere of influence, but is outside of city limits and the ultimate responsibility of the County of San Mateo.

Note: Values shown are accurate only for comparison among results in this plan. See Section 2, Chapter 1 for a discussion of data limitations

TABLE 10-6. PRESENT LAND USE IN WILDFIRE HAZARD ZONES[b]

	Number of Structures[a]							
	Residential	Commercial	Industrial	Agriculture/ Forestry	Religion	Government	Education	Total
Atherton	0	0	0	0	0	0	0	0
Belmont	1,087	8	0	0	0	0	3	1,098
Brisbane	0	0	1	0	0	0	0	1
Burlingame	0	0	0	0	0	0	0	0
Colma	0	0	0	0	0	0	0	0
Daly City	0	0	0	0	0	0	0	0
East Palo Alto	0	0	0	0	0	0	0	0
Foster City	0	0	0	0	0	0	0	0
Half Moon Bay	8	1	0	3	0	0	0	12
Hillsborough	1,257	13	0	0	0	0	0	1,270
Menlo Park	0	0	0	0	0	0	0	0
Millbrae	0	0	0	0	0	0	0	0
Pacifica	0	0	0	0	0	0	0	0
Portola Valley	139	4	0	0	2	0	0	145
Redwood City	1,132	34	0	0	4	0	4	1,174
San Bruno	0	0	0	0	0	0	0	0
San Carlos	2,440	9	0	0	1	0	1	2,451
San Mateo	526	20	0	0	4	0	2	552
South San Francisco	0	0	0	0	0	0	0	0
Woodside	682	17	0	0	0	0	1	700
Unincorporated	6,107	221	4	290	3	11	20	6,656
Total	**13,378**	**327**	**5**	**293**	**14**	**11**	**31**	**14,059**

a. Structure type assigned to best fit HAZUS occupancy classes based on present use classifications provided by San Mateo County assessor's data. Where conflicting information was present in the available data, parcels were assumed to be improved.
b. Estimates include structure counts for very high, high, and medium severity zones.

Critical Facilities and Infrastructure

Tables 10-7 through Table 10-9 identify critical facilities located in wildfire hazard severity zones.

Currently there is 1 hazardous material containment sites identified in wildfire risk zones. During a wildfire event, containers with these materials could rupture because of the excessive heat and act as fuel for the fire, causing rapid spreading and escalating the fire to unmanageable levels. In addition, they could leak into surrounding areas, saturating soils and seeping into surface waters, and have a disastrous effect on the environment.

In the event of wildfire, there would likely be little damage to the majority of infrastructure. Most road and railroads would be without damage except in the worst scenarios. Power poles are the most at risk to wildfire because most are made of wood and susceptible to burning. In the event of a wildfire, pipelines could provide a source of fuel and lead to a catastrophic explosion.

TABLE 10-7. CRITICAL FACILITIES IN VERY HIGH SEVERITY WILDFIRE ZONES

	Medical and Health Services	Emergency Services	Government	Utilities	Transportation Infrastructure	Hazardous Materials	Community Economic Facilities	Other Assets	Total
Atherton	0	0	0	0	0	0	0	0	**0**
Belmont	0	0	0	4	0	0	0	3	**7**
Brisbane	0	0	0	0	0	0	0	0	**0**
Burlingame	0	0	0	0	0	0	0	0	**0**
Colma	0	0	0	0	0	0	0	0	**0**
Daly City	0	0	0	0	0	0	0	0	**0**
East Palo Alto	0	0	0	0	0	0	0	0	**0**
Foster City	0	0	0	0	0	0	0	0	**0**
Half Moon Bay	0	0	0	0	0	0	0	0	**0**
Hillsborough	0	0	0	0	3	0	0	0	**3**
Menlo Park	0	0	0	0	0	0	0	0	**0**
Millbrae	0	0	0	0	0	0	0	0	**0**
Pacifica	0	0	0	0	0	0	0	0	**0**
Portola Valley	0	0	0	0	0	0	0	0	**0**
Redwood City	0	1	0	0	0	0	0	1	**2**
San Bruno	0	0	0	0	0	0	0	0	**0**
San Carlos	0	0	0	3	0	0	0	1	**4**
San Mateo	0	0	0	1	0	0	0	1	**2**
South San Francisco	0	0	0	0	0	0	0	0	**0**

TABLE 10-7. CRITICAL FACILITIES IN VERY HIGH SEVERITY WILDFIRE ZONES

	Medical and Health Services	Emergency Services	Government	Utilities	Transportation Infrastructure	Hazardous Materials	Community Economic Facilities	Other Assets	Total
Woodside	0	0	0	0	4	0	0	0	**4**
Unincorporated	0	3	1	8	16	0	0	3	**31**
Total	**0**	**4**	**1**	**16**	**23**	**0**	**0**	**9**	**53**

TABLE 10-8. CRITICAL FACILITIES IN HIGH SEVERITY WILDFIRE ZONES

	Medical and Health Services	Emergency Services	Government	Utilities	Transportation Infrastructure	Hazardous Materials	Community Economic Facilities	Other Assets	Total
Atherton	0	0	0	0	0	0	0	0	**0**
Belmont	0	0	0	0	0	0	0	0	**0**
Brisbane	0	0	0	0	0	0	0	0	**0**
Burlingame	0	0	0	0	0	0	0	0	**0**
Colma	0	0	0	0	0	0	0	0	**0**
Daly City	0	0	0	0	0	0	0	0	**0**
East Palo Alto	0	0	0	0	0	0	0	0	**0**
Foster City	0	0	0	0	0	0	0	0	**0**
Half Moon Bay	0	0	0	0	1	0	0	0	**1**
Hillsborough	0	0	0	0	0	0	0	0	**0**
Menlo Park	0	0	0	0	0	0	0	0	**0**
Millbrae	0	0	0	0	0	0	0	0	**0**
Pacifica	0	0	0	0	0	0	0	0	**0**
Portola Valley	0	0	0	0	0	0	0	0	**0**
Redwood City	0	0	0	0	0	0	0	0	**0**
San Bruno	0	0	0	0	0	0	0	0	**0**
San Carlos	0	0	0	0	0	0	0	0	**0**
San Mateo	0	0	0	0	0	0	0	0	**0**
South San Francisco	0	0	0	0	0	0	0	0	**0**
Woodside	0	0	0	0	0	0	0	0	**0**
Unincorporated	1	2	0	13	30	1	0	3	**50**
Total	**1**	**2**	**0**	**13**	**31**	**1**	**0**	**3**	**51**

TABLE 10-9. CRITICAL FACILITIES IN MODERATE SEVERITY WILDFIRE ZONES

	Medical and Health Services	Emergency Services	Government	Utilities	Transportation Infrastructure	Hazardous Materials	Community Economic Facilities	Other Assets	Total
Atherton	0	0	0	0	0	0	0	0	**0**
Belmont	0	0	0	0	0	0	0	0	**0**
Brisbane	0	0	0	0	0	0	0	0	**0**
Burlingame	0	0	0	0	0	0	0	0	**0**
Colma	0	0	0	0	0	0	0	0	**0**
Daly City	0	0	0	0	0	0	0	0	**0**
East Palo Alto	0	0	0	0	0	0	0	0	**0**
Foster City	0	0	0	0	0	0	0	0	**0**
Half Moon Bay	0	0	0	0	0	0	0	0	**0**
Hillsborough	0	0	0	0	0	0	0	0	**0**
Menlo Park	0	0	0	0	0	0	0	0	**0**
Millbrae	0	0	0	0	0	0	0	0	**0**
Pacifica	0	0	0	0	0	0	0	0	**0**
Portola Valley	0	0	0	0	0	0	0	0	**0**
Redwood City	0	0	0	0	0	0	0	0	**0**
San Bruno	0	0	0	0	0	0	0	0	**0**
San Carlos	0	0	0	0	0	0	0	0	**0**
San Mateo	0	0	0	0	0	0	0	0	**0**
South San Francisco	0	0	0	0	0	0	0	0	**0**
Woodside	0	0	0	0	0	0	0	0	**0**
Unincorporated	0	1	0	6	20	0	0	0	**27**
Total	**0**	**1**	**0**	**6**	**20**	**0**	**0**	**0**	**27**

Environment

Fire is a natural and critical ecosystem process in most of California's diverse terrestrial ecosystems, dictating in part the types, structure, and spatial extent of native vegetation in the state. Many of California's ecosystems are adapted to historical patterns of fire occurrence in a given area. These patterns, called "fire regimes," include temporal attributes (frequency and seasonality), spatial attributes (size and spatial complexity), and magnitude attributes (intensity and severity), each of which have ranges of natural variability.

Ecosystem stability is threatened when any of the attributes for a given fire regime diverge from its range of natural variability. Compared with historical fire regimes, many mixed-conifer forests now experience fires that are more intense and severe, while chaparral brush-lands experience fire at a greater frequency. Both trends have profound impacts on ecosystem stability throughout California.

Wildfires can cause severe environmental impacts:

- **Damaged Fisheries**—Critical fisheries can suffer from increased water temperatures, sedimentation, and changes in water quality.
- **Soil Erosion**—The protective covering provided by foliage and dead organic matter is removed, leaving the soil fully exposed to wind and water erosion. Accelerated soil erosion occurs, causing landslides and threatening aquatic habitats.
- **Spread of Invasive Plant Species**—Non-native woody plant species frequently invade burned areas. When weeds become established, they can dominate the plant cover over broad landscapes, and become difficult and costly to control.
- **Disease and Insect Infestations**—Unless diseased or insect-infested trees are swiftly removed, infestations and disease can spread to healthy forests and private lands. Timely active management actions are needed to remove diseased or infested trees.
- **Destroyed Endangered Species Habitat**—Catastrophic fires can have devastating consequences for endangered species.
- **Soil Sterilization**—Topsoil exposed to extreme heat can become water repellant, and soil nutrients may be lost. It can take decades or even centuries for ecosystems to recover from a fire. Some fires burn so hot that they can sterilize the soil.

10.2.8 Vulnerability

Structures, aboveground infrastructure, critical facilities, and natural environments are all vulnerable to the wildfire hazard. No validated damage function is currently available to support wildfire mitigation planning. Except as discussed in this section, vulnerable populations, property, infrastructure and environment are assumed to be the same as described in the section on exposure.

Population

There are no recorded incidents of loss of life from wildfires within the planning area (San Mateo County 2010). Given the immediate response times to reported fires, the likelihood of injuries and casualties is minimal; therefore, injuries and casualties were not estimated for the wildfire hazard.

Smoke and air pollution from wildfires can be a severe health hazard, especially for sensitive populations, including children, the elderly, and those with respiratory and cardiovascular diseases. Smoke generated by wildfire consists of visible and invisible emissions that contain particulate matter (soot, tar, water vapor, and minerals), gases (carbon monoxide, carbon dioxide, and nitrogen oxides), and toxics (formaldehyde and benzene). Emissions from wildfires depend on the type of fuel, the moisture content of the fuel, the efficiency (or temperature) of combustion, and the weather. Public health impacts associated with wildfire include difficulty in breathing, odor, and reduction in visibility.

Wildfire may also threaten the health and safety of those fighting the fires. First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke.

Property

Loss estimations for the wildfire hazard are not based on damage functions because no such damage functions have been generated. Instead, loss estimates were developed representing 10 percent, 30 percent and 50 percent of the total replacement value of exposed structures. This approach allows emergency managers to select a range of economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered substantial by most building codes and typically requires total reconstruction of the structure. Table 10-10 lists the loss estimates for the general building stock for assets in jurisdictions that have an exposure to a fire hazard severity zone.

TABLE 10-10. LOSS ESTIMATES FOR WILDFIRE

		Estimated Loss Potential from Wildfire		
	Exposed Value[a]	10% Damage	30% Damage	50% Damage
Atherton	$0	$0.0	$0.0	$0.0
Belmont	$1,228,258,997	$122,825,899.7	$368,477,699.0	$614,129,498.4
Brisbane	$27,937,913	$2,793,791.3	$8,381,373.8	$13,968,956.3
Burlingame	$0	$0.0	$0.0	$0.0
Colma	$0	$0.0	$0.0	$0.0
Daly City	$0	$0.0	$0.0	$0.0
East Palo Alto	$0	$0.0	$0.0	$0.0
Foster City	$0	$0.0	$0.0	$0.0
Half Moon Bay	$63,924,916	$6,392,491.6	$19,177,474.7	$31,962,457.8
Hillsborough	$1,490,756,300	$149,075,630.0	$447,226,890.1	$745,378,150.1
Menlo Park	$0	$0.0	$0.0	$0.0
Millbrae	$0	$0.0	$0.0	$0.0
Pacifica	$135,094,333	$13,509,433.3	$40,528,299.8	$67,547,166.3
Portola Valley	$0	$0.0	$0.0	$0.0
Redwood City	$1,637,040,347	$163,704,034.7	$491,112,104.0	$818,520,173.3
San Bruno	$0	$0.0	$0.0	$0.0
San Carlos	$1,674,320,986	$167,432,098.6	$502,296,295.7	$837,160,492.9
San Mateo	$932,333,655	$93,233,365.5	$279,700,096.6	$466,166,827.6
South San Francisco	$0	$0.0	$0.0	$0.0
Woodside	$244,544,520	$24,454,452.0	$73,363,356.0	$122,272,260.0
Unincorporated	$12,756,680,390	$1,275,668,039.0	$3,827,004,117.0	$6,378,340,195.0
Total	$20,190,892,357.00	$2,019,089,235.70	$6,057,267,706.70	$10,095,446,177.70

a. Includes total exposed value from all severity zones: very high, high, moderate.
Note: Values shown are accurate only for comparison among results in this plan. See Section **Error! Reference source not found.** for a discussion of data limitations.

Critical Facilities and Infrastructure

Critical facilities of wood frame construction are especially vulnerable during wildfire events. In the event of wildfire, there would likely be little damage to most infrastructure. Most roads and railroads would be without damage except in the worst scenarios. Power lines are the most at risk from wildfire because most poles are made of wood and susceptible to burning. Fires can create conditions that block or prevent access and can isolate residents and emergency service providers. Wildfire typically does not have a major direct impact on bridges, but it can create conditions that obstruct bridges. Many bridges in areas of high to moderate fire risk are important because they provide the only ingress and egress to large areas and in some cases to isolated neighborhoods.

Environment

The environment vulnerable to wildfires is the same as the environment exposed to the hazard. A wildfire event can alter the landscape, although it primarily damages or destroys vegetation and wildlife habitats. Wildfires also have beneficial natural functions, including removal of invasive plants, renewal of nutrients in soil, pest control, and the potential to create new habitats. When managed successfully, wildfires promote biological diversity and healthy ecosystems (Pacific Biodiversity Institute 2016).

Parks and recreational areas in San Mateo County have greater vulnerability to wildfires than do more developed regions. San Bruno Mountain Park, a landmark of local and regional significance, is one of the more noteworthy of this type of area. It stands as an open-space island amid the peninsula’s urban northern end of the Santa Cruz Mountain Range. Its ridgeline has numerous slopes exceeding 50 percent and elevations from 250 feet to over 1,300 feet. Fourteen species of rare or endangered plants, along with numerous endangered and threatened butterflies, make their home on San Bruno Mountain. The San Bruno Mountain State and County Park Master Plan, last updated in 2001, recommends development of a fire management plan to cover fire management policies and procedures, public education, reduction of the existing heavy fuel load, and how to best utilize fire for the enhancement of endangered species’ habitats (San Mateo County 2001).

Economic Impact

Wildfires are typically assumed to only have negative economic impacts; however, this assumption is not quite accurate, based on a research project conducted by the University of Oregon’s Ecosystem Workforce Program. Fires have significant negative economic impacts, including the disruption of the daily lives of employees and employers and instability in local labor markets. Even so, fires can also have some positive impacts, as countywide employment and wages increase in some sectors during wildfires, reducing the negative effect of short-term employment disruption.

Fire management also involves increased spending in wages, supplies, and living resources for firefighters. In 2012, the U.S. Forest Service contributed an average of 6 percent of its funding per county to counties where large wildfires occurred. Although such spending does not completely offset the economic losses from severe wildfires, it does help mitigate the extent of the losses. Even with this benefit in mind, fire suppression funds and wildfires themselves still contribute to longer-term economic instability in local markets, amplification of seasonal “ups and downs,” and reduction in tourism and natural resource economic sector earnings (University of Oregon 2012).

10.2.9 Future Trends in Development

Highly urbanized portions of the planning area have little or no exposure to wildfire risk. Urbanization tends to alter the natural fire regime and can create the potential for the expansion of urbanized areas into wildland areas. The expansion of the WUI can be managed with strong land use and building codes. The planning area is well equipped with these tools, and this planning process has asked each planning partner to assess its capabilities with regards to the tools. As San Mateo County experiences future growth, it is anticipated that the exposure to this hazard will remain as assessed or even decrease over time due to these capabilities.

Additionally, SB 1241, mentioned earlier in this profile, requires the legislative body of a county or city "to adopt a comprehensive, long-term general plan that includes various elements, including, among others, a safety element for the protection of the community from unreasonable risks associated with, among other things, wildland and urban fires. The safety element includes requirements for state responsibility areas, as defined, and very high fire hazard severity zones, as defined" (California Legislative Information 2012). This requirement ensures that every planning partner will continue to incorporate fire management planning and preventative measures into their community development and growth management practices.

