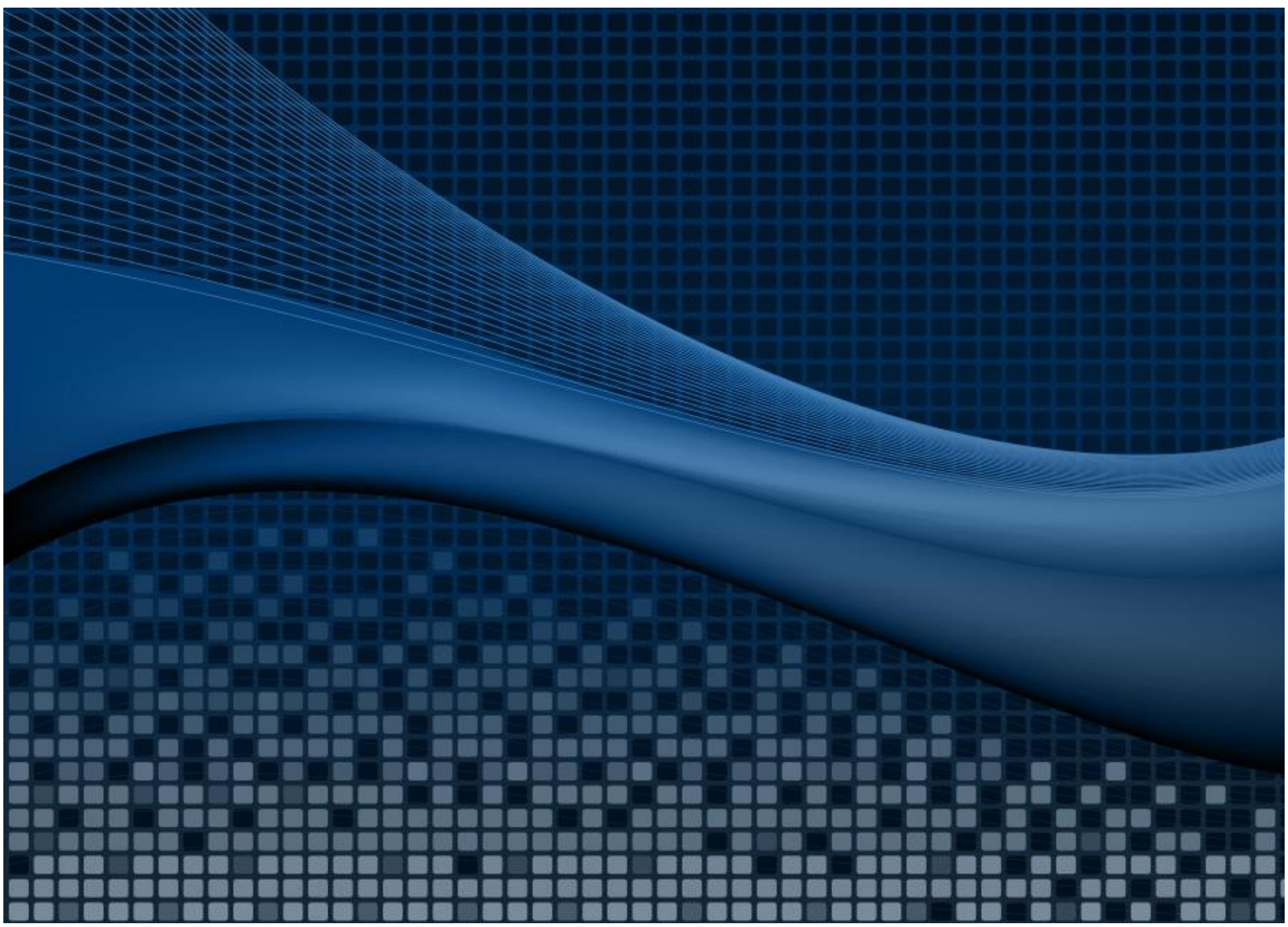
Attachment 4

ATTACHMENT 2

Santa Clara County Operational Area Hazard Mitigation Plan

Volume 1—Operational-Area-Wide Elements



TETRA TECH

September 19, 2017

Santa Clara County Operational Area Hazard Mitigation Plan

Volume 1—Operational-Area-Wide Elements

September 19, 2017

PREPARED FOR

County of Santa Clara
Office of Emergency Services

55 West Younger Avenue, Suite 450
San José, CA 95110
Phone: 408.808.7800

PREPARED BY

Tetra Tech

1999 Harrison Street
Suite 500
Oakland, CA 94612

Phone: 510.302.6300
Fax: 510.433.0830
tetratech.com

Tetra Tech Project #103s4628

\\IWRS065FS1\Data\Active\0_HazMitigation\103s4628.emi_SantaClaraCountyHMP\2017-09_FEMASubmittal\2017-09-19_Vol1_SantaClaraHMP_FEMASubmittal.docx

CONTENTS

Appendices

Tables

Figures

ACKNOWLEDGMENTS

County of Santa Clara

- Darrell G. Ray Jr., CEM, Emergency Management Specialist, Santa Clara County Office of Emergency Services/Santa Clara County Fire Department
- Louay Toma, MPA, Emergency Management Specialist, Santa Clara County Office of Emergency Services/Santa Clara County Fire Department
- Cindy Stewart, Senior Emergency Planning Coordinator, Office of Emergency Services
- David S. Flamm, CEM, Deputy Director, Santa Clara County Office of Emergency Services

Consultants

- Rob Flaner, CFM, Tetra Tech, Inc., Project Manager
- Jessica Cerutti, CFM, Tetra Tech, Inc., Lead Project Planner
- Carol Bauman, GISP, Tetra Tech, Inc., Risk Assessment Lead
- Stephen Veith, MUP, Tetra Tech, Inc., GIS/Hazus Analyst
- Kristen Gelino, MUP, CFM, Tetra Tech, Inc., Planner
- Kari Valentine, CFM, Tetra Tech, Inc., Planner
- Emily Slotnick, MUP, ACIP, CFM; Tetra Tech, Inc., Planner
- Dan Portman, Tetra Tech, Inc., Technical Editor