TABLE 10-11. MODERATE WILDFIRE RISK – FUTURE LAND USE EXPOSURE

Jurisdiction	Agriculture/Resource Extraction		Commercial		Education		Industrial		Mixed Use		Other/Unknown		Parks/Open Space		Residential		Water		Total
	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)
ATHERTON	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
BELMONT	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
BRISBANE	64.7	44.93%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	79.3	55.07%	0.0	0.00%	0.0	0.00%	**143.9**
BURLINGAME	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	48.24%	0.0	51.22%	0.0	0.54%	0.0	0.00%	**0.1**
COLMA	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
DALY CITY	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
EAST PALO ALTO	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
FOSTER CITY	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
HALF MOON BAY	0.1	63.80%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	28.64%	0.0	7.57%	0.0	0.00%	0.0	0.00%	**0.1**
HILLSBOROUGH	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	8.4	90.13%	0.9	9.54%	0.0	0.33%	0.0	0.00%	**9.3**
MENLO PARK	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
MILLBRAE	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	34.50%	0.0	65.50%	0.0	0.00%	0.0	0.00%	**0.0**
PACIFICA	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
PORTOLA VALLEY	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	1.0	100.00%	0.0	0.00%	0.0	0.00%	**1.0**
REDWOOD CITY	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	100.00%	0.0	0.00%	0.0	0.00%	**0.0**
SAN BRUNO	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.2	99.20%	0.0	0.49%	0.0	0.31%	0.0	0.00%	**0.2**
SAN CARLOS	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
SAN MATEO	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
SOUTH SAN FRANCISCO	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.1	65.24%	0.0	33.21%	0.0	1.55%	0.0	0.00%	**0.1**
WOODSIDE	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.03%	0.0	1.70%	0.5	76.24%	0.2	22.04%	0.0	0.00%	**0.7**
UNINCORPORATED	29,900.8	62.53%	9.2	0.02%	0.3	0.00%	0.0	0.00%	243.1	0.51%	212.5	0.44%	17,092.0	35.74%	359.8	0.75%	0.0	0.00%	**47,817.8**
Total	**29,965.6**	**62.46%**	**9.2**	**0.02%**	**0.3**	**0.00%**	**0.0**	**0.00%**	**243.1**	**0.51%**	**221.2**	**0.46%**	**17,173.8**	**35.80%**	**360.0**	**0.75%**	**0.0**	**0.00%**	**47,973.2**

TABLE 10-12. HIGH WILDFIRE RISK – FUTURE LAND USE EXPOSURE

Jurisdiction	Agriculture/Resource Extraction		Commercial		Education		Industrial		Mixed Use		Other/Unknown		Parks/Open Space		Residential		Water		Total
	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)
ATHERTON	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	100.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	**0.0**
BELMONT	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.2	97.80%	0.0	0.37%	0.0	1.84%	0.0	0.00%	**0.2**
BRISBANE	10.9	11.07%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.7	0.71%	87.1	88.22%	0.0	0.00%	0.0	0.00%	**98.7**
BURLINGAME	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	33.34%	0.1	66.66%	0.0	0.00%	0.0	0.00%	**0.1**
COLMA	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	100.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	**0.0**
DALY CITY	0.0	0.00%	0.0	0.00%	0.1	1.76%	0.0	0.00%	0.0	0.00%	3.6	53.68%	3.0	44.54%	0.0	0.01%	0.0	0.00%	**6.7**
EAST PALO ALTO	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
FOSTER CITY	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
HALF MOON BAY	0.0	0.13%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.1	67.25%	0.0	21.00%	0.0	11.62%	0.0	0.00%	**0.2**
HILLSBOROUGH	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.8	32.03%	1.7	67.97%	0.0	0.00%	0.0	0.00%	**2.5**
MENLO PARK	0.0	0.00%	0.6	10.46%	0.0	0.00%	0.0	0.00%	4.6	77.90%	0.2	2.90%	0.5	8.74%	0.0	0.00%	0.0	0.00%	**6.0**
MILLBRAE	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	1.0	68.76%	0.5	31.24%	0.0	0.00%	0.0	0.00%	**1.4**
PACIFICA	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.1	100.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	**0.1**
PORTOLA VALLEY	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.5	9.62%	2.0	34.95%	3.1	55.43%	0.0	0.00%	**5.7**
REDWOOD CITY	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	74.12%	0.0	25.88%	0.0	0.00%	0.0	0.00%	**0.0**
SAN BRUNO	0.0	0.00%	0.0	35.03%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	4.61%	0.0	59.88%	0.0	0.48%	0.0	0.00%	**0.1**
SAN CARLOS	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	46.14%	0.0	51.82%	0.0	2.03%	0.0	0.00%	**0.0**
SAN MATEO	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
SOUTH SAN FRANCISCO	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.1	36.89%	0.1	33.46%	0.1	29.64%	0.0	0.00%	**0.2**
WOODSIDE	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.2	34.02%	0.3	54.15%	0.0	0.00%	0.1	11.82%	0.0	0.00%	**0.6**
UNINCORPORATED	42,094.3	45.13%	3.6	0.00%	33.0	0.04%	0.0	0.00%	2,368.0	2.54%	1,281.5	1.37%	46,438.5	49.78%	1,064.1	1.14%	0.0	0.00%	**93,282.9**
Total	**42,105.3**	**45.08%**	**4.2**	**0.00%**	**33.1**	**0.04%**	**0.0**	**0.00%**	**2,372.8**	**2.54%**	**1,289.1**	**1.38%**	**46,533.4**	**49.82%**	**1,067.4**	**1.14%**	**0.0**	**0.00%**	**93,405.3**

TABLE 10-13. VERY HIGH WILDFIRE RISK – FUTURE LAND USE EXPOSURE

Jurisdiction	Agriculture/Resource Extraction		Commercial		Education		Industrial		Mixed Use		Other/Unknown		Parks/Open Space		Residential		Water		Total
	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)
ATHERTON	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
BELMONT	0.0	0.00%	21.3	2.74%	40.7	5.26%	0.0	0.00%	0.0	0.00%	29.2	3.76%	212.0	27.37%	468.2	60.45%	3.2	0.42%	**774.5**
BRISBANE	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
BURLINGAME	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	43.29%	0.0	56.71%	0.0	0.00%	0.0	0.00%	**0.0**
COLMA	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
DALY CITY	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
EAST PALO ALTO	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
FOSTER CITY	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
HALF MOON BAY	112.9	14.09%	0.0	0.00%	1.0	0.12%	5.3	0.67%	0.0	0.00%	95.4	11.91%	572.6	71.47%	13.9	1.74%	0.0	0.00%	**801.2**
HILLSBOROUGH	0.0	0.00%	0.0	0.00%	2.9	0.20%	0.0	0.00%	0.0	0.00%	151.2	10.45%	132.6	9.16%	1,160.4	80.19%	0.0	0.00%	**1,447.1**
MENLO PARK	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
MILLBRAE	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	27.65%	0.1	72.35%	0.0	0.00%	0.0	0.00%	**0.1**
PACIFICA	0.0	0.00%	0.0	0.00%	0.1	1.70%	0.0	0.00%	0.0	0.00%	2.0	63.94%	0.5	17.04%	0.5	17.32%	0.0	0.00%	**3.1**
PORTOLA VALLEY	0.0	0.00%	0.0	0.00%	2.2	0.65%	0.0	0.00%	0.0	0.00%	4.1	1.17%	15.6	4.50%	325.7	93.68%	0.0	0.00%	**347.6**
REDWOOD CITY	0.0	0.00%	2.8	0.38%	0.0	0.00%	0.0	0.00%	0.0	0.00%	122.9	16.60%	199.5	26.96%	414.8	56.06%	0.0	0.00%	**739.9**
SAN BRUNO	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
SAN CARLOS	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	19.2	1.92%	303.2	30.26%	679.5	67.82%	0.0	0.00%	**1,001.9**
SAN MATEO	0.0	0.00%	13.9	4.92%	83.5	29.61%	0.0	0.00%	0.0	0.00%	21.2	7.51%	5.5	1.93%	158.0	56.02%	0.0	0.00%	**282.1**
SOUTH SAN FRANCISCO	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	**0.0**
WOODSIDE	0.0	0.00%	5.8	0.20%	0.0	0.00%	0.0	0.00%	0.0	0.00%	43.0	1.46%	2,510.0	85.06%	392.0	13.29%	0.0	0.00%	**2,950.8**
UNINCORPORATED	12,583.5	31.32%	10.3	0.03%	51.6	0.13%	0.0	0.00%	0.0	0.00%	1,192.5	2.97%	24,214.8	60.27%	2,122.7	5.28%	0.0	0.00%	**40,175.4**
Total	**12,696.4**	**26.17%**	**54.0**	**0.11%**	**182.0**	**0.38%**	**5.3**	**0.01%**	**0.0**	**0.00%**	**1,680.7**	**3.46%**	**28,166.3**	**58.05%**	**5,735.8**	**11.82%**	**3.2**	**0.01%**	**48,523.7**

10.2.10 Scenario

A major conflagration in San Mateo County might begin with a wet spring, adding to fuels already present on the forest floor. Flashy fuels would build throughout the spring. The summer could see the onset of insect infestation. A dry summer could follow the wet spring, exacerbated by dry hot winds. Carelessness with combustible materials or a tossed lit cigarette, or a sudden lighting storm, could trigger a multitude of small, isolated fires.

The embers from these smaller fires could be carried miles by hot, dry winds. The deposition zone for these embers would be deep in the forests and interface zones. Fires that start in flat areas move slower, but wind still pushes them. It is not unusual for a wildfire pushed by wind to burn the ground fuel and later climb into the crown and reverse its track. This scenario is one of many ways that fires can escape containment, typically during periods when response capabilities are overwhelmed. These new small fires would most likely merge. Suppression resources would be redirected from protecting the natural resources to saving more remote subdivisions.

The worst-case scenario would be an event similar to the October 1991 Tunnel Fire in Alameda County, where the wildfire spreads to structures, leading to numerous deaths and injuries, hundreds of acres burned, and millions of dollars in property damage. Additionally, fire severity would be exacerbated if the event occurred during an active fire season, where resources are already spread thin. Firefighting teams would be exhausted or unavailable. Many federal assets would be responding to other fires that started earlier in the season. While local fire districts would be extremely useful in the urban interface areas, they have limited wildfire capabilities or experience, and they would have a difficult time responding to the ignition zones. Even though the existence and spread of the fire is known, it may not be possible to respond to it adequately, so an initially manageable fire can become out of control before resources are dispatched.

To further complicate the problem, heavy rains could follow, causing flooding and landslides and releasing tons of sediment into rivers, permanently changing floodplains and damaging sensitive habitat and riparian areas. Such a fire followed by rain could release millions of cubic yards of sediment into streams for years, creating new floodplains and changing existing ones. With the forests removed from the watershed, stream flows could easily double. Floods that could be expected every 50 years may occur every couple of years. With the streambeds unable to carry the increased discharge because of increased sediment, the floodplains and floodplain elevations would increase.

10.2.11 Issues

The major issues for wildfire are the following:

- Public education and outreach to people living in or near the fire hazard zones should include information about and assistance with mitigation actions such as defensible space and advance identification of evacuation routes and safe zones.
- Wildfires could cause landslides as a secondary natural hazard.
- Climate change could affect the wildfire hazard.

- Future growth into interface areas should continue to be managed.
- Area fire districts need to continue to train on wildland-urban interface events.
- Vegetation management activities—This issue would include enhancement through expansion of the target areas as well as additional resources.
- Regional consistency of higher building code standards such as residential sprinkler requirements and prohibitive combustible roof standards.
- Firefighters in remote and rural areas are faced with limited water supply and lack of hydrant taps. Rural areas are adapting to these conditions by developing a secondary water source. Areas that once were considered rural could become urban with incorporation and annexation, coupled with development
- Expand certifications and qualifications for fire department personnel.
- Ensure that all firefighters are trained in basic wildfire behavior, basic fire weather, and that all company officers and chief level officers are trained in the wildland command and strike team leader level.

Chapter 11.
Human-Caused Hazards

11.1 General Background

Although the DMA does not require an assessment of human-caused hazards, the Steering Committee officials decided to include human-caused hazards in this hazard mitigation plan for the following reasons:

- San Mateo County takes a proactive approach to disaster preparedness, especially in an effort to protect the safety of all citizens.
- Preparation for and response to a human-caused disaster will involve many of the same staff training, critical decisions, and commitment of resources as a natural hazard.
- The multi-hazard mitigation planning effort is an opportunity to inform the public about all hazards, including human-caused hazards.
- The likelihood of a human-caused hazard in San Mateo County is greater than several of the identified natural hazards in this plan.

Human-caused hazards fall into the following categories:

- Manmade hazards include acts of terrorism, including the use of weapons of mass destruction and cyber threats. These hazards are intentional, criminal, malicious acts.
- Technological hazards are incidents that arise from human activities such as the manufacture, transportation, storage and use of hazardous materials; pipeline and tank releases; and airline incidents. These incidents are assumed to be accidental in nature, with unintended consequences.

DEFINITIONS

Distribution Pipeline— Pipeline systems designed to transport refined materials to the end user.

Malware— Malicious code designed to steal, ransom, conceal, or destroy information from vulnerable or infected computer or network systems.

Terrorism— The unlawful use or threatened use of force or violence against people or property, with the intention of intimidating or coercing societies or governments. Terrorism is either foreign or domestic, depending on the origin, base, and objectives of the terrorist or organization.

Technological Hazards— Hazards from accidents associated with human activities such as the manufacture, transportation, storage and use of hazardous materials.

Transmission Pipeline— Large diameter pipes designed to transport raw material from the point of excavation to refineries for processing.

Weapons of Mass Destruction— Chemical, biological, radiological, nuclear, and explosive weapons associated with terrorism.

Hazardous Material— A substance or combination of substances that because of their concentration, physical, chemical, or infectious characteristics, may cause or contribute to an increase in mortality or an increase in serious, irreversible, or incapacitating reversible illness, or pose a present or potential hazard to human life, property, or the environment.

11.1.1 Manmade Hazards

Terrorism

The Federal Bureau of Investigation (FBI) categorizes terrorism in the United States primarily as one of two types:

- Domestic terrorism involves groups or individuals whose terrorist activities are directed at elements of our government or population without foreign direction. The bombing of the Alfred P. Murrah federal building in Oklahoma City is an example of domestic terrorism. The FBI is the primary response agency for domestic terrorism. The FBI is the primary investigative agency for terrorism affecting the United States, while response to domestic terrorism remains a local responsibility. The FBI and the Department of Homeland Security (DHS) work together to coordinate domestic preparedness programs and activities of the United States to limit acts posed by terrorists including the use of weapons of mass destruction (WMDs).
- International terrorism involves groups or individuals whose terrorist activities are foreign-based and/or directed by countries or groups outside the United States, or whose activities transcend national boundaries. Examples include the 1993 bombing of the World Trade Center, the 1983 U.S. Capitol and the attacks of September 11, 2001 at the World Trade Center and the Pentagon.

The three key elements to defining a terrorist event are as follows:

- Activities involve the use of illegal force.
- Actions are intended to intimidate or coerce.
- Actions are committed in support of political or social objectives.

At least three important considerations distinguish terrorism hazards from other types of hazards:

- In the case of chemical, biological, and radioactive agents, their presence may not be immediately obvious, making it difficult to determine when and where they may have been released, who has been exposed, and what danger is present for first responders and emergency medical technicians.
- There is limited scientific understanding of how these agents affect the population at large.
- Terrorism evokes very strong emotional reactions including anxiety, fear, anger, despair, and depression.

Those involved with terrorism response, including public health and public information staff, are trained to deal with the public's emotional reaction swiftly as response to the event occurs. The area of the event must be clearly identified in all emergency alert messages, to prevent those not affected by the incident from overwhelming local emergency rooms and response resources therefore reducing service to those actually affected. The public will be informed clearly and frequently about what government agencies are doing to mitigate the impacts of the event. The public will also be given clear directions on how to protect the health of individuals and families.

According to Federal Emergency Management Agency (FEMA) 386-7, terrorism refers to the use of weapons of mass destruction, including biological, chemical, nuclear and radiological weapons; arson, incendiary, explosive and armed attacks; industrial sabotage and intentional hazardous materials releases; agro-terrorism; and cyberterrorism (detailed in the Cyber Threats section below). The following are potential methods used by terrorists that could affect the County of San Mateo as a direct target or collaterally:

- Conventional explosive
- Biological agent
- Chemical agent
- Nuclear bomb
- Radiological agent
- Arson/incendiary attack
- Armed attack
- Cyberterrorism (described in the Cyber Threats section)
- Agro-terrorism
- Intentional hazardous material release.

Table 11-1 provides a hazard profile summary for terrorism-related hazards. For each type of hazard, the following factors are addressed:

- **Application Mode**—Application mode describes the human acts or unintended events necessary to cause the hazard to occur.
- **Duration**—Duration is the length of time the hazard is present. For example, the duration of a tornado may be just minutes, but a chemical warfare agent such as mustard gas, if un-remediated, can persist for hours or weeks under the right conditions.
- **Dynamic or Static Characteristics**—Dynamic or static characteristics of a hazard describe its tendency, or that of its effects, to either expand, contract, or remain confined in time, magnitude, and space. For example, the physical destruction caused by an earthquake is generally confined to the place in which it occurs, and it does not usually get worse unless aftershocks or other cascading failures occur; in contrast, a cloud of chlorine gas leaking from a storage tank can change location by drifting with the wind and can diminish in danger by dissipating over time.
- **Mitigating and Exacerbating Conditions**—Mitigating conditions are characteristics of the target and its physical environment that can reduce the effects of a hazard. For example, earthen berms can provide protection from bombs; exposure to sunlight can render some biological agents ineffective; and effective perimeter lighting and surveillance can minimize the likelihood of someone approaching a target unseen. In contrast, exacerbating conditions are characteristics that can enhance or magnify the effects of a hazard. For example, depressions or low areas in terrain can trap heavy vapors, and a proliferation of street furniture (trash receptacles, newspaper vending machines, mail boxes, etc.) can provide hiding places for explosive devices.