Stakeholders

- Kent Fielden, American Red Cross
- Joseph Cefalu, Campbell Police Department
- Marsha Hovey, Collaborating Agencies Disaster Relief Effort
- Kara Gross, Joint Venture
- Jennifer Ponce, Morgan Hill Emergency Services
- Lisa Schoenthal, Santa Clara (City) Emergency Services
- Lynn Brown, Mountain View Emergency Services
- Ian Hogg, Mineta San José International Airport
- Cay Denise MacKenzie, San José Office of Emergency Services
- Jared Hart, San José Planning, Building and Code Enforcement
- Brian Glass, Santa Clara County Fire Department
- Raymond Fields, Santa Clara Valley Water District
- Michael Brill, Valley Transportation Authority
- John Lang, Silicon Valley Economic Development Alliance
- Bart Spencer, Central County Fire Department (San Mateo County)

Special Acknowledgments

The development of this plan would not have been possible without the dedication and commitment to this process by the Santa Clara County Operational Area Local Hazard Mitigation Plan Working Group. The dedication of this volunteer committee to allocate their time to this process is greatly appreciated. Also, the citizens of Santa Clara County Operational Area are commended for their participation in the outreach strategy implemented for this plan. This outreach success will set the course to the successful implementation of this plan.

EXECUTIVE SUMMARY

HAZARD MITIGATION PLANNING BACKGROUND

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. Santa Clara County and a partnership of local governments within the county have developed a hazard mitigation plan to reduce risks from natural disasters in the Santa Clara County Operational Area—defined as the unincorporated county and incorporated jurisdictions within the geographical boundaries of the county. The plan complies with federal and state hazard mitigation planning requirements to establish eligibility for funding under Federal Emergency Management Agency (FEMA) grant programs.

Initial Regional Planning Efforts for Hazard Mitigation

The Association of Bay Area Governments (ABAG) provides communities in the San Francisco Bay area with planning and research resources related to land use, housing, environmental and water resource protection, disaster resilience, energy efficiency, hazardous waste mitigation, risk management and financial services. In 2004, ABAG led a regional effort to address hazard mitigation planning for Bay Area jurisdictions. ABAG's regional template was used by numerous counties and cities to meet federal hazard mitigation planning requirements. The ABAG process enabled individual planning processes to meet local government needs, while pooling resources and eliminating redundant planning efforts.

In 2010, ABAG conducted its second regional planning effort. Municipalities that used the 2010 updated ABAG tools to meet federal hazard mitigation planning requirements included the County of Santa Clara and the cities of Campbell, Cupertino, Gilroy, Los Altos, Los Altos Hills, Los Gatos, Milpitas, Monte Sereno, Morgan Hill, Mountain View, Palo Alto, San José, Santa Clara, Saratoga and Sunnyvale. ABAG discontinued its full support of the regional planning concept in 2015, so jurisdictions that were covered under the regional plan must initiate individual or reformed multijurisdictional planning efforts to continue to comply with federal mitigation planning requirements.

The 2016 Santa Clara County Operational Area Planning Effort

In 2016, Santa Clara County, the Santa Clara County Fire Department, and all incorporated cities in Santa Clara County teamed together to prepare an updated multi-jurisdiction hazard mitigation plan tailored to the local needs and capabilities of the Santa Clara County Operational Area. The planning partnership developed a new plan from scratch, using lessons learned from the earlier ABAG planning efforts. The 2016 plan differs from previous plans in the following ways:

- The plan is not a subset of a larger regional effort. It focuses on the geographic region of the Santa Clara County Operational Area and on hazards of concern specific to that area.
- The plan follows the planning guidance of FEMA's Community Rating System so that it maximizes the planning benefit for the nine communities in the Operational Area participating in that program.
- Newly available data and tools provide for a more detailed and accurate risk assessment.

- The risk assessment has been formatted to provide information on risk and vulnerability that will allow a measurement of cost-effectiveness, as required under FEMA mitigation grant programs.
- The update gave the planning partners an opportunity to engage local citizens and gauge their perception of risk and support for risk reduction through mitigation.

PLAN DEVELOPMENT APPROACH

Phase 1—Organization

A core planning group consisting of a contract consultant and Santa Clara County Office of Emergency Services staff was assembled to facilitate the update of this plan. A planning partnership was formed by engaging the eligible local governments within the Operational Area and making sure they understood their expectations for compliance under the updated plan. A 19-member working group was assembled to oversee the plan update, consisting of both governmental and not-governmental stakeholders within the Operational 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 ABAG hazard mitigation plan, the California statewide hazard mitigation plan, and existing programs that may support hazard mitigation actions.

Phase 2—Risk Assessment

Risk assessment is the process of measuring the potential loss of life resulting from natural hazards, as well as personal injury, economic injury and property damage, in order to determine the vulnerability of people, buildings, and infrastructure to natural hazards. For this update, risk assessment models were enhanced with new data and technologies that have become available since 2010. The Working Group used the risk assessment to rank risk and to gauge the potential impacts of each hazard of concern in the Operational Area. The risk assessment included the following:

- Hazard identification and profiling
- Assessment of the impact of hazards on physical, social, and economic assets
- Identification of particular areas of vulnerability
- Estimates of the cost of potential damage.

Based on the risk assessment, hazards were ranked for the risk they pose to the overall Operational Area, as shown in Table ES-1.

Table ES-1. Hazard Risk Ranking

Hazard Ranking	Hazard Event	Category
1	Earthquake	High
2	Flood	High
3	Severe Weather	High
4	Dam and Levee Failure	Medium
5	Landslide	Medium
6	Wildfire	Medium
7	Drought	Medium

Each planning partner also ranked hazards for its own area. Table ES-2 summarizes the categories of high, medium and low (relative to other rankings) based on the numerical ratings that each jurisdiction assigned each hazard.

Table ES-2. Summary of Hazard Ranking Results

	Number of Jurisdictions Assigning Ranking to Hazard			
	High	Medium	Low	Not Ranked
Dam Failure	0	4	10	3
Drought	0	1	15	1
Earthquake	17	0	0	0
Flood	0	17	0	0
Landslide	1	10	3	3
Severe weather	2	15	0	0
Wildfire	5	5	3	4

The results indicate the following general patterns:

- The earthquake hazard was most commonly ranked as high.
- The flood, landslide and severe weather hazards were most commonly ranked as medium.
- The dam failure and drought hazards were most commonly ranked as low.

Phase 3—Public Outreach

The Core Planning Group implemented a multi-media public involvement strategy utilizing the outreach capabilities of the planning partnership that was approved by the Working Group. The strategy included public meetings to introduce the planning process and present the risk assessment, a hazard mitigation survey, a project website, the utilization of social media (Facebook, Twitter and Nextdoor) and multiple media releases.

Phase 4—Goals, Objectives and Actions

The Working Group reviewed and updated the goals from the 2010 ABAG plan and developed a set of objectives. The planning partnership selected a range of appropriate mitigation actions to work toward achieving the goals set forth in this plan update. Additionally, the Working Group selected a set of county-wide mitigation actions.

Phase 5—Implementation and Maintenance Strategy

The Working Group developed a plan implementation and maintenance strategy that includes annual progress reporting, a strategy for continued public involvement, a commitment to plan integration with other relevant plans and programs, and a recommitment from the planning partnership to actively maintain the plan over the five-year performance period.

Phase 6—Plan Document Development

The Core Planning Group and Working Group assembled a document to meet federal hazard mitigation planning requirements for all partners. The updated plan contains two volumes. Volume 1 contains components that apply to all partners and the broader Operational Area. Volume 2 contains all components that are jurisdiction-specific. Each planning partner has a dedicated annex in Volume 2.

Phase 7—Adoption

Once pre-adoption approval has been granted by the California Office of Emergency Services and FEMA Region IX, the final adoption phase will begin. Each planning partner will individually adopt the updated plan.

Phase 8—Plan Implementation

Plan implementation will occur over the next five years as the planning partnership begins to implement the countywide and jurisdiction-specific actions identified in this plan.

MITIGATION GOALS AND OBJECTIVES

The following guiding principle guided the Working Group and the planning partnership in selecting the actions contained in this plan update:

> Carefully plan for the maintenance and enhancement of a disaster-resistant Operational Area by reducing the current and future potential loss of life, property damage, and environmental degradation from various hazards, while accelerating economic recovery from those hazards.

Goals

The Working Group and the planning partnership established the following goals for the plan update:

1. Actively develop community awareness, understanding, and interest in hazard mitigation and empower the Operational Area to engage in the shaping of associated mitigation policies and programs.
2. Minimize potential for loss of life, injury, social impacts, and dislocation due to hazards.
3. Minimize potential for damage to property, economic impacts, and unusual public expense due to hazards.
4. Provide essential information to the whole community that promotes personal preparedness and includes advice to reduce personal vulnerability to hazards.
5. Encourage programs and projects that promote community resiliency by maintaining the functionality of critical Operational Area resources, facilities, and infrastructure.
6. Promote an adaptive and resilient Operational Area that proactively anticipates the impacts of climate change.

The effectiveness of a mitigation strategy is assessed by determining how well these goals are achieved.

Objectives

The following objectives were identified to help establish priorities for recommended mitigation actions. 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 are as follows:

1. Develop and provide updated information about threats, hazards, vulnerabilities, and mitigation strategies to state, regional, and local agencies, as well as private sector groups.
2. Improve understanding of the locations, potential impacts, and linkages among threats, hazards, vulnerability, and measures needed to protect life.
3. Encourage the incorporation of mitigation best management measures into plans, codes, and other regulatory standards for public, private, and non-governmental entities within the Operational Area.
4. Inform the public on the exposure to natural hazard risk and ways to increase the public's capability to prevent, prepare, respond, recover, and mitigate impacts of natural hazard events.
5. Establish and maintain partnerships in the identification and implementation of mitigation measures in the Operational Area.
6. Advance community and natural environment sustainability and resilience to future impacts through preparation and implementation of state, regional, and local projects.
7. Reduce repetitive property losses from all hazards.

8. Where feasible and cost-effective, encourage property protection measures for vulnerable structures located in hazard areas.
9. Improve systems that provide warning and emergency communications.

MITIGATION ACTION PLAN

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 more than 344 mitigation actions for implementation by individual planning partners, as presented in Volume 2 of this plan. In addition, the Working Group and planning partnership identified countywide actions benefiting the whole partnership, as listed in Table ES-3.

Table ES-3. Hazard Mitigation Action Plan Matrix

Action Number and Description	Priority
Action SCOA-1—Continue to maintain a website that will house the Operational Area hazard mitigation plan, its progress reports, and all components of the plan's maintenance strategy to provide the planning partners and public ongoing access to the plan and its implementation.	High
Action SCOA-2— Continue to leverage, support and enhance ongoing, regional public education and awareness programs as a method to educate the public on risk, risk reduction and community resilience.	High
Action SCOA-3—Continue ongoing communication and coordination in the implementation of the Santa Clara County Operational Area Hazard Mitigation Plan.	High
Action SCOA-4—Continue to support the use, development and enhancement of a regional crisis communications system.	High
Action SCOA-5—Strive to capture time-sensitive, perishable data—such as high water marks, extent and location of hazard, and loss information—following hazard events to support future updates to the risk assessment.	High
Action SCOA-6—Identify new and comprehensive hazard datasets to improve and augment future updates to the risk assessment	High

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. The County of Santa Clara and its planning partners will assume responsibility for adopting the recommendations of this plan and committing resources toward implementation. The framework established by this plan commits all planning partners to pursue actions when the benefits of a project exceed its costs. The planning partnership developed this plan with extensive public input, and public support of the actions identified in this plan will help ensure the plan's success.

PART 1—PLANNING PROCESS AND COMMUNITY PROFILE

1. INTRODUCTION TO HAZARD MITIGATION PLANNING

1.1 WHY PREPARE THIS PLAN?

1.1.1 The Big Picture

Hazard mitigation is defined as any action taken to reduce or alleviate the loss of life, personal injury, and property damage that can result from a disaster. It involves long- and short-term actions implemented before, during and after disasters. Hazard mitigation activities include planning efforts, policy changes, programs, studies, improvement projects, and other steps to reduce the impacts of hazards.