Most terrorist events in the United States have been bombing attacks, involving detonated and undetonated explosive devices, tear gas, pipe bombs, and fire bombs. The effects of terrorism can vary from loss of life and injuries to property damage and disruptions in services such as electricity, water supplies, transportation, or communications. Any of the methods above may have an immediate effect or a delayed effect. Terrorists often choose targets that offer limited danger to themselves and areas with relatively easy public access. Foreign terrorists look for visible targets where they can avoid detection before and after an attack such as international airports, large cities, major special events, and high-profile landmarks.

In dealing with intentional human-caused hazards, the unpredictability of human beings must be considered. People with a desire to perform criminal acts may seek out targets of opportunity that may not fall into established lists of critical areas or facilities. First responders train not only to respond to organized terrorism events, but also to random acts by individuals who, for a variety of reasons ranging from fear to emotional trauma to mental instability, may choose to harm others and destroy property.

While education, heightened awareness, and early warning of unusual circumstances may deter crime and terrorism, intentional acts that harm people and property are possible at any time. Public safety entities would then react to the threat, locating, isolating, and neutralizing further damage, and investigating potential scenes and suspects to bring criminals to justice.

TABLE 11-1. EVENT PROFILES FOR TERRORISM

Hazard	Application Mode	Hazard Duration	Static/Dynamic Characteristics	Mitigating and Exacerbating Conditions
Conventional Bomb	Detonation of explosive device on or near target; delivery via person, vehicle, or projectile.	Instantaneous; additional "secondary devices, and/or diversionary activities may be used, lengthening the duration of the hazard until the attack site is determined to be clear.	Extent of damage is determined by type and quantity of explosive. Effects generally static other than cascading consequences, incremental structural failure, etc.	Overpressure at a given standoff is inversely proportional to the cube of the distance from the blast; thus, each additional increment of standoff provides progressively more protection. Terrain, forestation, structures, etc. can provide shielding by absorbing and/or deflecting energy and debris. Exacerbating conditions include ease of access to target; lack of barriers and shielding; poor construction; and ease of concealment of device.
Chemical Agent	Liquid and aerosol contaminants can be dispersed using sprayers or other aerosol generators; liquids vaporizing from puddles and containers; or munitions.	Chemical agents may pose viable threats for hours to weeks depending on the agent and the conditions in which it exists.	Contamination can be carried out of the initial target area by persons, vehicles, water, and wind. Chemicals may be corrosive or otherwise damaging over time if not remediated.	Air temperature can affect evaporation of aerosols. Ground temperature affects evaporation of liquids. Humidity can enlarge aerosol particles, reducing inhalation hazard. Precipitation can dilute and disperse agents but can spread contamination. Wind can disperse vapors but also cause target area to be dynamic. The micro-meteorological effects of buildings and terrain can alter travel and duration of agents. Shielding in the form of sheltering in place can protect people and property from harmful effects.

TABLE 11-1. EVENT PROFILES FOR TERRORISM

Hazard	Application Mode	Hazard Duration	Static/Dynamic Characteristics	Mitigating and Exacerbating Conditions
Arson or Incendiary Attack	Initiation of fire or explosion on or near target via direct contact, or remotely via projectile.	Generally minutes to hours.	Extent of damage is determined by type and quantity of device, accelerant, and materials present at or near target. Effects generally static other than cascading consequences, incremental structural failure, etc.	Mitigating factors include built-in fire detection and protection systems, and fire-resistive construction techniques. Inadequate security can allow easy access to target, easy concealment of an incendiary device, and undetected initiation of a fire. Non-compliance with fire and building codes, as well as failure to maintain existing fire protection systems can substantially increase the effectiveness of a fire weapon.
Armed Attack	Tactical assault or sniping from remote location, or random attack based on fear, emotion, or mental instability.	Generally minutes to days.	Varies based on the perpetrators' intent and capabilities.	Inadequate security can allow easy access to target, easy concealment of weapons, and undetected initiation of an attack.
Biological Agent	Liquid or solid contaminants can be dispersed using sprayers or aerosol generators, or by point or line sources such as munitions, covert deposits, and moving sprayers.	Biological agents may pose viable threats for hours to years depending on the agent and the conditions in which it exists.	Depending on the agent used and the effectiveness with which it is deployed, contamination can be spread via wind and water. Infection can spread via human or animal vectors.	Altitude of release aboveground can affect dispersion; sunlight is destructive to many bacteria and viruses; light to moderate wind will disperse agents but higher winds can break up aerosol clouds; the micro-meteorological effects of buildings and terrain can influence aerosolization and travel of agents.
Agro-terrorism	Direct, generally covert contamination of food supplies or introduction of pests and/or disease agents to crops and livestock.	Days to months.	Varies by type of incident. Food contamination events may be limited to specific distribution sites, whereas pests and diseases may spread widely. Generally no effects on built environment.	Inadequate security can facilitate adulteration of food and introduction of pests and disease agents to crops and livestock.

TABLE 11-1. EVENT PROFILES FOR TERRORISM

Hazard	Application Mode	Hazard Duration	Static/Dynamic Characteristics	Mitigating and Exacerbating Conditions
Radiological Agent	Radioactive contaminants can be dispersed using sprayers or aerosol generators, or by point or line sources such as munitions.	Contaminants may remain hazardous for seconds to years depending on material used.	Initial effects will be localized to site of attack; depending on meteorological conditions, subsequent behavior of radioactive contaminants may be dynamic.	Duration of exposure, distance from source of radiation, and the amount of shielding between source and target determine exposure to radiation.
Nuclear Bomb	Detonation of nuclear device underground, at the surface, in the air, or at high altitude.	Light/heat flash and blast/shock wave last for seconds; nuclear radiation and fallout hazards can persist for years. Electromagnetic pulse from a high-altitude detonation lasts for seconds and affects only unprotected electronic systems.	Initial light, heat, and blast effects of a subsurface, ground, or air burst are static and determined by the device's characteristics and employment; fallout of radioactive contaminants may be dynamic, depending on meteorological conditions.	Harmful effects of radiation can be reduced by minimizing the time of exposure. Light, heat, and blast energy decrease logarithmically as a function of distance from seat of blast. Terrain, forestation, structures, etc. can provide shielding by absorbing and/or deflecting radiation and radioactive contaminants.
Intentional Hazardous Material Release (fixed facility or transportation)	Solid, liquid, and/or gaseous contaminants may be released from fixed or mobile containers	Hours to days.	Chemicals may be corrosive or otherwise damaging over time. Explosion and/or fire may be subsequent. Contamination may be carried out of the incident area by persons, vehicles, water, and wind.	As with chemical weapons, weather conditions directly affect how the hazard develops. The micro-meteorological effects of buildings and terrain can alter travel and duration of agents. Shielding in the form of sheltering in place can protect people and property from harmful effects. Non-compliance with fire and building codes, as well as failure to maintain existing fire protection and containment features, can substantially increase the damage from a hazardous materials release.

Source: FEMA 386-7

Cyber Threats

As information technology continues to flourish and grow in capability and interconnectivity, cyber threats become increasingly frequent and destructive. In 2014, internet security teams at Symantec and Verizon indicated that nearly 1 million new pieces of malware – malicious code designed to steal or destroy information

– were created every day (Harrison 2015). The San Mateo Steering Committee identified two separate types of cyber threats that may occur within the Planning Area: cyberattacks and cyberterrorism.

Cybercrime

Computer systems on the county, local, and individual level are likely to experience a variety of cybercrime, from malware to targeted attacks on system capabilities. These cybercrime attacks specifically seek to breach information technology (IT) security measures designed to protect an individual or organization. The initial attack is subsequently followed by further, more severe attacks for the purpose of causing harm or stealing data. Organizations are prone to a multitude of different types of attacks.

Table 11-2 describes the most frequent cyberattack mechanisms faced by organizations today.

TABLE 11-2. COMMON CYBERATTACK MECHANISMS

Type	Description
Socially Engineered Trojans	Programs designed to mimic legitimate processes (e.g. updating software, running fake antivirus software) with the end goal of human-interaction caused infection. When the victim runs the fake process, the Trojan is installed on the system.
Unpatched Software	Nearly all software has weak points that may be exploited by malware. Most common software exploitations occur with Java, Adobe Reader, and Adobe Flash. These vulnerabilities are often exploited as small amounts of malicious code are often downloaded via drive-by download.
Phishing	Malicious email messages that ask users to click a link or download a program. Phishing attacks may appear as legitimate emails from trusted third parties.
Password Attacks	Third party attempts to crack a user's password and subsequently gain access to a system. Password attacks do not typically require malware, but rather stem from software applications on the attacker's system. These applications may use a variety of methods to gain access, including generating large numbers of generated guesses, or dictionary attacks, in which passwords are systematically tested against all of the words in a dictionary.
Drive-by Downloads	Malware is downloaded unknowingly by the victims when they visit an infected site.
Denial of Service Attacks	Attacks that focus on disrupting service to a network in which attackers send high volumes of data until the network becomes overloaded and can no longer function.
Man in the Middle (MITM)	MITM attacks mirror victims and endpoints for online information exchange. In this type of attack, the MITM communicates with the victim who believes is interacting with the legitimate endpoint website. The MITM is also communicating with the actual endpoint website by impersonating the victim. As the process goes through, the MITM obtains entered and received information from both the victim and endpoint.
Malvertising	Malware downloaded to a system when the victim clicks on an affected ad.
Advanced Persistent Threat (APT)	An attack in which the attacker gains access to a network and remains undetected. APT attacks are designed to steal data instead of cause damage.

Since 2013, a new type of cyberattack is becoming increasingly common against individuals and small- and medium-sized organizations. This attack is called cyber ransom. Cyber ransom occurs when an individual downloads ransom malware, or ransomware, often through phishing or drive-by download, and the subsequent execution of code results in encryption of all data and personal files locally stored on the system. The victim then receives a message that demands a fee in the form of electronic currency, such as BitCoin, for the decryption code (Figure 11-1). With millions of threats created each day, the importance of protection against cyberattacks becomes a necessary function of everyday operations for individuals, government, and businesses located in San Mateo County. The increasing dependency on technology for vital information storage and the often automated method of infection means higher stakes for protection and education.

Cyberterrorism

FIGURE 11-1. POP-UP MESSAGE INDICATING RANSOMWARE INFECTION

Cyberterrorism is the use of existing computers and information, particularly over the internet, to recruit others to an organization's cause, cause physical or financial harm, or cause a severe disruption of infrastructure service. The motive behind such disruptions can be driven by religious, political, or other objectives. Similar to traditional terrorism tactics, cyberterrorism's purpose is to evoke very strong emotional reactions such as anxiety, fear, anger, despair, depression, or even sympathy as a recruitment tool for an organization. However, the mechanism for achieving these goals are through IT and not necessarily a tangible violent or physically disruptive action.

The purpose of cyberterrorism can be broken out into three main objectives: organizational, undermining, and destructiveness. Each objective indicates a use of IT for a specific purpose (Kostadinov 2012).

As an **organizational** objective, cyberterrorism includes specific functions outside of or in addition to a typical cyberattack. Terrorist groups today use the internet on a daily basis. This daily use may include recruitment, training, fundraising, communication, or planning. Organizational cyberterrorism can use platforms such as social media, as a tool to spread a message beyond country borders and instigate physical forms of terrorism. Additionally, organizational goals may use systematic attacks as a tool for training new members of a faction in cyber warfare.

Undermining as an objective seeks to achieve the hindrance of normal functioning computer systems, services, or websites. Such methods include defacing, denying, and exposing information. While undermining tactics are typically used due to high dependence on online structures to support vital operational functions, they typically do not result in grave consequences unless undertaken as part of a larger attack.

Three kinds of undermining attacks that can be conducted on computers include attacks of physical means, electronic means, and attacks using malicious code (Waldron 2011). Specifically, these types of attacks include:

- Directing conventional kinetic weapons against computer equipment, a computer facility, or transmission lines to create a physical attack that disrupts the reliability of equipment.
- The power of electromagnetic energy, most commonly in the form of an electromagnetic pulse (EMP), can be used to create an electronic attack (EA) directed against computer equipment or data transmissions. By overheating circuitry or jamming communications, an EA disrupts the reliability of equipment and the integrity of data.
- Malicious code can be used to create a cyberattack, or computer network attack (CNA), directed against computer processing code, instruction logic, or data. The code can generate a stream of malicious network packets that can disrupt data or logic through exploiting vulnerability in computer software, or a weakness in the computer security practices of an organization. This type of cyberattack can disrupt the reliability of equipment, the integrity of data, and the confidentiality of communications (Wilson 2008).

The **destructive** objective for cyberterrorism is what organizations fear most. Through the use of computer technology and the internet, terrorists seek to inflict destruction or damage on tangible property or assets, and even death or injury to individuals. There are no cases of pure cyberterrorism as of the date of this plan.

11.1.2 Technological Hazards

Technological hazards are associated with human activities such as the manufacture, transportation, storage and use of hazardous materials. Incidents related to these hazards are assumed to be accidental with unintended consequences. Technological hazards in San Mateo County can be categorized as follows:

- Hazardous materials incidents
- Pipeline and tank incidents
- Aircraft accidents.

Hazardous Materials Incidents

Hazardous materials are substances that are considered severely harmful to human health and the environment, as defined by the United States Environmental Protection Agency (USEPA) Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (commonly known as Superfund).

Many hazardous materials are commonly used substances which are harmless in their normal uses, but are quite dangerous if released. The United States Environmental Protection Agency (USEPA) designates more than 800 substances as hazardous and identifies many more as potentially hazardous due to their characteristics and the circumstances of their release (USEPA 2013).

If released or misused, hazardous substances can cause death, serious injury, long-lasting health effects, and damage to structures, other properties, and the environment. Many products containing hazardous substances are used and stored in homes and these products are shipped daily on highways, railroads, waterways, and pipelines.

The following are the most common types of hazardous material incidents:

- **Fixed-Facility Hazardous Materials Incident**—This is the uncontrolled release of materials from a fixed site capable of posing a risk to health, safety, and property as determined by the Resource and Conservation and Recovery Act. It is possible to identify and prepare for a fixed-facility incident because federal and state laws require those facilities to notify state and local authorities about what is being used or produced at the site.
- **Hazardous Materials Transportation Incident**—A hazardous materials transportation incident is any event resulting in uncontrolled release of materials during transport that can pose a risk to health, safety, and property as defined by Department of Transportation Materials Transport regulations. Transportation incidents are difficult to prepare for because there is little if any notice about what materials could be involved should an accident happen. Hazardous materials transportation incidents can occur at any place within the country, although most occur on the interstate highways or major federal or state highways, or on the major rail lines.

Pipeline and Tank Hazards

Transmission and distribution pipelines provide two differing services. Transmission pipelines transport raw material for further refinement. These pipes are large and far reaching, operating under high pressure. Distribution pipelines provide the processed materials to the end user. These are smaller in diameter, some as small as a half an inch, and operate under lower pressure.

Although pipelines are the safest and most reliable way to transport natural gas, crude oil, liquid petroleum products, and chemical products, there is still an inherent risk due to the nature of the hazardous materials. Pipelines are regulated by the Office of the State Fire Marshall Pipeline Safety Division. Pipelines are also monitored by a complex data web called System Control and Data Acquisition (SCADA), measuring the flow rate, temperature and pressure. The network transfers real-time data via satellite from the pipelines to a control center where the valves, pumps, and motors are remotely operated. If tampering with the pipeline occurs, an alarm sounds. The ensuing valve reaction is instantaneous, with the alarm system isolating any rupture and setting off a chain reaction that shuts down pipeline pumps and alerts pipeline operators within seconds.

Pipeline failure incidents, both distribution and transmission, can occur when pipes corrode, are damaged during excavation, incorrectly operated, or damaged by other forces. More serious accidents occur on distribution pipelines than on any other type due to their sheer number, intricate networking system, and location in highly populated areas.

Tank hazards, both above and below ground, have potential to cause immense damage due to the large quantities of concentrated hazardous materials in a single location. Potential results of an event involving a tank release include fire, explosion, and exposure to toxic substances.

Aviation Accidents

Aviation accidents can occur for numerous reasons including mechanical failure, poor weather conditions, and pilot error. They are defined as an occurrence associated with the operation of an aircraft which takes place between the time a person boards the aircraft with the intention of flight, to the time the person has disembarked the aircraft. There are three different occurrences that determine an aviation accident: a person is fatally or seriously injured; the aircraft sustains damage or structural failure; or the aircraft is missing or completely inaccessible. An aviation incident is an occurrence, other than an accident, associated with the operation of an aircraft which affects or could affect the safety of operation (International Civil Aviation Organization, 2001).

Aviation accidents are often devastating incidents that may result in serious injuries or fatalities. The Federal Aviation Administration (FAA) and the National Transportation Safety Board (NTSB) are the agencies responsible for monitoring air travel and investigating accidents. Some of the most common causes of aviation accidents occur as a result of violating FAA and NTSB regulations. Some other causes of accidents include, but are not limited to:

- **Pilot or flight crew errors** – Pilot errors are the number one cause of aviation accidents and account for the highest number of fatalities. Pilots have the responsibility to transport passengers safely from one place to another and follow FAA and NTSB regulations to better ensure passenger safety. If a pilot or flight crew makes an error, an accident may occur.
- **Faulty equipment** – Faulty aircraft equipment and/or mechanical features are another common cause of an aviation accident.
- **Aircraft design flaws** – The manufacturer of an aircraft is responsible for an aviation accident if the structural design is flawed and results in an accident.
- **Failure to properly fuel or maintain the aircraft** – If regulations and safety standards set by the FAA or NTSB are violated, an accident may occur.
- **Negligence of Federal Air Traffic Controllers (ATC)** – The failure of air traffic controllers to properly monitor the airways is another cause of aviation accidents.

11.2 Human-Caused Hazard Profile

11.2.1 Past Events

State of California

Manmade: Terrorism and Cyber Threat Events

According to the Governor's Office of Emergency Services Terrorism Response Plan, the State of California has had a long history of defending the public against domestic and foreign terrorists. Domestic terrorist groups in California have been focused on political or social issues, while the limited internationally based incidents have targeted the state's immigrant communities due to foreign disputes. Advanced technologies and communication have allowed these groups to become more sophisticated and better organized, with remote members linked electronically.