For many years, federal disaster funding focused on relief and recovery after disasters occurred, with limited funding for hazard mitigation planning in advance. The Disaster Mitigation Act (DMA; Public Law 106-390), passed in 2000, shifted the federal emphasis toward planning for disasters before they occur. The DMA requires state and local governments to develop hazard mitigation plans as a condition for federal disaster grant assistance. Regulations developed to fulfill the DMA's requirements are included in Title 44 of the Code of Federal Regulations (44 CFR).

The responsibility for hazard mitigation lies with many, including private property owners, commercial interests, and local, state and federal governments. The DMA encourages cooperation among state and local authorities in pre-disaster planning. The enhanced planning network called for by the DMA helps local governments to articulate accurate needs for mitigation, resulting in faster allocation of funding and more cost-effective risk-reduction projects.

The DMA also promotes sustainability in hazard mitigation. To be sustainable, hazard mitigation needs to incorporate sound management of natural resources and address hazards and mitigation in the largest possible social and economic context.

1.1.2 Purposes for Planning

Fourteen jurisdictions within the Santa Clara County Operational Area (OA)—defined as the unincorporated county and incorporated jurisdictions within the geographical boundaries of Santa Clara County—participated in the regional hazard mitigation plan prepared in 2010 by Santa Clara County Office of Emergency Services with support from Dewberry Consultants and in collaboration with the Association of Bay Area Governments (ABAG). That regional plan was adopted and approved in compliance with the DMA. It called for updates on a five-year cycle. This update fulfills that requirement.

This hazard mitigation plan update identifies resources, information, and strategies for reducing risk from natural hazards. Participating jurisdictions are referred to in this plan as planning partners. Elements and strategies in the plan were selected because they meet a program requirement and because they best meet the needs of the planning partners and their citizens. One of the benefits of multi-jurisdictional planning is the ability to pool resources and eliminate redundant activities within the OA that have uniform risk exposure and vulnerabilities. The Federal Emergency Management Agency (FEMA) encourages multi-jurisdictional planning under its guidance for the

DMA. This plan will help guide and coordinate mitigation activities throughout the OA. It was developed to meet the following objectives:

- Meet or exceed requirements of the DMA.
- Enable all planning partners to continue using federal grant funding to reduce risk through mitigation.
- Meet the needs of each planning partner as well as state and federal requirements.
- Create a risk assessment that focuses on local hazards of concern.
- Meet the planning requirements of FEMA’s Community Rating System (CRS), allowing planning partners that participate in the CRS program to maintain or enhance their CRS classifications.
- Coordinate existing plans and programs so that high-priority projects to mitigate possible disaster impacts are funded and implemented.

1.2 WHO WILL BENEFIT FROM THIS PLAN?

The whole community of the Santa Clara County OA—including residents, visitors, and industry—is the ultimate beneficiary of this hazard mitigation plan. The plan reduces risk for those who live in, work in, and visit the OA. It provides a viable planning framework for all foreseeable natural hazards. Participation in development of the plan by key stakeholders helped ensure that outcomes will be mutually beneficial. The resources and background information in the plan are applicable across the OA, and the plan’s goals and recommendations can lay groundwork for the development and implementation of local mitigation activities and partnerships.

1.3 CONTENTS OF THIS PLAN

This plan has been set up in two volumes so that elements that are jurisdiction-specific can easily be distinguished from those that apply to the overall Santa Clara County OA:

- Volume 1—Volume 1 includes all federally required elements of a disaster mitigation plan that apply to the OA. This includes the description of the planning process, public involvement strategy, goals and objectives, hazard risk assessment, mitigation actions, and a plan maintenance strategy.
- Volume 2—Volume 2 includes all federally required jurisdiction-specific elements, in annexes for each participating jurisdiction. It includes a description of the participation requirements established for participants in this plan, as well as instructions and templates that the partners used to complete their annexes. Volume 2 also includes “linkage” procedures for eligible jurisdictions that did not participate in development of this plan but wish to adopt it in the future.

Both volumes include 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 Volume 1 include information or explanations to support the main content of the plan:

- Appendix A—Public outreach information used in preparation of this update.
- Appendix B—Template for progress reports to be completed as this plan is implemented.
- Appendix C—Plan adoption resolutions from planning partners.

All planning partners will adopt Volume 1 in its entirety and at least the following parts of Volume 2: Part 1; each partner’s jurisdiction-specific annex; and the appendices.

2. PLAN UPDATE—WHAT HAS CHANGED

2.1 THE PREVIOUS PLAN

Fourteen jurisdictions in the Santa Clara County OA were covered under the 2010 Association of Bay Area Governments 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 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. A jurisdiction covered by a plan that has expired is not able to pursue elements of federal funding under the Robert T. Stafford Act for which a current hazard mitigation plan is a prerequisite.

2.2.2 Changes in Development

Hazard mitigation plan updates must be revised to reflect changes in development within the OA since the previous plan (44 CFR Section 201.6(d)(3)). The plan must describe changes in development in hazard-prone areas that increased or decreased vulnerability for each jurisdiction since the last plan was approved. If no changes in development impacted the jurisdiction's overall vulnerability, 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 impact vulnerability.

According to data from the California Department of Finance, the OA experienced a 7.6-percent increase in population between 2010 and 2015, an average annual growth rate of 1.52 percent per year. Participating planning partners have adopted general plans that govern land-use decisions and policy-making, as well as building codes and specialty ordinances based on state and federal mandates. This plan update assumes that some new development triggered by the increase in population occurred in hazard areas. Because all such new development would have been regulated pursuant to local programs and codes, it is assumed that vulnerability did not increase even if exposure did.

2.2.3 New Analysis Capabilities

The risk assessment for the previous Santa Clara County OA hazard mitigation plan 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 levee failure, earthquake, and flood. Exposure and vulnerability estimates are presented at the community level. This enhanced risk assessment, and the full participation of every local jurisdiction within the county, allows for a more detailed understanding of the ways risk in the OA is changing over time.

2.3 THE UPDATED PLAN—WHAT IS DIFFERENT?

Although the Santa Clara County OA's 2010 hazard mitigation plan update was prepared under the ABAG process, the OA's stakeholders, including County agencies, municipalities, and special districts, determined that a new Operational Area-wide hazard mitigation plan would better suit the needs and capabilities of the 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 ongoing commitment to the plan's success. Some of the major differences between the current and previous plans are as follows:

- The plan has been totally restructured as an Operational Area plan, focusing only on the geographic area of Santa Clara County. The risk assessment is not a subset of a larger regional effort. Instead, it is isolated to the Santa Clara County OA and focuses on the hazards of concern for the OA.
- 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. (Hazus) Multi-Hazard computer model or new data such as FEMA's countywide Digital Flood Insurance Rate Maps.
- The planning process creates the opportunity for all municipal planning partners to prepare to meet the requirements of California Senate Bill 379 during the next plan update. That bill 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 of Santa Clara, local cities, and other 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's goals objectives and actions are more clearly defined. The plan identifies actions rather than strategies as was the case with the prior plans. 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, which was difficult prior to this plan update.
- This plan update includes local jurisdictions that did not participate during the 2010 ABAG process, including the Town of Los Altos Hills, the City of Milpitas, and the Santa Clara County Fire Department. The inclusion of these jurisdictions has provided area planners with a greater understanding of risk exposure and mitigation needs across the wider OA. Additionally, their participation in this latest plan update will benefit the wider OA planning community by amplifying the benefits of multi-jurisdictional mitigation projects, ultimately making all local jurisdictions more competitive for mitigation grant funding.

There are fundamental differences in the planning process conducted for this update and past planning efforts under the ABAG initiative. The planning partners have treated this update as an opportunity to perform a "functional reset" in mitigation planning. The focus of this update was to transition from a nine-county regional scale, to an OA-specific scale. 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	Previous Plan	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 for this update was based upon the CRS 10-step planning process, which emphasizes comprehensive risk assessment and public engagement. Volume 1 Chapters 2, 3, 4, and 5 describe the planning process for the update.

44 CFR Requirement	Previous Plan	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. These are primarily qualitative risk assessments with quantitative modeling for the earthquake hazard using Hazus.	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 the Santa Clara County OA. The risk assessment includes multiple-scenario modeling for dam failure, earthquake, flood and sea-level rise. Hazard profiles are standardized for each hazard of concern, so that there is uniformity in the discussion of each hazard and the information provided can support ranking of risk for each jurisdiction. Other hazards of interest were qualitatively assessed to develop a more complete picture of the hazards facing the OA.
§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 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.

44 CFR Requirement	Previous Plan	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. Critical facilities were defined for the OA, 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 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.
§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.

44 CFR Requirement	Previous Plan	Updated Plan
§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.	A guiding principal, seven goals, and 11 objectives are described in Chapter 16. 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 1, Part 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.
§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 18.
§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 five-year cycle.	Appendix B of the ABAG plan contains a plan maintenance and update process.	Volume 1, Part 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
§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.	Volume 1, Part 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 2.

44 CFR Requirement	Previous Plan	Updated Plan
§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.	Volume 1, Part 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 1, Appendix C contains the resolutions of all planning partners that adopted this plan.

3. PLAN UPDATE APPROACH

The process followed to develop the Santa Clara County Operational Area Hazard Mitigation Plan had the following primary objectives:

- Secure grant funding.
- Form a planning group.
- Identify Stakeholders
- Establish a planning partnership.
- Define the Santa Clara County OA.
- Establish a volunteer working group.
- Coordinate with other agencies.
- Review existing programs.
- Engage the public.

These objectives are discussed in the following sections.

3.1 GRANT FUNDING

This planning effort was supplemented by a FEMA Hazard Mitigation Assistance grant in fiscal year 2014. Santa Clara County Office of Emergency Services (OES) was the applicant agent for the grant. It covered 75-percent of the cost for development of this plan; the planning partners covered the balance through in-kind contributions.

3.2 FORMATION OF THE PLANNING GROUP

Santa Clara County OES hired Tetra Tech, Inc. to assist with development and implementation of the plan. The Tetra Tech project manager assumed the role of the lead planner, reporting directly to the Santa Clara County OES project manager. A planning group was formed to lead the planning effort, made up of the following members:

- Darrell Ray, Santa Clara County Office of Emergency Services/Santa Clara County Fire Department
- Louay Toma, Santa Clara County Office of Emergency Services/Santa Clara County Fire Department
- Rob Flaner, Tetra Tech
- Carol Baumann, Tetra Tech

This planning group—designated the Santa Clara County Operational Area Local Hazard Mitigation Plan (LHMP) Core Planning Group (or the Core Planning Group)—coordinated regularly during the course of this project to track plan development milestones and to identify meeting content for a working group established to help with development of the update.

3.3 DEFINING STAKEHOLDERS

For this planning process, "stakeholder" was defined as: *any person or public or private entity that owns or operates facilities that would benefit from the mitigation actions of this plan, and/or has an authority or capability to support mitigation actions identified by this plan*. Stakeholders were separated into two categories:

- **Participatory Stakeholders**—Stakeholders that actively participated in the planning process as planning partners or members of the Steering Committee.
- **Coordinating Stakeholders**—Stakeholders that were not able to commit to actively participating in the process as a participatory stakeholder, but were kept apprised of plan development milestones or were able to provide data that was used in the plan development.

At the beginning of the planning process, the planning team identified a list of stakeholders to engage during the development of the Santa Clara County Operational Area Hazard Mitigation Plan. The following stakeholders played a role in the planning process:

- **Federal Agencies:**
  - FEMA Region IX provided updated planning guidance, provided summary and detailed data for the planning area from the National Flood Insurance Program (NFIP) (including repetitive loss information), and conducted plan review.
  - The U.S. Geological Survey (USGS) provided ShakeMaps to support the earthquake risk assessment.
- **State Agencies:**
  - The California Governor's Office of Emergency Services (CalOES) facilitated FEMA review, provided updated planning guidance, and reviewed the draft and final versions of the plan prior to FEMA review.
  - The California Department of Forestry and Fire Protection (CAL FIRE) provided fire severity mapping to support the wildfire risk assessment.
  - The California Department of Water Resources provided information on NFIP compliance for the cities.
- **Regional and Local Stakeholders**—The planning team offered regional and local stakeholders the opportunity to be informed about the planning process. The following organizations received information about the planning process, were invited to provide input, and elected to participate in the planning process as full members of the Working Group:
  - Santa Clara County agencies:
    - Santa Clara County Fire Department
    - Santa Clara Valley Water District
    - Santa Clara Valley Transportation Authority
    - Mineta San José International Airport
    - American Red Cross, Santa Clara Valley Chapter
    - Santa Clara County, Community Emergency Response Team (CERT)
    - Santa Clara County Office of Education
  - San Mateo County
  - Alameda County
  - Pacific Gas and Electric (PG&E)