Technological: Hazardous Materials Release, Pipeline and Tank, and Aircraft Accidents

No comprehensive source was found for technological hazard incidents affecting the entire State of California. Technological events are typically regional or local in nature due to the limited reach of such events.

Regional

Manmade:

Terrorism Events

The Bay Area has not experienced a regional terrorism event. However, the 2016 hosting of Super Bowl 50 in Santa Clara County highlighted and increased the mainstream exposure of the Bay Area for potential future terrorist events.

Cyber Threats

In December 2015, University of California at Berkeley experienced a massive cyberattack that left upwards of 80,000 people exposed to cybercrime. As one of the largest employers in the Bay Area, this cyberattack reached beyond jurisdictional and county lines to affect the entire Bay Area (Bay City News, 2015).

Technological Hazard Incidents

Hazardous Materials Release

The Bay Area has not experienced a hazardous materials release event with a regional affect. Hazardous material releases are often localized due to the limited release of such events.

Pipeline or Tank Hazard

The Bay Area has not experienced a regional pipeline or tank hazard event. Pipeline or tank hazards are often localized due to the limited release of such events.

Aircraft Accidents

The Bay Area has not experienced an aircraft accident that caused widespread devastation throughout the region, such as the Aeromexico DC-9 airplane the collided with a private plane and crashed in a residential neighborhood in Cerritos, California. Aircraft accidents have been localized and somewhat contained.

Local

Manmade:

Terrorism Events

On August 24, 2009, a student at Hillsdale High School in the City of San Mateo intended to detonate multiple homemade bombs and murder fellow students. Security was alerted before the student was able to execute his plan.

From 1975–1977, the New World Liberation Front planned and executed multiple minor attacks in Belmont, Burlingame, Redwood City, the City of San Mateo, San Bruno, and Hillsborough. Successful attacks resulted in minor property damage with one reported injury in San Mateo.

In May 1972, left-wing militants injured one person during a bombing of MB Associates in Menlo Park.

Cyber Threats

On December 3, 2014, multiple Bay Area governments were shut down as a result of a global cyberattack. Burlingame and Belmont experienced website outages due to a denial of service attack on a San Francisco-based company that provided services for the affected jurisdictions.

Technological:

Hazardous Materials Release

Although hazardous material incidents can happen almost anywhere, certain areas are at higher risk. Jurisdictions near roadways that are frequently used for transporting hazardous materials and jurisdictions with industrial facilities that use, store, or dispose of such materials all have an increasing potential for major incidents, as do jurisdictions crossed by certain railways, waterways, airways and pipelines. Hazardous materials are transported through the County via highways and pipelines. Public facilities and numerous businesses located in the County store and use reportable quantities of hazardous materials. San Mateo County's level of exposure to hazardous materials can be understood by examining the County's types of businesses, commercial traffic routes, highway, and sea exposure.

CERCLA, Emergency Planning and Community Right-to-Know Act (EPCRA) and California law require responsible parties to report hazardous material releases if certain criteria is met. CERCLA requires that all releases of hazardous substances (including radionuclides) exceeding reportable quantities be reported by the responsible party to the National Response Center. If an accidental chemical release exceeds the EPCRA applicable minimal reportable quantity, the facility must notify State Emergency Response Commissions (SERCs) and Local Emergency Planning Committees (LEPCs) for any area likely to be affected by the release, and provide a detailed written follow-up as soon as practicable. Information about accidental chemical releases must be made available to the public. California Governor's Office of Emergency Services (Cal OES) Spill Release Archive Files contain spreadsheet files that list all spills reported to the Cal OES Warning Center for a specific year. In 2015, there were 108 reportable hazardous materials releases within San Mateo County. This year, through April 11, 2016, there have been 51 reportable hazardous materials releases so far, meeting the criteria that exceeds reportable quantities.

Pipeline

Pipelines owned and operated by various companies run beneath the County and City streets. Pipelines are primarily underground, which keeps them away from public contact and accidental damage, except where distribution pipelines meet their termination point for providing their source for public consumption. Despite safety and efficiency statistics, increases in energy consumption and population growth near pipelines present the potential for a pipeline emergency incident. While pipelines are generally the safest method of transporting hazardous chemicals, they are not fail-safe. Pipeline product releases, whether in the form of a slow leak or violent rupture, are a risk in any community.

The 2010 San Bruno pipeline explosion occurred on September 9, 2010, in San Bruno, California, killing eight people and causing more than $54 million in damage to homes and vehicles, with additional costs to rebuild San Bruno's streets, sewers, sidewalks and other infrastructure. A 30-inch diameter steel natural gas pipeline owned by Pacific Gas & Electric (PG&E) exploded into flames in the Crestmoor residential neighborhood, two miles west of San Francisco International Airport. In 2011, PG&E was subject to an exhaustive review of the pipelines' safety and approval for restoration of full pressure from the California Public Utilities Commission (CPUC). PG&E reduced the pipelines' pressure by about 20 percent as a precaution shortly after the natural gas accident in San Bruno. Since then, the utility has verified the safety of these pipelines through a robust program that includes pressure tests, records verification and visual pipeline inspections.

Aircraft

The San Francisco International Airport (SFO) is located in an unincorporated area of the County. According to the Airports Council International, SFO is the 5th busiest airport in the nation in terms of passenger volume and 13th busiest in cargo volume. Air traffic statistics for January of 2016 include 34,076 flights consisting of passenger carriers, air taxis, civil, and military planes. Statistics for 2015 include 34,172 carrier flights. In 2014, SFO was the 9th busiest airport in the United States based on the number of flight operations. On July 6, 2013, an Asiana Airlines Boeing 777 with more than 300 passengers and crew members on board crashed while landing at San Francisco International Airport. According to U.S. court filings, three people were killed and more than 180 were injured. Since the airport opened in 1927, there have been 14 airplane crashes at SFO.

11.2.2 Location

Manmade:

Terrorism

The State of California and Office of Homeland Security have identified numerous high-profile targets for potential terrorists in California. Large population centers, high-visibility tourist attractions, and critical infrastructure accessible to the public present security challenges of an ongoing nature in California. The network of highways, railways, ports, and airports used to transport significant amounts of hazardous materials poses a significant technological hazards threat. Multiple incidents may happen simultaneously, and all typically require a multi-agency, multi-jurisdictional response.

Cyber Threats

Possible cyberterrorist targets include the banking industry, power plants, air traffic control centers, and water systems; and especially facilities that rely on computers, computer systems, and programs for their operations.

Both public and private operations within San Mateo County are threatened on a near-daily basis by the millions of currently engineered cyberattacks developed to automatically seek technological vulnerabilities.

Technological:

Hazardous Materials Release

Fixed Site

Hazardous materials are stored before and after they are transported to their intended use. This may include service stations that store gasoline and diesel fuel in underground storage tanks (USTs); hospitals that store radioactive materials, flammable materials and other hazardous substances; or manufacturers, processors, distributors, and recycling plants for chemical industries which store a variety of chemicals on site (FEMA 2013).

For the purpose of this plan, fixed sites include buildings or property where hazardous materials are manufactured or stored, and are regulated under various programs by the USEPA.

The USEPA Toxic Substances Control Act of 1976 provides the USEPA with authority to require reporting, record-keeping and testing requirements, and restrictions relating to chemical substances and/or mixtures. Certain substances are generally excluded from TSCA, including among others, food, drugs, cosmetics, and pesticides. TSCA addresses the production, importation, use, and disposal of specific chemicals including polychlorinated biphenyls (PCBs), asbestos, radon, and lead-based paint. According to TSCA, one USEPA regulated facility is located in Redwood City.

In addition to TSCA facilities, facilities identified under the Resource Conservation and Recovery Act Information (RCRA Info) databases were also reviewed for this plan. Hazardous waste information is contained in RCRA Info, a national program management and inventory system about hazardous waste handlers. In general, entities that generate, transport, treat, store, and dispose of hazardous waste are required to provide information about their activities to state environmental agencies. These agencies pass on the information to regional and national USEPA offices. This regulation is governed by the Resource Conservation and Recovery Act (RCRA), as amended by the Hazardous and Solid Waste Amendments of 1984. There are over 1,500 RCRA facilities within San Mateo County.

Transportation

Incidents involving hazardous materials in transit can occur through a variety of vehicles in and around San Mateo County. The Planning Area hosts a variety of major transportation networks through which trains, aircraft, water vessels, and commercial trucks transporting hazardous materials travel daily.

Pipeline and Tank

Pipeline

Jet fuel is delivered via pipelines to SFO underground, and in populated areas. These pipelines must be over three feet below the asphalt, with pipes made of at least one-inch thick steel. If a pipe ruptures, valves would cut off and operators would receive an automatic alarm. Additionally, PG&E runs multiple natural gas transmission pipelines throughout the County, such as the one that exploded in 2010.

The U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) provides an interactive mapping tool for public awareness of major transmission pipelines that run through a user-defined geographical area. Figure 11-2 presents the pipeline query results for San Mateo County.

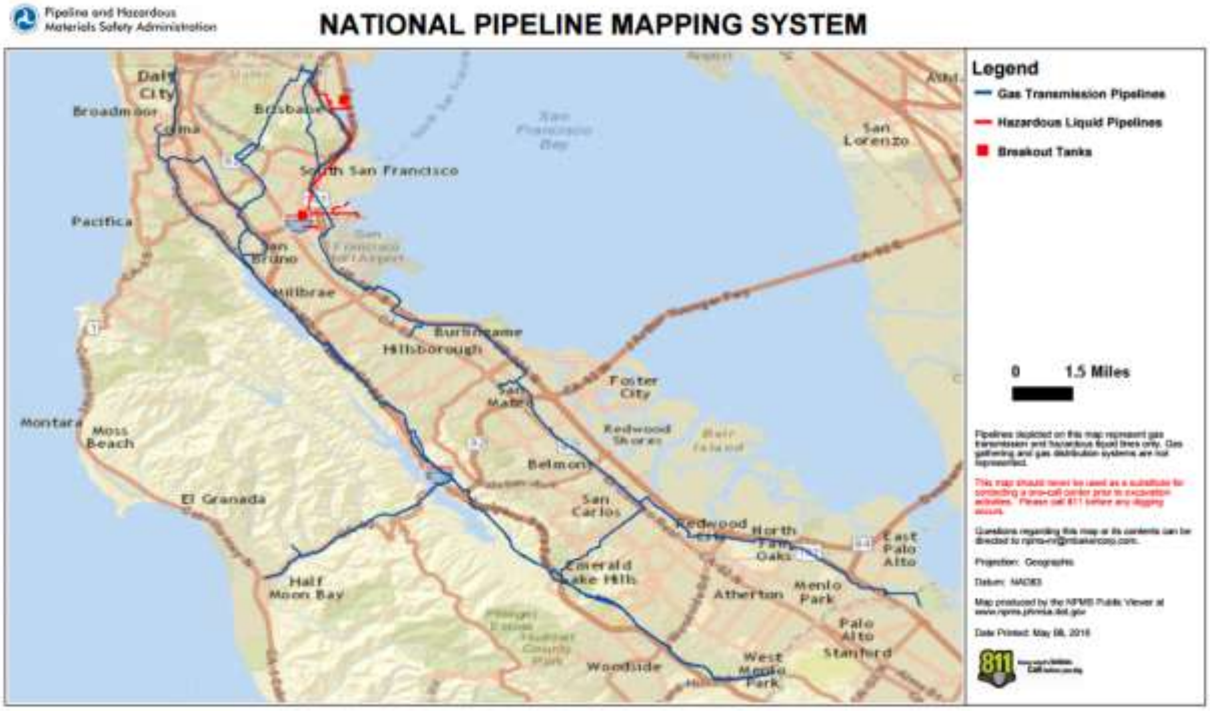


FIGURE 11-2. TRANSMISSION PIPELINES OF SAN MATEO COUNTY

Distribution pipelines run throughout highly populated areas for the purpose of providing refined materials for public use and consumption. Large distribution lines, called “mains,” move the gas close to cities. These main lines, along with the much smaller service lines that travel to homes and businesses, account for the vast majority of underground pipeline system.

Tank

Jet fuel to be used for planes at SFO is stored at SFO Fuel, an airline consortium which leases the SFO Fuel Tank Farm Facility at the SFO. The tank farm facility is operated by Chevron and includes seven above-ground storage tanks with a total capacity of nearly 15 million gallons. The largest tanks can hold up to approximately 90,000 barrels of jet fuel. **There are risks in storing petroleum in aboveground storage tanks, which can leak and pose a threat to the land, environment, and navigable waterways.** A container (i.e. storage tank) cannot be used for storage unless its material and construction are compatible with the material stored and conditions of storage such as pressure and temperature. There are many aboveground tanks within San Mateo County.

The County of San Mateo has a stringent program for aboveground fuel storage tanks. The Health and Safety Code defines an “aboveground storage tank” or “storage tank” as a tank that has the capacity to store 55 gallons or more of petroleum and is substantially or totally above the surface of the ground. Additionally, a “Tank Facility” means one or more aboveground storage tanks, including any piping that is integral to the tanks, that contain petroleum, and are used by a single business entity at a single location or site. A Tank Facility that stores 1,320 gallons or more of petroleum in aboveground storage containers or tanks is required to comply with the Aboveground Petroleum Storage Act (APSA), prepare and implement a Spill Prevention Control and Countermeasure (SPCC) plan, and submit an annual Aboveground Petroleum Storage Tank Facility Statement.

Aircraft Accidents

San Mateo County is home to the San Francisco International Airport (SFO). SFO infrastructure is owned and operated by the City and County of San Francisco, while the land on which SFO is located belongs to the San Mateo County. SFO is the only airport located within San Mateo County that has international air traffic. SFO was invited to take part in this plan and declined. Because SFO infrastructure is owned and operated by the City and County of San Francisco, SFO is covered in the San Francisco hazard mitigation plan and is not a planning partner in the San Mateo planning process. San Mateo County operates two local airports – one in Half Moon Bay, and one in San Carlos. Outside of those airports located within County lines, Oakland International and Mineta San Jose International are located in close proximity to the County. As such, incoming air traffic to these two additional high volume airports has the potential to cause accidents within San Mateo County. Figure 11-3 shows the location of these identified airports.

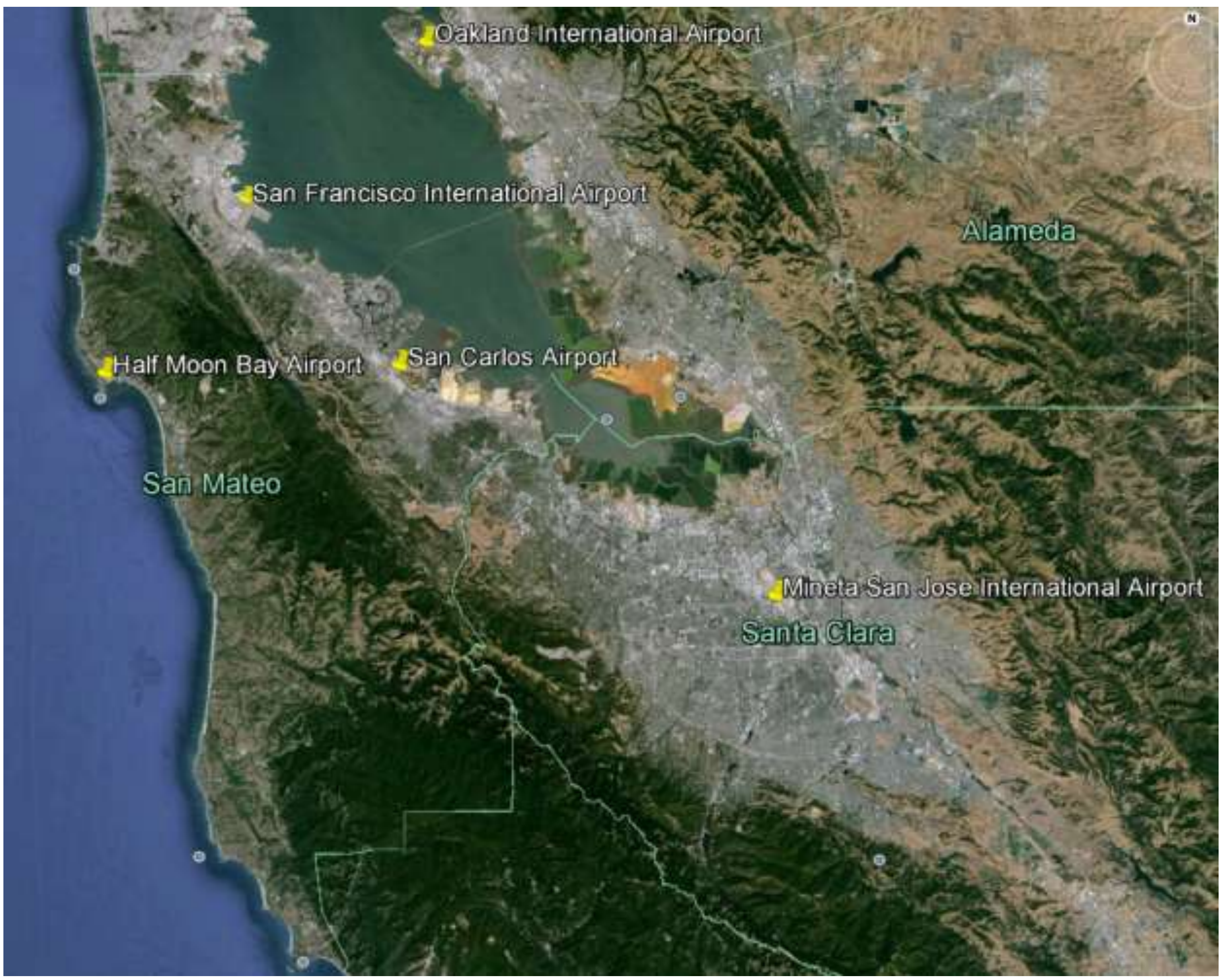


FIGURE 11-3. AIRPORTS AROUND SAN MATEO COUNTY

Source: Google Maps

11.2.3 Frequency

Manmade:

Terrorism

As of 2015, California's economy was the largest of any state in the U.S. San Mateo County's proximity to San Francisco and Silicon Valley presents unique conditions for terrorist attacks. The transportation, energy, and communications systems that cross the County have impacts on the local, regional, and even national economy. In general, the risks of a terrorist event involving a WMD are as follows:

- **Chemical**—The risk of a chemical event is present in San Mateo County. The agricultural community in San Mateo County uses and stores significant amounts of chemicals for peaceful and productive means that could be used in destructive ways.
- **Explosives**—Pipe bomb and suspicious package events have occurred in San Mateo County in the past. While none of the events has been specifically identified as a WMD-related attack, the elements necessary to construct a WMD are readily available. Additionally, the agricultural communities maintain sufficient products and quantities for use in explosive events.
- **Radiological/Nuclear**—The major transportation arteries for vehicles or rail that cross through San Mateo County contribute to the risk of a radiological event. Such products can unknowingly pass through any one of the regional transportation corridors.
- **Biological**—Anthrax incidents that occurred in the U.S. in October 2001 demonstrate the potential for spreading terror through biological WMDs. The introduction of Newcastle disease in the United States demonstrates how an agent can be introduced to livestock, causing harm to public health and the economy.
- **Combined Hazards**—WMD agents can be combined to have a greater total effect. When combined, the impacts of the event can be immediate and longer-term. Casualties will likely suffer from both immediate and long-term burns and contamination. Given the risks associated with chemical agents in San Mateo County, the possibility exists for such a combined event to occur.