3.4 ESTABLISHMENT OF THE PLANNING PARTNERSHIP

Santa Clara County OES opened this planning effort to all eligible local governments within the OA. The Core Planning Group made a presentation at a stakeholder meeting on July 19, 2016 to introduce the mitigation planning process and solicit planning partners. Key meeting objectives were as follows:

- Provide an overview of the Disaster Mitigation Act.
- Describe the reasons for a plan.
- Outline the hazard mitigation work plan.
- Outline planning partner expectations.
- Seek commitment to the planning partnership.
- Seek volunteers for the working group.

Each jurisdiction wishing to join the planning partnership was asked to provide a "letter of intent to participate" that designated a point of contact for the jurisdiction and confirmed the jurisdiction's commitment to the process and understanding of expectations. Linkage procedures have been established (see Volume 2 of this plan) for any jurisdiction wishing to link to the Santa Clara County Operational Area Hazard Mitigation Plan in the future. The planning partners covered under this plan are listed in Table 3-1.

Table 3-1. Municipal Planning Partners

Jurisdiction	Point of Contact	Title
County of Santa Clara	David Flamm	Deputy Director, Emergency Services
City of Campbell	Joe Cefalu	Captain, Police Department
City of Cupertino	Timm Borden	Director, Public Works
City of Gilroy	Roy Shackel	Fire Captain OES Coordinator
City of Los Altos	Scott McCrossin	Captain, Police Department
Town of Los Altos Hills	Marsha Hovey	Emergency Preparedness Consultant
Town of Los Gatos	Laurel Prevetti	Town Manager
City of Milpitas	Toni Charlop	Manager, Emergency Services
City of Monte Sereno	Debra Figone	Interim City Manager
City of Morgan Hill	Jennifer Ponce	Coordinator, Emergency Services
City of Mountain View	Lynn Brown	Coordinator, Emergency Services
City of Palo Alto	Nathan Rainey	Coordinator, Emergency Services
City of San José	Cay Denise MacKenzie	Senior Emergency Services Planner
City of Santa Clara	Lisa Schoenthal	Coordinator, Emergency Services
City of Saratoga	Michael Taylor	Director, Recreation and Facilities
City of Sunnyvale	Vinnie Mata	Captain, Public Safety
Santa Clara County Fire Department	Brian Glass	Battalion Chief

3.5 DEFINING THE PLANNING AREA

The defined planning area for this update has been defined as the Santa Clara County Operational Area (OA). The OA is defined as the unincorporated county and incorporated cities within the geographical boundary of Santa Clara County. Relevant OA characteristics are described in Chapter 4. All partners to this plan have jurisdictional authority within this OA. Figure 4-1 in Chapter 4 shows the geographic boundary of the defined planning area for this plan update.

3.6 ESTABLISHMENT OF A WORKING GROUP

Hazard mitigation planning enhances collaboration and support among diverse parties whose interests can be affected by hazard losses. A working group, made up of participatory stakeholders, was formed to oversee all phases of this plan. The official title for this group was the Santa Clara County Operational Area LHMP Working Group (or the Working Group). Its members included key planning partner staff, citizens, and other stakeholders from within the OA. The Core Planning Group assembled a list of candidates willing to fully participate in the planning process, with interests within the OA that could have recommendations for the plan or be impacted by its recommendations. The planning partners confirmed a committee of 19 members at the kickoff meeting. Table 3-2 lists the Working Group members.

Table 3-2. Santa Clara County Operational Area LHMP Working Group Members

Name	Title	Jurisdiction/Agency
David Flamm	Deputy Director	Santa Clara County OES
Darrell Ray	Emergency Management Planner	Santa Clara County OES/Fire Department
Louay Toma	Emergency Management Planner	Santa Clara County OES/Fire Department
Kent Fielden	Volunteer	American Red Cross, Santa Clara Valley Chapter
Joseph Cefalu	Captain	Campbell Police Department
Marsha Hovey	Volunteer	Collaborating Agencies Disaster Relief Effort
Kara Gross	Executive Director	Joint Venture, Silicon Valley
Jennifer Ponce	Coordinator	Morgan Hill Emergency Services
Lisa Schoenthal	Coordinator	Santa Clara (City) Emergency Services
Lynn Brown	Coordinator	Mountain View Emergency Services
Anne Wein	Operations Research Analyst	US Geological Survey (USGS)
Ian Hogg	Superintendent	Mineta San José International Airport
Cay Denise MacKenzie	Director	Senior Emergency Services Planner
Jared Hart	Planner	San José Planning
Brian Glass	Battalion Chief	Santa Clara County Fire Department
Raymond Fields	Project Manager	Santa Clara Valley Water District
Michael Brill	System Safety	Santa Clara Valley Transportation Authority
John Lang	Economic Development Coordinator	Silicon Valley Economic Development Alliance
Bart Spencer	Emergency Services Coordinator	Central County Fire
John Lang	Program Manager	Silicon Valley Economic Development Alliance

Leadership roles and ground rules were established during the Working Group's initial meeting on August 24, 2016. The Working Group agreed to meet once per month, as needed throughout the course of the plan's development. The Core Planning Group facilitated each Working Group meeting, which addressed a set of objectives based on an established work plan. The Working Group met eight times from August 2016 through April 2017. Meeting agendas, notes and attendance logs are available for review upon request. All Working Group meetings were open to the public and advertised as such via the hazard mitigation planning website. Agendas and meeting notes were posted to the hazard mitigation plan website.

3.7 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, businesses, academia, and other private and nonprofit interests (44 CFR, Section 201.6(b)(2)). This task was accomplished by the Core Planning Group as follows:

- **Working Group Involvement**—Identified participatory stakeholders were invited to participate on the Working Group by formal invitation from the Core Planning Group via email.
- **Agency Notification**— The following agencies and contacts were invited to participate in the plan development process from the beginning and were kept apprised of plan development milestones through regular participation as full Steering Committee members. These were considered coordinating stakeholders as defined in Section 3.3:

  - ❖ California Office of Emergency Services (CalOES), Emergency Services Coordinator
  - ❖ FEMA Region IX, Lead Community Planner
  - ❖ California Department of Water Resources, California State NFIP Coordinator
  - ❖ Association of Bay Area Governments, Resilience Program Coordinator
  - ❖ Santa Clara Valley Water District, Security and Emergency Services Unit Manager
  - ❖ American Red Cross.
  - ❖ NASA Ames Research Center, Risk Manager
  - ❖ Collaborating Agencies Disaster Relief Effort.
  - ❖ Silicon Valley Community Foundation.

  These agencies received meeting announcements, meeting agendas, and meeting minutes by e-mail throughout the plan development process. Some of these agencies supported the effort by attending meetings or providing feedback on issues.

- **Pre-Adoption Review**—all the agencies listed above were provided an opportunity to review and comment on this plan, primarily through the hazard mitigation plan website (see Section 3.9). Each agency was sent an e-mail message informing them that draft portions of the plan were available for review. In addition, the complete draft plan was sent to CalOES and FEMA for a pre-adoption review to ensure program compliance.

3.8 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)). Chapter 4 of this plan provides a review of laws and ordinances in effect within the OA that can affect hazard mitigation actions. In addition, the following programs can affect mitigation within the OA:

- California Fire Code.
- 2016 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.

An assessment of all planning partners’ regulatory, technical and financial capabilities to implement hazard mitigation actions is presented in Chapter 4 and in the individual jurisdiction-specific annexes in Volume 2. Many of these relevant plans, studies and regulations are cited in the capability assessment.

3.9 PUBLIC INVOLVEMENT

Broad public participation in the planning process helps ensure that diverse points of view about the OA's needs are considered and addressed. The public must have opportunities to comment on disaster mitigation plans during the drafting stages and prior to plan approval (44 CFR, Section 201.6(b)(1)). The Community Rating System expands on these requirements by making CRS credits available for optional public involvement activities.

3.9.1 Strategy

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

- Include members of the public on the Working Group.
- Use a survey to determine if the public's perception of risk and support of hazard mitigation has changed since the initial planning process.
- Attempt to reach as many OA citizens as possible using multiple media.
- Identify and involve OA stakeholders.

Stakeholders and the Santa Clara County Operational Area LHMP Working Group

Stakeholders are the individuals, agencies and jurisdictions that have a vested interest in the recommendations of the hazard mitigation plan, including all planning partners. The effort to include stakeholders in this process included stakeholder participation on the Working Group.

The planning process involved a broad range of federal, state, regional, and local stakeholders. The following stakeholders played a role in the planning process:

- Federal Agencies—FEMA Region IX provided updated planning guidance, provided summary and detailed data for the OA from the National Flood Insurance Program (including repetitive loss information), and conducted plan review. Representatives from the National Weather Service and U.S. Geological Survey served as subject matter advisors for the Working Group.
- State Agencies—CalOES facilitated FEMA review, provided updated planning guidance, and reviewed the draft and final versions of the plan prior to FEMA review.
- Regional and Local Stakeholders—The Core Planning Group offered regional and local stakeholders the opportunity to remain informed about the planning process. The following organizations received information about the planning process and invitations to provide input, and elected to participate in the planning process as members or subject matter advisors to the Working Group:
  - City of Campbell
  - City of Cupertino
  - City of Gilroy
  - City of Milpitas
  - City of Monte Sereno
  - City of Mountain View
  - City of Morgan Hill
  - City of Palo Alto
  - City of San José
  - City of Santa Clara
  - City of Saratoga
  - City of Sunnyvale
  - Town of Los Altos Hills
  - Town of Los Gatos
  - County of Santa Clara

- ❖ America Red Cross (ARC)
- ❖ Central County (San Mateo) Fire District
- ❖ Joint Venture Silicon Valley
- ❖ Mineta International Airport
- ❖ Santa Clara County Fire Department
- ❖ Santa Clara Valley Water District (SCVWD)
- ❖ Silicon Valley Economic Development Alliance
- ❖ Valley Transportation Authority (VTA).

Survey

A hazard mitigation plan survey (see Figure 3-1) was developed by the Core Planning Group with guidance from the Working Group. The survey was used to gauge household 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. The answers to its 30 questions helped guide the Working Group in selecting goals, objectives and mitigation strategies. The survey was made available on the hazard mitigation plan website and advertised throughout the course of the planning process.

The results of this survey were provided to each of the planning partners in a toolkit used to support the jurisdictional annex process (as described in the introduction to Volume 2 of this plan). Each planning partner was able to use the survey results to help identify actions as follows:

- Gauge the public's perception of risk and identify what citizens are concerned about.
- Identify the best ways to communicate with the public.
- Determine the level of public support for the different mitigation strategies.
- Understand the public's willingness to invest in hazard mitigation.

Approximately 2,100 surveys were completed during the course of this planning process. The complete survey and a summary of its findings can be found in Appendix A of this volume.

Information Booths

Hazard mitigation information booths were hosted at two farmer's markets, on January 15, 2017 in Campbell and on January 21, 2017 in Sunnyvale (see Figure 3-2 through Figure 3-4). Each was open from 9 a.m. to 1 p.m. During these events, Core Planning Group members spoke with members of the public about the project and invited them to take the survey and visit the project website. Members of the public were invited to receive a personalized risk assessment based on the project risk assessment results. A computer workstation allowed citizens to see information on their property, including exposure and damage estimates for earthquake and flood hazard events. Participating property owners were provided printouts of this information for their properties.

Final Public Comment period

A final public comment period was conducted to allow the public to provide comment on the proposed draft of the plan prior to submittal to CalOES for pre-adoption review and approval. This public comment period ran for 14 days from April 5 to April 21, 2017. The public comment period was advertised via a formal press release disseminated on April 5, 2017 and well as being posted on the hazard mitigation plan website: (https://www.sccgov.org/sites/oes/SCCOAHMP20162017/Pages/home.aspx). The posted draft plan was accompanied by a narrated PowerPoint presentation (see Figure 3-5) accessible on the website that explained to the public the content of the plan and the basis for its preparation. The website provided the public with a point of contact to provide formal comment if they so desired.