Cyber Threats

Cyberattacks are experienced on a daily basis, often times without being noticed. Up-to-date virus protection software used in both public and private sectors prevent most cyberattacks from becoming successful. Programs that promote public education to that end are also an effective way in which to mitigate cyber threats.

Cyberterrorism is much less common than cyberattacks, and the frequency is unknown.

Technological:

Hazardous material incidents may occur at any time in San Mateo County, given the presence of transportation routes bisecting the County, the location of businesses and industry that use hazardous materials, the presence of scattered illegitimate businesses such as clandestine drug laboratories at any given time, and the improper disposal of hazardous waste.

11.2.4 Severity

The severity of human-caused hazards is challenging to measure. Severity could range from a minor transportation accident to a full-scale terrorist attack.

The term mass-casualty incident (MCI) is often applied to transportation accidents involving air travel, as well as multi-vehicle highway accidents. However, MCIs may also result from hazardous materials incidents or acts of violence, such as shootings or hostage situations. Effects may include serious injuries, loss of life, and associated property damage.

Because large numbers of patients may be involved, significant MCIs may tax local emergency medical and hospital resources, and therefore require a regional response. MCIs may occur throughout the County, day or night, at any time of the year on any roadway.

The location of SFO and local airports face the risk of an MCI. Adverse weather may also play a role in roadway or air accidents. Pipeline and tank explosions can expose populations to fire or toxic materials. MCIs may also result from acts of violence or terrorism, which could include a chemical, biological or radiological incident, contaminating persons and requiring mass decontamination.

11.2.5 Warning Time

Very few terrorism incidents are preceded by a warning, and in the case of a technological hazard, accidents occur without predictability under circumstances that give responders little time to prepare. Nonetheless, the San Mateo County Sheriff's Office (SMSO) contributes staffing to the San Francisco Division Office of the Joint Terrorism Task Force. In addition, SMSO operates one of four regional Fusion Centers in California; they are intended to be information-sharing enterprises to bridge gaps between local, state, and federal efforts on an all-hazards, all-crimes level, and is known as the Northern California Regional Intelligence Center (NCRIC). The NCRIC is a government program that helps safeguard the community by serving as a dynamic security nexus to detect, prevent, investigate, and respond to criminal and terrorist activity. The NCRIC disseminates intelligence and facilitates communications between federal, state, and local agencies, and private sector critical infrastructure partners to help them take action on threats and public safety issues. Continued concentrated and deliberate efforts through the NCRIC may increase warning times.

11.3 Secondary Hazards

Human-caused hazards are not like natural hazards that have measurable secondary impacts. The largest secondary impact caused by human-caused hazards would be economic. Economic impacts from human-caused hazards could be significant:

- The cost of a terrorist act would be felt in terms of loss of life and property, disruption of business activity and long-term emotional impacts. Recovery would take significant resources and expense at the local level.
- The economic impact of computer security breaches associated with data and telecommunications losses can be staggering.

- Pipeline and tank failure impacts can include both the cost of community recovery for the area surrounding the failure site and the cost of a disruption of services for the material transported by the pipeline
- A large aircraft accident could have compounding effects on the economy, from recovery needs if an aircraft accident occurred in a residential neighborhood, to revenue lost from cancelled incoming flights.
- Hazardous materials releases have the potential to cause major disruptions to local businesses that house hazardous materials. Additionally, a hazardous materials release could cause businesses to close if they are located in the path of the hazardous materials flow.

11.4 Exposure

The human-caused hazard risk assessment is based on a system that measures a facility's criticality and physical vulnerability. Criticality is a measure of the potential consequence of an accident or terrorist event as well as the attractiveness of the facility to a potential adversary or threat. The criticality for each critical facility is based on the factors shown in Table 11-3. The criticality for each critical facility is based on the following:

- **Awareness**—How aware is the public of the existence of the facility, site, system, or location?
- **Hazardous Materials**—Are flammable, explosive, biological, chemical and/or radiological materials present on site?
- **Collateral Damage Potential**—What are the potential consequences for the surrounding area if the asset is attacked or damaged?
- **Site Population**—What is the potential for mass causalities, based on the capacity of the facility?
- **Public or Emergency Functions**—Does the facility perform a function during an emergency? Is this facility or function capable of being replicated elsewhere?

TABLE 11-3. CRITICALITY FACTORS

Criterion	Low	Medium	High
Awareness	Not known/Neighborhood	City/Region/County	State/National
Hazardous Materials	None/Limited & secure	Moderate/Large & secure	Large/Minimal or no security
Collateral Damage Potential	None or low	Moderate/Immediate area or within 1 mile radius	High/Immediate area or within 1 mile radius
Site Population	0–300	301–1,000	1,001 or greater
Public/Emergency Function	No emergency function, or could be used in the future for emergency function	Support Emergency Function—Redundant site	Emergency Function—Critical service with or without redundancy

Vulnerability is a measure of the physical opportunity for an accident or an adversarial attack. This assessment takes into consideration physical design, existing countermeasures, and site layout. The vulnerability for each critical facility is based on the criteria shown in Table 11-4. The vulnerability for each critical asset is based on the following:

- **Accessibility**—How accessible is the facility or site to the public?
- **Automobile Proximity**—How close can an automobile get to the facility? How vulnerable is the facility to a car bomb attack?
- **Asset Mobility**—Is the facility or asset's location fixed or mobile? If mobile, how often is it moved, relocated, or repositioned?
- **Proximity to other critical facilities**—If the facility is close to other critical facilities then there could be an increased probability of the facility receiving collateral damage.
- **Secure design**—General evaluation of areas of obstruction, air intake locations, parking lot and road design and locations, and other site design aspects.

TABLE 11-4. VULNERABILITY CRITERIA

Criterion	Description	Ratings		
		Low	Medium	High
Accessibility	How accessible is the facility or site to the public?	Remote location, secure perimeter, tightly controlled access	Controlled access, protected or unprotected entry	Open access, unrestricted, patrolling security, sign restrictions
Automobile Proximity	How close can an automobile get to the facility? How vulnerable is the facility to a car bomb attack?	Not within 75–100 feet	Not within 25–50 feet	Adjacent or not within 10 feet
Asset Mobility	Is the facility location fixed or mobile? If mobile, how often is it moved, relocated, or repositioned?	Moves or is relocated frequently	Moves or is relocated occasionally	Permanent or fixed
Proximity to other Critical Facilities	If the facility is close to other critical facilities, there is an increased chance of the facility receiving collateral damage.	Greater than 1.5–2 miles	Greater than 3/4–1 mile	Within 1/2–3/4 mile
Secure Design	General evaluation of areas of obstruction, air intake locations, parking lot and road design and locations, and other site design aspects.	No areas for concealment of packages, air intakes are on roof, accessways are not under the structure.	Area of concealment present, greater than 25 feet from the structure; Air intakes located at least 10 feet above ground, may have under structure access drives.	Areas of concealment within 25 feet, air intakes at ground level, under structure access drives.

11.4.1 Population

A human-caused hazard event could range from an isolated accident to a highly coordinated act of destruction by multiple agents upon multiple targets. Large-scale incidents have the potential to kill or injure many citizens in the immediate vicinity, and may also affect people at a relative distance from the initial event. This report does not consider a set distance to determine those more or less at risk. Variables affecting exposure for a WMD attack and a hazardous material accident include the type of product, the physical and chemical properties of the substance, the physical state of the product (solid, liquid, or gas), the ambient temperature, wind speed, wind direction, barometric pressure, and humidity.

With so many variables to determine "toxic endpoints" as defined by the California Environmental Protection Agency, distances are difficult to forecast. In general, those close to the major transportation corridors or businesses with acutely hazardous materials are more at risk for some sort of effect; but again, each chemical incident will be different and the scenarios are too numerous to describe in this plan.

Hazardous materials pose a significant risk to emergency response personnel. All potential first responders and follow-on emergency personnel in the Planning Area currently are and will be properly trained to the level of emergency response actions required of their individual position at the response scene. Hazardous materials also pose a serious long-term threat to public health and safety, property, and the environment.

11.4.2 Property

San Mateo County is among the fastest growing counties in California, making it a higher profile target for terrorism. Additionally, San Mateo's location between Silicon Valley and San Francisco make San Mateo County vulnerable to secondary and cascading effects of a possible terrorist threat.

11.4.3 Critical Facilities and Infrastructure

Critical facilities are limited to identified planning partner facilities, and other government facilities such as the U.S. Post Office, private utility infrastructure and administrative offices, and medical facilities. Secure areas vary from jurisdiction to jurisdiction. Based on the criticality factors and vulnerability criteria described above, these facilities are all at risk because of their accessibility, automobile accessibility, and lack of a secure or hardened design.

11.4.4 Environment

The risk of human-caused hazards to the environment is considerable. Hazardous materials spilled along roads or railways as a result of an intentional or unintentional act could easily pollute rivers, streams, wetlands, riparian areas, and adjoining fields. Other hazardous materials released into the air could severely impact plant and animal species. By reducing the risk exposure to the built environment, the county will also mitigate potential losses to the natural environment.

11.5 Vulnerability

11.5.1 Population

Although human-caused hazards have not resulted in a large number of deaths in this area, this type of hazard can be deadly and widespread. Injuries and casualties were not estimated for this hazard. Any individuals exposed to human-caused hazards are considered to be at risk, particularly those working as first responder professionals.

11.5.2 Property

All structures in San Mateo County are physically vulnerable to a human-caused hazard. The emphasis on accessibility, the opportunity for roof access, driveways underneath some structures, unmonitored areas, the proximity of many structures to road and airline transportation corridors and underground pipelines, and the potential for a terrorist to strike any structure randomly, all have an impact on the vulnerability of structures.

11.5.3 Critical Facilities and Infrastructure

Most critical facilities and infrastructure in San Mateo County would be vulnerable to human-caused hazards, including utilities, data and telecommunications systems, and transportation facilities.

11.5.4 Environment

The environment vulnerable to a human-caused hazard is the same as the environment exposed to the hazard. While human-caused disasters have caused significant damage to the environment, estimating damage can be difficult. Loss estimation platforms such as Hazards U.S. – Multi-Hazard (HAZUS-MH) are not equipped to measure environmental impacts of these types of hazards. The best gauge of vulnerability of the environment would be a review of damage from past human-caused hazard events. Loss data for damage to the environment were not available at the time of this plan update. Capturing this data from future events could be beneficial in measuring the vulnerability of the environment for future updates.

11.5.5 Economic impacts

Economic impacts from human-caused hazards could be significant. The cost of a terrorist act would be felt in terms of loss of life and property, disruption of business activity, and long-term emotional impacts. Recovery would take significant resources and expense at the local level.

The economic impact of data and telecommunications losses can be staggering as computer security breaches, crime conducted via the internet such as identify theft, and many more forms of human-caused economic losses occur daily. Millions of dollars are lost each year as criminals and cyber-terrorists steal sensitive information and funds from individuals and organizations.

11.6 Future Trends in Development

The threat of human-caused hazards and the availability of Homeland Security Funds will influence future development of the County's critical facilities. However, the potential for human-caused hazards in San Mateo County is not likely to lessen or prohibit future development.

11.7 Scenario

Two human-caused hazard scenarios could have a significant impact on San Mateo County. The first scenario would involve hazardous materials being transported via pipeline or highway systems that bisect the Planning Area. The release of hazardous materials via intentional or unintentional means could impact large population centers within the County, particularly on the populated Bayside. Knowledge of the location of pipelines and vehicles would play a role in preparedness for this scenario, thus reducing its potential impact. The biggest issue in response to hazardous material is material identification and containment.

The second scenario that could have a significant impact on the Planning Area would be a terrorist event at a large gathering place such as a mall or event center. Terrorist events happen with little or no warning. With a population of nearly 800,000 people and location on the San Francisco Peninsula, San Mateo County has potential targets for terrorist activities. The County has taken steps to assess these sites as well as probable scenarios.

11.8 Issues

Important issues associated with human-caused hazards in San Mateo County that support future mitigation actions include but are not limited to the following:

- Participate in regional, state and federal efforts to gather terrorism information at all levels and keep public safety officials briefed at all times regarding any local threats. Staff will then further develop response capabilities based on emerging threats.
- Continue all facets of emergency preparedness training for Police, Fire, Public Works, and Manager/Public Information staff in order to respond quickly in the event of a human-caused disaster. Enhance awareness training for all public employees to recognize threats or suspicious activity to prevent an incident from occurring.
- Work proactively with hazardous materials facilities regarding: placards and labeling of containers; emergency plans and coordination; standardized response procedures; notification of the types of materials being transported through San Mateo County on at least an annual basis; conducting random inspections of transporters as allowed by each company; installation of mitigating techniques along critical locations; routine hazard communication initiatives; and continuously looking to the use of safer alternative products to conduct transport operations.
- Participate in the Cal OES Disaster Resistant California annual conference and other training sessions sponsored by regional, state, and federal agencies.
- Utilize Crime Prevention Through Environmental Design (CPTED) in future planning efforts and enhance existing infrastructure and buildings to prevent or mitigate human-caused incidents. CPTED is an urban planning design process that integrates crime prevention with neighborhood design and community development. CPTED is based on the theory that the proper design and effective use of the built environment can reduce crime and the fear of crime and improve the quality of life. CPTED creates an environment where the physical characteristics, building layout, and site planning allow inhabitants to become key agents in ensuring their own security.
- Participate in regional training exercises per the requirements of Homeland Security Presidential Directive #8 in support of national preparedness. These training exercises, sponsored by the Bay Area Urban Area Security Initiative (UASI), will test and evaluate the ability to coordinate the activities of city, county, and state government first responders, volunteer organizations, and the private sector in responding to terrorism and technological hazards. The trainings will enhance

interagency coordination, provide training to staff, test response and recovery capabilities, and activate the National Incident Management System, Standardized Emergency Management System (SEMS), and the mutual aid system.

- Work with the private sector to enhance and create Business Continuity Plans in the event of an emergency.
- Review existing automatic/mutual aid agreements with other public safety agencies to identify opportunities for enhancement.
- Maintain a regional emergency services information line that the public can contact 24 hours a day during an emergency incident.
- Coordinate with Planning Area school districts to ensure that their emergency preparedness plans include preparation for human-caused incidents.
- Encourage local businesses to adopt IT and telecommunications recovery plans.

Chapter 12.
Planning Area Risk Ranking

A risk ranking was performed for the hazards of concern described in this plan. This risk ranking assesses the probability that each hazard will occur as well as its likely impact on the people, property, and economy of the planning area. The risk ranking methodology and results were reviewed, discussed, and approved by the Steering Committee. When available, estimates of risk were generated with data from HAZUS-MH or geographic information system (GIS) analysis using methodologies promoted by the Federal Emergency Management Agency (FEMA). Qualitative assessments were used for hazards of concern with less robust datasets. As appropriate, results were adjusted based on local knowledge and other information that was not captured in the quantitative assessments. The results are used in establishing mitigation priorities.

12.1 Probability of Occurrence

The probability of occurrence of a hazard is indicated by a probability factor based on the likelihood of annual occurrence:

- **High**—Hazard event is likely to occur within 25 years (Probability Factor = 3)
- **Medium**—Hazard event is likely to occur within 100 years (Probability Factor =2)
- **Low**—Hazard event is not likely to occur within 100 years (Probability Factor =1)
- **No exposure**—There is no probability of occurrence (Probability Factor = 0).

The assessment of hazard frequency is generally based on past hazard events in the area. Table 12-1 summarizes the probability assessment for each hazard of concern for this plan.

TABLE 12-1. PROBABILITY OF HAZARDS

Hazard Event	Probability (high, medium, low)	Probability Factor
Dam failure	Low	1
Drought	High	3
Earthquake	High	3
Flood[b]	High	3
Landslide	High	3
Severe weather	High	3
Tsunami	High	3
Wildfire	High	3

a. 100-year probabilistic results are used for risk ranking
b. 1 percent annual chance flood event is used for risk ranking

12.2 Impact

Hazard impacts will be assessed in three categories: impacts on people, impacts on property, and impacts on the local economy. Numerical impact factors are assigned as follows:

- **People**—Values are assigned based on the percentage of the total ***population exposed*** to the hazard event. The degree of impact on individuals will vary and is not measurable, so the calculation assumes for simplicity and consistency that all people exposed to a hazard because they live in a hazard zone will be equally affected when a hazard event occurs. It should be noted that planners could use an element of subjectivity in assigning values for impacts on people. Impact factors were assigned as follows:
  - High—30 percent or more of the population is exposed to a hazard (Impact Factor = 3)
  - Medium—15 percent to 29 percent of the population is exposed to a hazard (Impact Factor = 2)
  - Low—14 percent or less of the population is exposed to the hazard (Impact Factor = 1)
  - No impact—None of the population is exposed to a hazard (Impact Factor = 0).
- **Property**—Values are assigned based on the percentage of the total ***property value exposed*** to the hazard event:
  - High—25 percent or more of the total assessed property value is exposed to a hazard (Impact Factor = 3)
  - Medium—10 percent to 24 percent of the total assessed property value is exposed to a hazard (Impact Factor = 2)
  - Low—9 percent or less of the total assessed property value is exposed to the hazard (Impact Factor = 1)
  - No impact—None of the total assessed property value is exposed to a hazard (Impact Factor = 0).
- **Economy**—Values are assigned based on the percentage of the total ***property value vulnerable*** to the hazard event. Values represent estimates of the loss from a major event of each hazard in comparison to the total assessed value of the property exposed to the hazard. Vulnerability was considered the same as or a percentage of exposure because of the lack of loss estimation tools specific to some hazards, such as wildfire, landslide and severe weather. Loss estimates separate from the exposure estimates were generated for the earthquake and flood hazards using HAZUS-MH.
  - High—Estimated loss from the hazard is 15 percent or more of the total exposed property value (Impact Factor = 3)
  - Medium—Estimated loss from the hazard is 5 percent to 14 percent of the total exposed property value (Impact Factor = 2)
  - Low—Estimated loss from the hazard is 4 percent or less of the total exposed property value (Impact Factor = 1)
  - No impact—No loss is estimated from the hazard (Impact Factor = 0).

The impacts of each category are assigned a weighting factor to reflect its significance: impact on people is given a weighting factor of 3; impact on property is given a weighting factor of 2; and impact on the economy is given a weighting factor of 1.

Table 12-2, Table 12-3 and Table 12-4 summarize the impacts for each hazard.

TABLE 12-2. IMPACT ON PEOPLE FROM HAZARDS

Hazard Event	Impact (high, medium, low)	Impact Factor	Multiplied by Weighting Factor (3)
Dam failure[a]	Medium	2	2 x 3 = 6
Drought[b]	None	0	0 x 3 = 0
Earthquake	High	3	3 x 3 = 9
Flood[c]	Low	1	1 x 3 = 3
Landslide	Low	1	1 x 3 =3
Severe weather	Medium	2	2 x 3 = 6
Tsunami	Low	1	1 x 3 = 3
Wildfire	Low	1	1 x 3 = 3

a. Inundation areas for the following dams are included in the combined inundation area: Bear Gulch, Emerald Lake, Felt Lake, Laurel Creek, Lower Crystal Springs, Pilarcitos, Ricky Dam, San Andreas, Searsville.
b. All people in the planning area would be exposed to drought, but drought does not generally cause death or injury.
c. 1 percent annual chance flood event is used for risk ranking

TABLE 12-3. IMPACT ON PROPERTY FROM HAZARDS

Hazard Event	Impact (high, medium, low)	Impact Factor	Multiplied by Weighting Factor (2)
Dam failure[a]	Medium	2	2 x 2 = 4
Drought[b]	None	0	0 x 2 = 0
Earthquake	High	3	3 x 2 = 6
Flood[c]	Low	1	1 x 2 = 2
Landslide	Low	1	1 x 2 = 2
Severe weather	Medium	2	2 x 2 = 4
Tsunami	Low	1	1 x 2 = 2
Wildfire	Low	1	1 x 2 = 2

a. Inundation areas for the following dams are included in the combined inundation area: Bear Gulch, Emerald Lake, Felt Lake, Laurel Creek, Lower Crystal Springs, Pilarcitos, Ricky Dam, San Andreas, Searsville
b. All property in the planning area would be exposed to drought, but impacts to structures are expected to be minimal.
c. 1 percent annual chance flood event is used for risk ranking

TABLE 12-4. IMPACT ON ECONOMY FROM HAZARDS

Hazard Event	Impact (high, medium, low)	Impact Factor	Multiplied by Weighting Factor (1)
Dam failure[a]	Medium	2	2 x 1 = 2
Drought	Low	1	1 x 1 = 1
Earthquake[b]	Low	1	1 x 1 = 1
Flood[c]	Low	1	1 x 1 = 1
Landslide	Low	1	1 x 1 = 1
Severe weather	*Low*	1	1 x 1 = 1
Tsunami	Low	1	1 x 1 = 1
Wildfire	Medium	2	2 x 1 = 2

a. Inundation areas for the following dams are included in the combined inundation area: Bear Gulch, Emerald Lake, Felt Lake, Laurel Creek, Lower Crystal Springs, Pilarcitos, Ricky Dam, San Andreas, Searsville
b. 100-year probabilistic results are used for risk ranking
c. 1 percent annual chance flood event is used for risk ranking

12.3 Risk Rating and Ranking

The risk rating for each hazard was calculated by multiplying the probability factor by the sum of the weighted impact factors for people, property, and operations, as summarized in Table 12-5.

A priority of high, medium, or low was assigned to each hazard based on these ratings. The hazard ranked as being of highest concern is earthquake. Hazards ranked as being of medium concern are severe weather, wildfire, flood, landslide, and tsunami. The hazards ranked as being of lowest concern are dam failure and drought. Table 12-6 shows the hazard risk ranking.

TABLE 12-5. HAZARD RISK RATING

Hazard Event	Probability Factor	Sum of Weighted Impact Factors	Total (Probability x Impact)
Dam failure[a]	1	(6+4+2) = 12	12
Drought[b]	3	(0+0+1) = 1	3
Earthquake	3	(9+6+1) = 16	48
Flood[c]	3	(3+2+1) = 6	18
Landslide	3	(3+2+1) = 6	18
Severe weather	3	(6+4+1) = 11	33
Tsunami	3	(3+2+1) = 6	18
Wildfire	3	(3+2+2) = 7	21

TABLE 12-6. HAZARD RISK RANKING

Hazard Ranking	Hazard Event	Category
1	Earthquake	High
2	Severe weather	Medium
3	Wildfire	Medium
4	Flood	Medium
4	Landslide	Medium
4	Tsunami	Medium
5	Dam failure	Low
6	Drought	Low

SECTION 3:
MITIGATION STRATEGY

Chapter 1.
Goals and Objectives

Hazard mitigation plans must identify goals for reducing long-term vulnerabilities to the hazards identified, as outlined in 44 Code of Federal Regulations (CFR) Section 201.6(c)(3)(i). As part of the planning process, the Steering Committee reviewed the goals and objectives of the 2010 plan. After discussion, the committee concluded that the goals and objectives should be revisited and revised to more fully align with other community objectives and priorities. Through several facilitated discussions and exercises, the Steering Committee established an updated set of goals and measurable objectives for the hazard mitigation plan, as well as guiding principles. The resulting guiding principles, goals, objectives, and initiatives in this plan update all support each other. Goals were selected based on their relevance and connection to other planning efforts. Objectives were selected that met multiple goals. Mitigation initiatives were prioritized based on the initiative meeting multiple objectives.

1.1 Guiding Principles

A guiding principle focuses the range of objectives and actions to be considered. A guiding principle is not a goal because it does not describe a hazard mitigation outcome and it is broader than a hazard-specific objective. The guiding principles for the San Mateo County Hazard Mitigation Plan are as follows:

1. Provide a dynamic, actionable approach to hazard planning that integrates with other planning mechanisms to enhance or support hazard mitigation.
2. Invite and enhance the public's awareness and understanding of hazards.
3. Create a decision making tool for policy and decision makers.
4. Promote compliance with State and Federal Program requirements.
5. Assure inter-jurisdictional coordination on hazard mitigation activities.
6. Integrate the concepts of climate change into the mitigation planning process.
7. Support economic viability after a hazard event.

1.2 Goals

The following are the mitigation goals for this plan:

1. Protect life and property;
2. Provide information to residents to better understand the hazards of the region and ways to reduce their personal vulnerability to those hazards;
3. Promote hazard mitigation as an integrated public policy and as a standard business practice;
4. Increase resilience of infrastructure and critical facilities;
5. Protect the environment;
6. Develop and implement mitigation strategies that use public funds in an efficient and cost-effective way; and,

7. Improve community emergency management capability.

The effectiveness of a mitigation strategy is determined by how well these goals are achieved.

1.3 Objectives

Each selected objective meets multiple goals, serving as a stand-alone measurement of the effectiveness of a mitigation action, rather than as a subset of a goal. The objectives also are used to help establish priorities. The objectives are as follows:

1. Improve understanding of the locations, potential impacts, and linkages among threats, hazards, vulnerability, and measures needed to protect life safety and health.
2. Establish and maintain partnerships among all levels of government, the private sector, community groups, and institutions of higher learning that improve and implement methods to protect life and property.
3. Develop and provide updated information about threats, hazards, vulnerabilities, and mitigation strategies to state, regional, and local agencies, as well as private-sector groups.
4. Encourage incorporation of mitigation measures into repairs, major alterations, new development, and redevelopment practices, especially in areas subject to substantial hazard risk.
5. Promote and implement hazard mitigation plans and projects that are consistent with state, regional, and local climate action and adaptation goals, policies, and programs.
6. Advance community resilience through preparation, adoption, and implementation of state, regional, and local multi-hazard mitigation plans and projects.
7. Encourage life and property protection measures for all communities and structures located in hazard areas.
8. Actively promote effective coordination of regional and local hazard mitigation planning and action among state agencies, cities, counties, special districts, tribal organizations, councils of governments, metropolitan planning organizations, and regional transportation to create resilient and sustainable communities.
9. Improve systems that provide warning and emergency communications.
10. Promote dialogue between government representatives, private business, non-profit organizations, and the public regarding hazard mitigation.
11. Retrofit, purchase, or relocate structures in high hazard areas, especially those known to be repetitively damaged.

Chapter 2.
Mitigation Alternatives

Catalogs of hazard mitigation alternatives were developed that present a broad range of alternatives to be considered for use in the planning area, in compliance with 44 CFR (Section 201.6(c)(3)(ii)). One catalog was developed for each hazard of concern evaluated in this plan. The catalogs for each hazard are listed in Tables 2-1 through Table 2-9. The catalogs present alternatives that are categorized in two ways:

- By what the alternative would do:
- Manipulate a hazard
- Reduce exposure to a hazard
- Reduce vulnerability to a hazard
- Increase the ability to respond to or be prepared for a hazard

- By who would have responsibility for implementation:
- Individuals
- Businesses
- Government

Hazard mitigation initiatives recommended in this plan were selected from among the alternatives presented in the catalogs. The catalogs provide a baseline of mitigation alternatives that are backed by a planning process, are consistent with the planning partners' goals and objectives, and are within the capabilities of the partners to implement. Additionally, the ABAG action items from the 2010 initiative were reviewed and incorporated in the alternatives list. These items are represented in **bold print** in the tables below.

Some of these actions may not be feasible based on the selection criteria identified for this plan. The purpose of the catalog was to equip the planning partners with a list of what could be considered to reduce risk of the hazards within the planning area. All actions identified in Volume 2 of this plan were selected based on the selection criteria described in Chapter 1 of Volume 2.

TABLE 2-1. CATALOG OF MITIGATION ALTERNATIVES—DAM FAILURE

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
• None	• Remove dams • Remove levees/ upgrade levees • Harden dams	• Remove dams • Remove levees/upgrade levees • Harden dams
Reduce Exposure		
• Relocate out of dam failure inundation areas.	• Replace earthen dams with hardened structures	• Replace earthen dams with hardened structures • Relocate critical facilities out of dam failure inundation areas. • Consider open space land use in designated dam failure inundation areas.
Reduce Vulnerability		

TABLE 2-1. CATALOG OF MITIGATION ALTERNATIVES—DAM FAILURE

Personal Scale	Corporate Scale	Government Scale
• Elevate home to appropriate levels.	• Flood-proof facilities within dam failure inundation areas	• Adopt higher regulatory floodplain standards in mapped dam failure inundation areas. • Retrofit critical facilities within dam failure inundation areas.
Increase Preparation or Response Capability		
• Learn about risk reduction for the dam failure hazard. • Learn the evacuation routes for a dam failure event. • Educate yourself on early warning systems and the dissemination of warnings.	• Educate employees on the probable impacts of a dam failure. • Develop a continuity of operations plan.	• Map dam failure inundation areas. • Enhance emergency operations plan to include a dam failure component. • Institute monthly communications checks with dam operators. • Inform the public on risk reduction techniques • Adopt real-estate disclosure requirements for the re-sale of property located within dam failure inundation areas. • Consider the probable impacts of climate in assessing the risk associated with the dam failure hazard. • Establish early warning capability downstream of listed high hazard dams. • Consider the residual risk associated with protection provided by dams in future land use decisions.

TABLE 2-2. CATALOG OF MITIGATION ALTERNATIVES— DROUGHT

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
• None	• None	• Groundwater recharge through stormwater management
Reduce Exposure		
• None	• None	• Identify and create groundwater backup sources
Reduce Vulnerability		
• Drought-resistant landscapes • Reduce water system losses • Modify plumbing systems (through water saving kits)	• Drought-resistant landscapes • Reduce private water system losses	• Water use conflict regulations • Reduce water system losses • Distribute water saving kits
Increase Preparation or Response Capability		
• Practice active water conservation	• Practice active water conservation	• Public education on drought resistance • Identify alternative water supplies for times of drought; mutual aid agreements with alternative suppliers • Develop drought contingency plan • Develop criteria “triggers” for drought-related actions • Improve accuracy of water supply forecasts • Modify rate structure to influence active water conservation techniques

TABLE 2-3. CATALOG OF MITIGATION ALTERNATIVES—EARTHQUAKE

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
• None	• None	• None
Reduce Exposure		
• Locate outside of hazard area (off soft soils)	• Locate or relocate mission-critical functions outside hazard area where possible	• Locate critical facilities or functions outside hazard area where possible
Reduce Vulnerability		
• Retrofit structure (anchor house structure to foundation) • Secure household items that can cause injury or damage (such as water heaters, bookcases, and other appliances) • Build to higher design	• Build redundancy for critical functions and facilities • Retrofit critical buildings and areas housing mission-critical functions • **Install specially-engineered pipelines in areas subject to faulting, liquefaction, earthquake-induced landsliding, or other earthquake hazard.**	• Harden infrastructure • Provide redundancy for critical functions • Adopt higher regulatory standards • **Install earthquake-resistant connections when pipes enter and exit bridges.**
Increase Preparation or Response Capability		
• Practice "drop, cover, and hold" • Develop household mitigation plan, such as creating a retrofit savings account, communication capability with outside, 72-hour self-sufficiency during an event • Keep cash reserves for reconstruction • Become informed on the hazard and risk reduction alternatives available. • Develop a post-disaster action plan for your household	• Adopt higher standard for new construction; consider "performance-based design" when building new structures • Keep cash reserves for reconstruction • Inform your employees on the possible impacts of earthquake and how to deal with them at your work facility. • Develop a continuity of operations plan	• Provide better hazard maps • Provide technical information and guidance • Enact tools to help manage development in hazard areas (such as tax incentives, information) • Include retrofitting and replacement of critical system elements in capital improvement plan • Develop strategy to take advantage of post-disaster opportunities • Warehouse critical infrastructure components such as pipe, power line, and road repair materials • Develop and adopt a continuity of operations plan • Initiate triggers guiding improvements (such as <50 percent substantial damage or improvements) • Further enhance seismic risk assessment to target high hazard buildings for mitigation opportunities. • Develop a post-disaster action plan that includes grant funding and debris removal components. • **Install portable facilities (such as hoses, pumps, emergency generators, or other equipment) to allow pipelines to bypass failure zones such as fault rupture areas, areas of liquefaction, and other ground failure areas (using a priority scheme if**

TABLE 2-3. CATALOG OF MITIGATION ALTERNATIVES—EARTHQUAKE

Personal Scale	Corporate Scale	Government Scale
		funds are not available for installation at all needed locations).

TABLE 2-4. CATALOG OF MITIGATION ALTERNATIVES—FLOOD

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
• Clear stormwater drains and culverts • Institute low-impact development techniques on property	• Clear stormwater drains and culverts • Institute low-impact development techniques on property	• Maintain drainage system • Institute low-impact development techniques on property • Dredging, levee construction, and providing regional retention areas • Structural flood control, levees, channelization, or revetments. • Stormwater management regulations and master planning • Acquire vacant land or promote open space uses in developing watersheds to control increases in runoff
Reduce Exposure		
• Locate outside of hazard area • Elevate utilities above base flood elevation • Institute low impact development techniques on property	• Locate business critical facilities or functions outside hazard area • Institute low impact development techniques on property • Harden/upgrade levee system	• Locate or relocate critical facilities outside of hazard area • Acquire or relocate identified repetitive loss properties • Promote open space uses in identified high hazard areas via techniques such as: planned unit developments, easements, setbacks, greenways, and sensitive area tracks. • Adopt land development criteria such as planned unit developments, density transfers, clustering • Institute low impact development techniques on property • Acquire vacant land or promote open space uses in developing watersheds to control increases in runoff • Harden/upgrade levee system
Reduce Vulnerability		
• Retrofit structures (elevate structures above base flood elevation) • Elevate items within house above base flood elevation • Build new homes above base flood elevation	• Build redundancy for critical functions or retrofit critical buildings • Provide flood-proofing measures when new critical infrastructure must be located in floodplains	• Harden infrastructure, bridge replacement program • Provide redundancy for critical functions and infrastructure • Adopt appropriate regulatory standards, such as: increased freeboard standards, cumulative substantial improvement or damage, lower substantial damage threshold; compensatory storage, non-conversion deed restrictions.

TABLE 2-4. CATALOG OF MITIGATION ALTERNATIVES—FLOOD

Personal Scale	Corporate Scale	Government Scale
• Flood-proof existing structures		• Stormwater management regulations and master planning. • Adopt "no-adverse impact" floodplain management policies that strive to not increase the flood risk on downstream communities. • Investigate ways to reduce coastal erosion vulnerability, especially in Pacifica and the unincorporated Midcoast area. • **Conduct a watershed analysis of runoff and drainage systems to predict areas of insufficient capacity in the storm drain and natural creek system.** • **Develop procedures for performing a watershed analysis to look at the impact of development on flooding potential downstream, including communities outside of the jurisdiction of proposed projects.** • **Elevate critical bridges affected by flooding to increase stream flow and maintain critical access and egress routes.** • **Place remote sensors in strategic locations for early warning of hazmat releases or use of weapons of mass destruction.**
Increase Preparation or Response Capability		
• Buy flood insurance • Develop household mitigation plan, such as retrofit savings, communication capability with outside, 72-hour self-sufficiency during and after an event • Develop household evacuation plan (coastal erosion in Pacifica only)	• Keep cash reserves for reconstruction • Support and implement hazard disclosure for the sale/re-sale of property in identified risk zones. • Solicit cost-sharing through partnerships with other stakeholders on projects with multiple benefits.	• Produce better hazard maps • Provide technical information and guidance • Enact tools to help manage development in hazard areas (stronger controls, tax incentives, and information) • Incorporate retrofitting or replacement of critical system elements in capital improvement plan • Develop strategy to take advantage of post-disaster opportunities • Warehouse critical infrastructure components • Develop and adopt a continuity of operations plan • Consider participation in the Community Rating System • Maintain existing data and gather new data needed to define risks and vulnerability • Train emergency responders • Create a building and elevation inventory of structures in the floodplain • Develop and implement a public information strategy • Charge a hazard mitigation fee

TABLE 2-4. CATALOG OF MITIGATION ALTERNATIVES—FLOOD

Personal Scale	Corporate Scale	Government Scale
		• Integrate floodplain management policies into other planning mechanisms within the planning area. • Consider the probable impacts of climate change on the risk associated with the flood hazard • Consider the residual risk associated with structural flood control in future land use decisions • Enforce National Flood Insurance Program • Adopt a Stormwater Management Master Plan • **Develop a comprehensive streambed vegetation management plan.**

TABLE 2-5. CATALOG OF MITIGATION ALTERNATIVES—LANDSLIDE

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
• Stabilize slope (dewater, armor toe) • Reduce weight on top of slope • Minimize vegetation removal and the addition of impervious surfaces.	• Stabilize slope (dewater, armor toe) • Reduce weight on top of slope	• Stabilize slope (dewater, armor toe) • Reduce weight on top of slope
Reduce Exposure		
• Locate structures outside of hazard area (off unstable land and away from slide-runout area)	• Locate structures outside of hazard area (off unstable land and away from slide-runout area)	• Acquire properties in high-risk landslide areas. • Adopt land use policies that prohibit the placement of habitable structures in high-risk landslide areas.
Reduce Vulnerability		
• Retrofit home.	• Retrofit at-risk facilities.	• Adopt higher regulatory standards for new development within unstable slope areas. • Armor/retrofit critical infrastructure against the impact of landslides. • **Establish requirements in zoning ordinances to address hillside development constraints, especially in areas of existing landslides.**
Increase Preparation or Response Capability		
• Institute warning system, and develop evacuation plan • Keep cash reserves for reconstruction • Educate yourself on risk reduction	• Develop evacuation plan • Keep cash reserves for reconstruction • Develop a continuity of operations plan	• Produce better hazard maps • Provide technical information and guidance • Enact tools to help manage development in hazard areas: better land controls, tax incentives, information • Develop strategy to take advantage of post-disaster opportunities • Warehouse critical infrastructure components

TABLE 2-5. CATALOG OF MITIGATION ALTERNATIVES—LANDSLIDE

Personal Scale	Corporate Scale	Government Scale
techniques for landslide hazards.	• Educate employees on the potential exposure to landslide hazards and emergency response protocol.	• Develop and adopt a continuity of operations plan • Educate the public on the landslide hazard and appropriate risk reduction alternatives.

TABLE 2-6. CATALOG OF MITIGATION ALTERNATIVES—SEVERE WEATHER

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
• None	• None	• None
Reduce Exposure		
• None	• None	• None
Reduce Vulnerability		
• Insulate house • Provide redundant heat and power • Insulate structure • Plant appropriate trees near home and power lines ("Right tree, right place" National Arbor Day Foundation Program)	• Relocate critical infrastructure (such as power lines) underground • Reinforce or relocate critical infrastructure such as power lines to meet performance expectations • Install tree wire • Ensure air-conditioned facilities for institutionalized vulnerable populations.	• Harden infrastructure such as locating utilities underground • Trim trees back from power lines • Designate snow routes and strengthen critical road sections and bridges • Provide publicly available cooling centers. • Disseminate information on public health impacts of severe weather.
Increase Preparation or Response Capability		
• Trim or remove trees that could affect power lines • Promote 72-hour self-sufficiency • Obtain a NOAA weather radio. • Obtain an emergency generator.	• Trim or remove trees that could affect power lines • Create redundancy • Equip facilities with a NOAA weather radio • Equip vital facilities with emergency power sources.	• Support programs such as "Tree Watch" that proactively manage problem areas through use of selective removal of hazardous trees, tree replacement, etc. • Establish and enforce building codes that require all roofs to withstand snow loads • Increase communication alternatives • Modify land use and environmental regulations to support vegetation management activities that improve reliability in utility corridors. • Modify landscape and other ordinances to encourage appropriate planting near overhead power, cable, and phone lines • Provide NOAA weather radios to the public. • Develop an extreme heat program.

TABLE 2-6. CATALOG OF MITIGATION ALTERNATIVES—SEVERE WEATHER

Personal Scale	Corporate Scale	Government Scale
		• **Have back-up emergency power available for critical intersection traffic lights.**

TABLE 2-7. CATALOG OF MITIGATION ALTERNATIVES—TSUNAMI

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
• Clear stormwater drains and culverts in inundation zones	• Clear stormwater drains and culverts in inundation zones	• Maintain drainage system in inundation zones • Structural flood control, levees, channelization, or revetments
Reduce Exposure		
• Relocate outside of hazard area, such as inundation zones	• Locate mission critical functions outside of hazard area, such as inundation zones whenever possible.	• Locate critical facilities and functions outside of hazard area, such as inundation zones, whenever possible.
Reduce Vulnerability		
• Avoid close proximity to San Francisco Bay for several days after the tsunami (to avoid seiche hazards) • Elevate items within house above base flood elevation • Flood-proof existing structures	• Build redundancy for critical functions or retrofit critical buildings • Harden and flood-proof critical facilities in inundation zones to the greatest extent practicable	• Maintain up to date with current tsunami warning technologies • Revise building codes and guidelines to adequately address the impacts of tsunamis on structures. • Harden infrastructure, bridge replacement program • Provide redundancy for critical functions and infrastructure • Harden and flood-proof critical facilities in inundation zones to the greatest extent practicable • Recommend that residents avoid close proximity to San Francisco Bay for several days after the tsunami (to avoid seiche hazards)
Increase Preparation or Response Capability		
• Develop and practice a household evacuation plan.	• Develop and practice a corporate evacuation plan • Inform employees through corporate sponsored outreach • Keep cash reserves for reconstruction • Support and implement hazard disclosure for the	• Regularly update tsunami inundation maps with probabilistic scenarios and to take into account emerging technology resources. • Revise building codes and guidelines to adequately address the impacts of tsunamis on structures. • Incorporate retrofitting or replacement of critical system elements in capital improvement plan • Develop and implement a public information strategy, with a focus on vulnerable populations

TABLE 2-7. CATALOG OF MITIGATION ALTERNATIVES—TSUNAMI

Personal Scale	Corporate Scale	Government Scale
	sale/re-sale of property in identified risk zones. • Solicit cost-sharing through partnerships with other stakeholders on projects with multiple benefits.	

TABLE 2-8. CATALOG OF MITIGATION ALTERNATIVES—WILDFIRE

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
• Clear potential fuels on property such as dry overgrown underbrush and diseased trees	• Clear potential fuels on property such as dry underbrush and diseased trees	• Clear potential fuels on property such as dry underbrush and diseased trees • Implement best management practices on public lands.
Reduce Exposure		
• Create and maintain defensible space around structures • Locate outside of hazard area • Mow regularly	• Create and maintain defensible space around structures and infrastructure • Locate outside of hazard area	• Create and maintain defensible space around structures and infrastructure • Locate outside of hazard area • Enhance building code to include use of fire resistant materials in high hazard area.
Reduce Vulnerability		
• Create and maintain defensible space around structures and provide water on site • Use fire-retardant building materials • Create defensible spaces around home	• Create and maintain defensible space around structures and infrastructure and provide water on site • Use fire-retardant building materials • Use fire-resistant plantings in buffer areas of high wildfire threat.	• Create and maintain defensible space around structures and infrastructure • Use fire-retardant building materials • Use fire-resistant plantings in buffer areas of high wildfire threat. • Consider higher regulatory standards (such as Class A roofing) • Establish biomass reclamation initiatives
Increase Preparation or Response Capability		
• Employ techniques from the National Fire Protection Association's Firewise Communities program to safeguard home • Identify alternative water supplies for fire fighting	• Support Firewise community initiatives. • Create /establish stored water supplies to be utilized for firefighting.	• More public outreach and education efforts, including an active Firewise program • Possible weapons of mass destruction funds available to enhance fire capability in high-risk areas • Identify fire response and alternative evacuation routes • Seek alternative water supplies • Become a Firewise community

TABLE 2-8. CATALOG OF MITIGATION ALTERNATIVES—WILDFIRE

Personal Scale	Corporate Scale	Government Scale
• Install/replace roofing material with non-combustible roofing materials.		• Use academia to study impacts/solutions to wildfire risk • Establish/maintain mutual aid agreements between fire service agencies. • Create/implement fire plans • Consider the probable impacts of climate change on the risk associated with the wildfire hazard in future land use decisions • **Develop unused or pedestrian rights-of-way as walkways to serve as additional evacuation routes.**

TABLE 2-9. CATALOG OF MITIGATION ALTERNATIVES—HUMAN-CAUSED HAZARDS

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
• Practice safe traveling procedures (for example, don't drive while tired or intoxicated)	• Promote a culture of health and safety to reduce risks of transportation accidents from travel fatigue or other concerns • Continuously look to the use of safer alternative products to conduct transport operations.	• Promote a culture of health and safety to reduce risks of transportation accidents from travel fatigue or other concerns • Continuously look to the use of safer alternative products to conduct transport operations. • Have police and emergency responders work with appropriate regional, state, and federal agencies to share information, identify threats, and respond to potential incidents to reduce criminal activity attempts and other threats. • **Provide information on hazardous waste disposal and/or drop off locations.** • **Remove septic tanks and other sources of contamination adjacent to economically-significant aquacultural and agricultural resources.**
Reduce Exposure		
• Relocate away from high-hazard areas	• Relocate critical or mission-essential facilities away from major highways and transportation corridors, as well as high-risk targets	• Relocate critical or mission-essential facilities away from major highways and transportation corridors, as well as high-risk targets • Harden critical infrastructure to the greatest extent possible
Reduce Vulnerability		

TABLE 2-9. CATALOG OF MITIGATION ALTERNATIVES—HUMAN-CAUSED HAZARDS

Personal Scale	Corporate Scale	Government Scale
• Notify police or response personnel of suspicious activities.	• Properly placard and label containers, update emergency plans, and coordinate response procedures with San Mateo County and local jurisdictions	• Maintain visible police and emergency responder presence in sensitive and high-risk locations • Work proactively with hazardous materials (HazMat) facilities regarding placards and labeling of containers, emergency plans and coordination, standardized response procedures, notification of the types of materials being transported through San Mateo County on at least an annual basis • Random inspections of transporters as allowed by each company • Installation of mitigating techniques along critical locations • Routine hazard communication initiatives
Increase Preparation or Response Capability		
• Develop a family mitigation plan and an evacuation plan if living near a high-risk target or major highway/transportation corridor	• Participate in jurisdictional/City, County, state, federal, and other efforts to practice response capabilities, gather relevant hazard information (such as on terrorism), and monitor vulnerabilities. • Coordinate in information-sharing initiatives with the local cities and County • Develop a Business Continuity Plan • Review existing automatic/mutual aid agreements • Adopt Information Technology and telecommunications recovery plans.	• Participate in regional, state and federal efforts to gather terrorism information at all levels and keep public safety officials briefed at all times regarding any local threats. Staff will then further develop response capabilities based on emerging threats. • Continue all facets of emergency preparedness training and exercises for Police, Fire, Public Works, and Manager/Public Information staff in order to respond quickly in the event of a human-caused disaster. • Participate in the Governor's Office of Emergency Services Disaster Resistant California annual conference and other training sessions sponsored by regional, state and federal agencies. • Utilize Crime Prevention through Environmental Design (CPTED) in future planning efforts as well as enhancing existing infrastructure and buildings to prevent or mitigate human-cause incidents. • Review existing automatic/mutual aid agreements • Maintain a regional around-the-clock emergency services information hotline for the public • Coordinate with school districts to ensure emergency preparedness plans include human-caused incidents.

Chapter 3.
Selected Countywide Mitigation Initiatives

Countywide hazard mitigation initiatives recommended in this plan were selected by the Steering Committee from among the alternatives presented in the mitigation catalog. Some of the initiatives identified in the mitigation catalog were determined not to be feasible or otherwise undesirable based on the selection criteria identified for this plan (such as lack of public support or a more cost-effective alternative is available). The Steering Committee reviewed and provided feedback on the catalog, ultimately selecting the countywide mitigation initiatives described in detail in the following sections. Those initiatives that have been chosen are backed by a planning process, are consistent with the established goals and objectives, and are within the capabilities of San Mateo County and its stakeholders to implement.

Table 3-1 lists each selected mitigation initiative, the lead agency for each, and appropriate implementation factors.

TABLE 3-1. HAZARD MITIGATION ACTION PLAN MATRIX

Applies to New or Existing Assets	Hazards Mitigated	Objectives Met	Lead Agencies[a]	Estimated Cost	Sources of Funding	Timeline[b]
Action CW-1—Continue to support the countywide actions identified in this plan.						
New and existing	All	All	San Mateo County and Jurisdictions	Low	General Fund	Short- and long-term
Action CW-2—Actively participate in the plan maintenance strategy identified in this plan.						
New and existing	All	All	San Mateo County and Jurisdictions	Low	General Fund	Short-term
Action CW-3—Continue to maintain a website that will house the regional hazard mitigation plan, its progress reports and all component of the plan's maintenance strategy to provide planning partners and public ongoing access to the plan and its implementation.						
N/A	All	All	San Mateo County and Jurisdictions	Low	Operating Budgets	Ongoing
Action CW-4—Continue to leverage/support/enhance ongoing, regional public education and awareness programs (such as "CERT, multi-jurisdiction, etc.") as a method to educate the public on risk, risk reduction, and community resilience.						
N/A	All	1, 2, 3, 6, 7, 10	San Mateo County and Jurisdictions	Low	Operating Budgets	Ongoing
Action CW-5—Provide technical support and coordination for available grant funding opportunities to the planning partnership.						
N/A	All	2, 3, 4, 5, 6, 7, 8, 10, 11	San Mateo County and Jurisdictions	Low	Operating Budgets	Ongoing
Action CW-6— Develop a standardized dataset for modeling sea-level rise impacts for regional and jurisdictional assessment purposes that takes into account both coastal and bay geomorphic features.						

TABLE 3-1. HAZARD MITIGATION ACTION PLAN MATRIX

Applies to New or Existing Assets	Hazards Mitigated	Objectives Met	Lead Agencies[a]	Estimated Cost	Sources of Funding	Timeline[b]
N/A	Flood, severe weather, landslide	1, 2, 3, 4, 5, 6, 7, 8, 10	San Mateo County and Jurisdictions	High	HMGP, LCP Grants	Short-term

a. Where applicable, certain actions will only pertain to municipalities within the planning area.
b. Ongoing indicates continuation of an action that is already in place. Short-term indicates implementation within five years. Long-term indicates implementation after five years.

3.1.1 Benefit/Cost Review

The initiative plan must be prioritized according to a benefit/cost analysis of the proposed initiatives and their associated costs, outlined in 44 CFR, Section 201.6(c)(3)(iii). The benefits of proposed initiatives were weighed against estimated costs as part of the initiative prioritization process. The benefit/cost analysis was not of the detailed variety required by the Federal Emergency Management Agency (FEMA) for project grant eligibility under the Hazard Mitigation Grant Program (HMGP) and Pre-Disaster Mitigation (PDM) grant program. A less formal approach was used because some initiatives may not be implemented for up to 10 years and associated costs and benefits could change dramatically in that time. Therefore, the apparent benefits versus the apparent cost of each initiative was reviewed. Parameters were established for assigning subjective ratings (high, medium, and low) to the costs and benefits of these initiatives.

The ratings of high, medium, and low are qualitative based solely on the comparison of one initiative to another. Implementation of an initiative should not be discouraged based on its identification as a low priority. All of the initiatives identified in the Hazard Mitigation Initiative Action Plan are and should be considered important steps to alleviate hazard impacts toward the people, property, and economy of San Mateo County.

Cost ratings were defined as follows:

- **High**—Existing funding will not cover the cost of the initiative; implementation would require new revenue through an alternative source (for example, bonds, grants, and fee increases).
- **Medium**—The initiative could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the initiative would have to be spread over multiple years.
- **Low**—The initiative could be funded under the existing budget. The initiative is part of or can be part of an ongoing existing program.

Benefit ratings were defined as follows:

- **High—**Initiative will provide an immediate reduction of risk exposure for life and property.
- **Medium—**Initiative will have a long-term impact on the reduction of risk exposure for life and property, or initiative will provide an immediate reduction in the risk exposure for property.
- **Low—**Long-term benefits of the initiative are difficult to quantify in the short term.

Using this approach, initiative with positive benefit versus cost ratios (such as high over high, high over medium, medium over low, and so forth) are considered cost-beneficial and are prioritized accordingly.

Planning partners may seek financial assistance under the HMGP or PDM programs, both of which require detailed benefit/cost analyses, for many of the strategies identified in this initiative plan. These analyses will be performed on projects during the application process using the FEMA benefit-cost model. Planning partners reserve the right to define "benefits" according to parameters that meet the goals and objectives of this plan for projects that are not seeking financial assistance from grant programs that require detailed analysis.

3.1.2 Initiative Plan Prioritization

Implementation Prioritization

Table 3-2 lists the implementation priority of each initiative, using the same parameters used in selecting the initiatives. A qualitative benefit-cost review was performed for each of these initiatives. The priorities are defined as follows:

- **High Priority**—An initiative that meets multiple objectives, has benefits that exceed cost, has funding secured, or is an ongoing project and meets eligibility requirements for a grant program. High priority initiative s can be completed in the short term (1 to 5 years). The key factors for high priority initiatives are that they have funding secured and can be completed in the short term.
- **Medium Priority**—An initiative that meets goals and objectives, that has benefits that exceed costs, and for which funding has not been secured but that is grant eligible. Initiative can be completed in the short term, once funding is secured. Medium priority projects will become high priority projects once funding is secured. The key factors for medium priority initiatives are that they are eligible for funding, but do not yet have funding secured, and they can be completed within the short term.
- **Low Priority**—An initiative that will mitigate the risk of a hazard, that has benefits that do not exceed the costs or are difficult to quantify, for which funding has not been secured, that is not eligible for grant funding, and for which the time line for completion is long term (1 to 10 years). Low priority initiatives may be eligible for grant funding from other programs that have not yet been identified. Low priority projects are "blue-sky" projects. Financing is unknown, and they can be completed over a long term.

Grant Funding Prioritization

Table 3-2 also lists the grant funding priority of each initiative. The priorities are defined as follows:

- **High Priority**—An initiative that has been identified as meeting grant eligibility requirements, assessed to have high benefits, is listed as high or medium priority, and where local funding options are unavailable or where dedicated funds could be used for projects that are not eligible for grant funding.

- **Medium Priority**—An initiative that has been identified as meeting grant eligibility requirements, assessed to have medium or low benefits, is listed as medium or low priority, and where local funding options are unavailable.
- **Low Priority**—An initiative that has not been identified as meeting grant eligibility requirements or has low benefits.
- Those initiatives identified as high-priority grant funding initiatives should be closely reviewed for consideration when grant funding opportunities arise.

TABLE 3-2. PRIORITIZATION OF MITIGATION INITIATIVES

Initiative #	# of Objectives Met	Benefits	Costs	Do Benefits equal or exceed Costs?	Is project Grant eligible?	Can Project be funded under existing programs/ budgets?	Implementation Priority	Grant Funding Priority
Action CW-1	11	Medium	Low	Yes	No	Yes	Medium	Low
Action CW -2	11	Medium	Low	Yes	No	Yes	Medium	Low
Action CW -3	11	Low	Low	Yes	No	Yes	Medium	Low
Action CW -4	6	Medium	Low	Yes	No	Yes	Medium	Low
Action CW -5	9	Medium	Low	Yes	No	Yes	Medium	Low
Action CW-6	9	Low	High	No	Yes	No	Low	Medium

a. Parameters were established for assigning subjective ratings (high, medium, and low) to the costs and benefits of these initiatives. The ratings of high, medium, and low are qualitative based solely on the comparison of one initiative to another. Implementation of an initiative should not be discouraged based on its identification as a low priority.

Chapter 4.
Plan Adoption

A hazard mitigation plan must document that it has been formally adopted by the governing body of the jurisdiction requesting federal approval of the plan, as outlined in 44 CFR Section 201.6(c)(5). Disaster Mitigation Act of 2000 (DMA) compliance and its benefits cannot be achieved until the plan is adopted. This plan will be submitted for a pre-adoption review to the California Office of Emergency Services (Cal OES), FEMA Region IX, and the Insurance Services Office (ISO) before it is adopted. Once pre-adoption approval has been provided, San Mateo County and planning partners will formally adopt the plan. All planning partners understand that DMA compliance cannot be achieved until the plan is adopted. A copy of the sample resolution is provided in Figure 4-1. Copies of the resolution adopting this plan for all planning partners can be found in Appendix G of this volume.

The coordination of adoption by the planning partners may allow for the batching, or simultaneous submission, of formal adoption resolutions. The collection and submission of the first batch of resolutions will be coordinated by the Plan Implementation Lead, San Mateo County, and those jurisdictions that receive a formal adoption notice within the first 45 days of APA designation by FEMA. Subsequent resolutions may be batched and submitted by the Plan Implementation Lead as resolutions are received.

RESOLUTION NO. 2016-XX
A RESOLUTION OF THE ____________________________
AUTHORIZING THE ADOPTION OF THE
SAN MATEO COUNTY HAZARD MITIGATION PLAN UPDATE

WHEREAS, all of San Mateo County has exposure to natural hazards that increase the risk to life, property, environment and the County's economy; and

WHEREAS; pro-active mitigation of known hazards before a disaster event can reduce or eliminate long-term risk to life and property; and

WHEREAS, The Disaster Mitigation Act of 2000 (Public Law 106-390) established new requirements for pre- and post-disaster hazard mitigation programs; and

WHEREAS; a coalition of San Mateo County, Cities, Towns and Special Districts with like planning objectives has been formed to pool resources and create consistent mitigation strategies within the San Mateo County planning area; and

WHEREAS, the coalition has completed a planning process that engages the public, assesses the risk and vulnerability to the impacts of natural hazards, develops a mitigation strategy consistent with a set of uniform goals and objectives, and creates a plan for implementing, evaluating and revising this strategy;

NOW, THEREFORE, BE IT RESOLVED that the ________________________:

1.) Adopts in its entirety, Volume I and the introduction, chapter ____ - the ________ jurisdictional annex, and the appendices of Volume II of the San Mateo County Hazard Mitigation Plan Update (HMP).

2.) Will use the adopted and approved portions of the HMP to guide pre- and post-disaster mitigation of the hazards identified.

3.) Will coordinate the strategies identified in the HMP with other planning programs and mechanisms under its jurisdictional authority.

4.) Will continue its support of the Steering Committee and continue to participate in the Planning Partnership as described by the HMP.

5.) Will help to promote and support the mitigation successes of all HMP Planning Partners.

PASSED AND ADOPTED on this X[st], X[nd], X[rd], X[th] day of XXX, 2016, by the following vote:

YES:
NO:
ABSENT:
ABSTAIN:

ATTEST: ____________________ ________________________

City Clerk, ______________ Mayor, ____________________

FIGURE 4-1. SAMPLE RESOLUTION ADOPTING HAZARD MITIGATION PLAN

Chapter 5.
Plan Implementation and Maintenance Strategy

This chapter presents a multi-jurisdictional plan implementation and maintenance process (CRS Step 10 and 44 CFR Section 201.6(c)(4)) that includes the following:

- A section describing how San Mateo County and its participating stakeholders will implement the recommendations of this plan over its 5-year performance period.
- A process San Mateo County and its planning partners will use to incorporate the requirements of the mitigation plan into other planning mechanisms, such as general or capital improvement plans, when appropriate.
- A section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan over the 5-year cycle.
- A discussion on how the community will continue public participation in the plan maintenance process.

This section details the formal process that will ensure that the San Mateo County Multi-Jurisdictional Hazard Mitigation Plan remains an active and relevant document and that the County and participating jurisdictions maintain their eligibility for applicable funding sources. It includes a schedule for monitoring and evaluating the Plan annually and producing an updated plan every five years. The plan's format allows sections to be reviewed and updated when new data becomes available, resulting in a plan that will remain current.

5.1.1 Plan Implementation and Coordination

The effectiveness of the plan depends on its implementation and the incorporation of its action items into existing local plans, policies, and programs. Together, the action items in the plan provide a framework for activities that San Mateo County and its planning partners can implement over the next 5 years. The steering committee established goals and objectives and prioritized mitigation initiatives that will be implemented through existing plans, policies, and programs.

The San Mateo County Office of Emergency Services (OES) will have primary responsibility for overseeing the plan implementation and maintenance strategy. Plan implementation and evaluation, however, will be a shared responsibility among all members of the planning partnership and agencies identified as lead or primary points of contact in the mitigation action plans. (See jurisdictional annexes in Volume 2 of this plan.)

It is anticipated that when this plan has been completed, there will be interest among the lead agencies identified in the action plan in pursuing grant funding under FEMA hazard mitigation grant programs and other relevant programs. Given the competitive nature of these programs, coordination and careful planning among the agencies will ensure the highest degree of success in seeking grant funding.

The steering committee has chosen to elect a Plan Implementation Lead to clarify responsibilities and to streamline efforts. The Plan Implementation Lead will strive to:

- Coordinate with lead agencies and stakeholders in identifying and developing opportunities for implementation of mitigation projects through existing mechanisms;
- Monitor grant funding opportunities identified in this plan; and
- Notify lead agencies when such funding opportunities become available.

The Plan Implementation Lead will coordinate implementation planning sessions as needed and with enough lead time to plan for pursuing Hazard Mitigation Assistance funds, which typically open in March or April. Several meetings may be held throughout the year, with at least one meeting held to coordinate with the annual mitigation grant cycle. (See the Annual Report subsection for more information.) The objectives of these sessions will be to:

- Identify and refine projects that are recommendations of this plan so that eligible, well-planned, vetted projects can be submitted for consideration when funding opportunities arise,
- Identify and develop strategies for incorporating mitigation projects into existing budgets, schedules, and planning mechanisms; and
- Provide input for the annual progress report regarding the actions and decisions of the committee.

The OES principal point of contact for coordinating review and engaging planning partner points of contact will be the San Mateo County OES Fire Liaison; this position will be known as the Plan Implementation Lead. At the time this plan was published, the Plan Implementation Lead is:

Brad Hartzell, Battalion Chief
North County Fire Authority
San Mateo County OES Fire Liaison
Operations Bureau – Emergency Planning Division
400 County Center | Redwood City, CA 94063
650-302-0807 | bhartzell@smcgov.org

5.1.2 Steering Committee

The hazard mitigation Steering Committee was a volunteer body that oversaw development of and made recommendations on key elements of the plan, including the implementation and maintenance strategy. It was the Steering Committee's position that an oversight committee with representation similar to that of the steering committee should have an active role in the plan implementation and maintenance. Therefore, it is recommended that the steering committee remain a viable body involved in key elements of the plan implementation and maintenance strategy. The steering committee will be folded into the existing San Mateo Emergency Manager's Association (EMA) Planning Committee; this new joint committee will be known as the Hazard Mitigation Working Group. The Hazard Mitigation Working Group will strive for representation from the planning partners, as well as other stakeholders. The Hazard Mitigation Working Group will use EMA meetings as a venue to discuss mitigation related activities and planning updates. EMA meetings are held quarterly, and hazard mitigation will be incorporated into every EMA meeting. The Plan Implementation Lead will coordinate with the OES Director and the EMA Planning Committee Lead in scheduling when reviews will occur.

This working group should strive to include representation from stakeholders in the planning area as well as the lead agencies identified. The hazard mitigation working group will work toward fulfilling the following three responsibilities:

- Coordinating project implementation,
- Reviewing the annual progress report, and
- Providing input to the Plan Implementation Lead on possible enhancements to be considered at the next update.

Future plan updates will be overseen by a steering committee similar to the one that participated in this plan development process, so keeping an interim working group intact will provide consistency and continued progress toward future updates.

Annual Progress Report

The Hazard Mitigation Working Group will also convene an annual working group meeting to evaluate the progress on the action plan during a 12-month performance period. This review will include items such as the following:

- Summary of any hazard events that occurred during the performance period and the impact of these events on the planning area;
- Review of mitigation success stories;
- Review of continuing public involvement;
- Brief discussion about why targeted strategies were not completed;
- Re-evaluation of the action plan to establish if the timeline for projects needs identified to be amended (such as changing a long-term project to a short-term one because of new funding);
- Recommendations for new projects;
- Changes in or potential for new funding options (grant opportunities); and
- The impact of any other planning programs or initiatives that involve hazard mitigation.

The steering committee has committed to preparing a progress report during the 2016 planning process. Participating planning partners are responsible for completing the template and forwarding this information to the Hazard Mitigation Working Group. The Hazard Mitigation Working Group will then prepare a formal annual report on the progress of the plan. This report should be used as follows:

- The reporting period will cover January to December of each reporting year;
- The Plan Implementation Lead will send out reminder e-mails to all planning partners no later than February 1 of each year;

- Planning partners will submit their status updates and sections of the annual report no later than March 1 of each year;
- The Plan Implementation Lead, in conjunction with the Hazard Mitigation Working Group, will prepare the annual report, including planning partner information, no later than March 15 of each year;
- San Mateo County OES will be responsible for ensuring the report is posted on the San Mateo County website page dedicated to the hazard mitigation plan;
- The Plan Implementation Lead will provide the report to the local media through a press release;
- The Hazard Mitigation Working Group will use the information in the annual report to identify projects of interest for the following year and to apply for Hazard Mitigation Assistance (HMA) funds, including Pre-Disaster Mitigation (PDM) and Flood Mitigation Assistance (FMA) grants; and
- The Hazard Mitigation Working Group will present to the San Mateo County Board of Supervisors and the planning partnership governing bodies to inform them of the progress of mitigation initiatives implemented during the reporting period.

Please note: Use of the progress report will be at the discretion of each planning partner. Annual progress reporting is not a requirement specified under 44 CFR; however, it may enhance the planning partnership's opportunities for funding, including HMA (PDM, FMA, and Hazard Mitigation Grant Program [HMGP])). While failure to implement this component of the plan maintenance strategy will not jeopardize a planning partner's compliance under the DMA, it may jeopardize its opportunity to partner and leverage funding opportunities with other planning partners. The Hazard Mitigation Working Group will follow up with planning partners that do not participate in the annual report as deemed necessary by the Plan Implementation Lead.

5.1.3 Plan Update

San Mateo County and its planning partners intends to update the hazard mitigation plan on a 5-year cycle from the date of initial plan adoption (Community Rating System [CRS] Step 10). This cycle may be accelerated to less than 5 years based on the following triggers:

- A federal disaster declaration that involves the planning area;
- A hazard event that causes loss of life; or
- A comprehensive update of the San Mateo General Plan or a participating planning partner's general or comprehensive plan.

It will not be the intent of future updates to develop a complete new hazard mitigation plan for the planning area. The update will, at a minimum, include the following elements:

- The update process will be convened through a steering committee.
- The hazard risk assessment will be reviewed and, if necessary, updated using best available information and technologies.

- The action plan will be reviewed and revised to account for any initiatives completed, dropped, or changed and to account for changes in the risk assessment or new policies identified under other planning mechanisms (such as the general plan).
- The draft update will be sent to appropriate agencies and organizations for comment.
- The public will be given an opportunity to comment on the update before it is adopted.
- Planning partnership governing bodies will adopt their portions of the updated plan.

5.1.4 Continuing Public Involvement

The public will continue to be apprised of the plan's progress through the hazard mitigation plan website and by providing copies of annual progress reports to the media. The website will not only house the final plan; it will become the single point of access and accumulation for information regarding the overall plan and plan implementation. Copies of the plan will be distributed to the San Mateo County library system. When the future update processes is initiated, a new public involvement strategy will be initiated based on guidance from a new steering committee. This strategy will be based on the needs and capabilities of San Mateo County and its planning partners at the time of the update. At a minimum, this strategy will include the use of local media outlets within the planning area.

5.1.5 Incorporation into Other Planning Mechanisms

The information on hazard, risk, vulnerability, and mitigation contained in this plan is based on the best science and technology available at the time this plan was prepared. The San Mateo County General Plan, and the various planning partners' general plans, are considered an integral part of the hazard mitigation plan. San Mateo County and participating planning partners, through adoption of a general plan, zoning ordinance, and other similar documents, have planned for the impacts of natural hazards. The plan development process provided the opportunity to review and expand on policies in these planning mechanisms. The general plan and the hazard mitigation plan are complementary documents that work together to achieve the goal of reducing risk exposure. An update to a general plan may trigger an update to the hazard mitigation plan, inclusive of jurisdiction-specific information. Specifically, current and future updates to county and municipal general plans, and other similar documents, will incorporate information provided on climate change into the general plan safety element, per Senate Bill 379.

San Mateo County and participating planning partners will create a linkage between the hazard mitigation plan and the general plan documents by identifying a mitigation initiative as such and giving that initiative a high priority. Other planning processes and programs to be coordinated with the recommendations of the hazard mitigation plan may include the following:

- Emergency response plans
- Natural hazard elements of community plans
- Capital improvement programs
- Municipal codes
- Community design guidelines

- Landscape design guidelines
- Stormwater management programs
- Water system vulnerability assessments
- Any additional plans as they are reviewed and updated during the performance period of this plan.

Some action items do not need to be implemented through regulation. Instead, these items can be implemented through creation of new educational programs, continued interagency coordination, or improved public participation. As information becomes available from other planning mechanisms that can enhance this plan, that information may be incorporated via the update process.