Santa Clara Operational Area
2016/2017 Hazard Mitigation Plan Survey

1. Survey Introduction

Santa Clara Operational Area Hazard Mitigation Questionnaire

A range of natural and human-caused disasters can affect any community. Santa Clara County and its incorporated cities, collectively known as the Santa Clara Operational Area, work diligently to mitigate threats and prepare for disasters.

To maintain a high level of preparedness, we need your help to identify and plan for future disasters. Data collected through this survey will help the Santa Clara Operational Area Local Hazard Mitigation Plan Workgroup to:

- Assess our residents' level of awareness regarding disasters;
- Determine areas vulnerable to various types of disasters;
- Coordinate activities to reduce the risk of injury or property damage in the future; and,
- Update the multi-jurisdiction Local Hazard Mitigation Plan.

Local Hazard Mitigation Plans are required to be updated every five years by the federal Disaster Mitigation Act of 2000 in order for the Operational Area to remain eligible for certain federal pre-disaster and post-disaster assistance. The Plan details the risks of both natural and human-caused hazards in the Santa Clara Operational Area and includes programs and projects that can help reduce the exposure of residents and businesses should an event occur.

This survey consists of three sets of questions. The first section is about your experience and knowledge of natural and human-caused hazards in general, and steps your household has taken to prepare for disasters. The second section is about the potential hazards near you and whether your knowledge of potential hazards influenced where you chose to live. The last section consists of demographic information that will be used in evaluating the responses to the questionnaire.

Please note that the information collected through this survey will be used solely for mitigation planning activities.

Thank you for taking the time to participate in the 2016/2017 Hazard Mitigation Questionnaire!

Figure 3-1. Introductory Page from Survey Distributed to the Public

Figure 3-2. Campbell Farmer's Market

Figure 3-3. Campbell Farmer's Market

Figure 3-4. Sunnyvale Farmer's Market

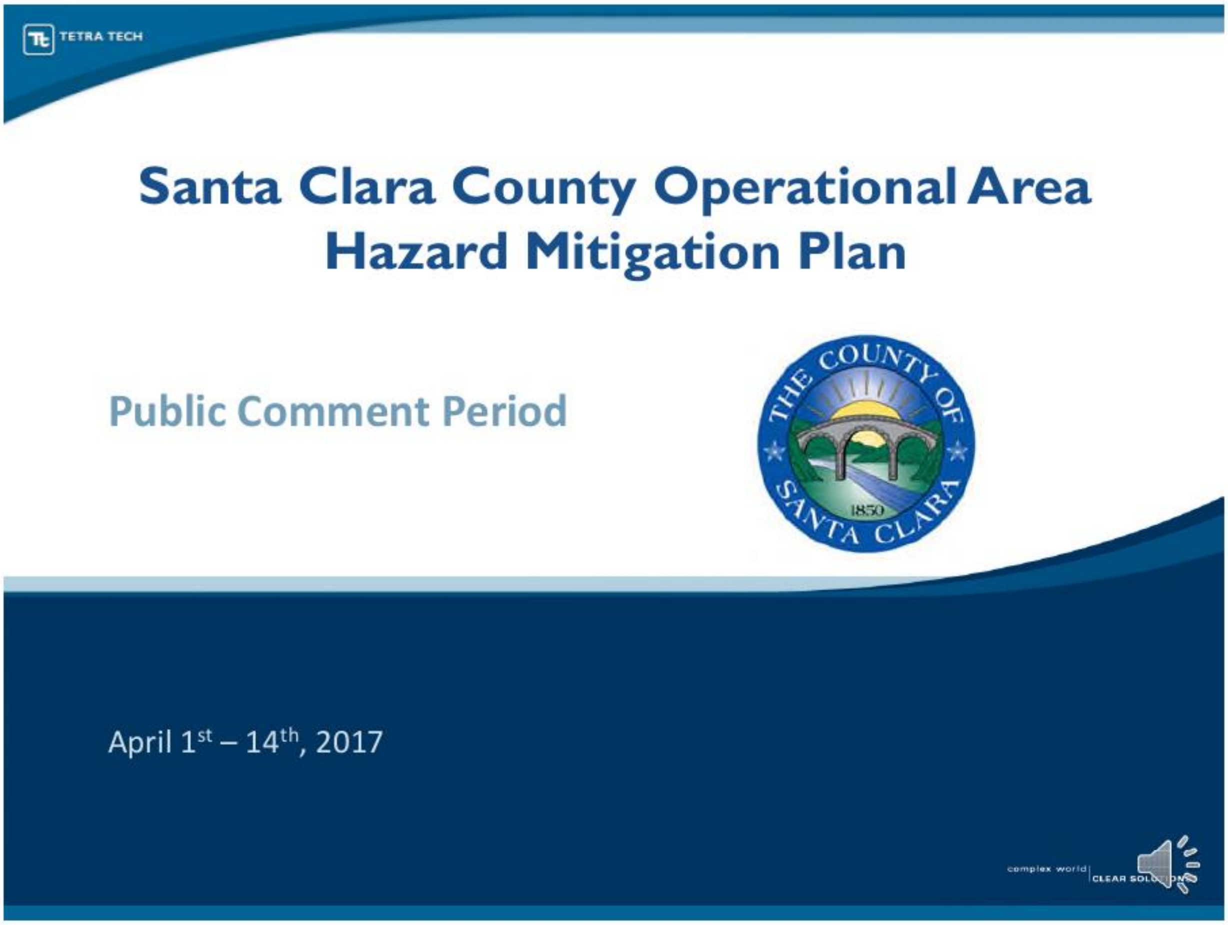


Figure 3-5. Public Comment Narrated Presentation

The Core Planning Group received five comments from the public during this comment period. These comments were reviewed by the Core Planning Group and incorporated in to the final plan as appropriate.

Press Releases

Press releases distributed in tandem with social media blasts were distributed over the course of the plan's development as key milestones were achieved and prior to each public meeting. The planning effort received the following press coverage:

- Wednesday, September 14, 2016—Announcement regarding the launch of the planning process distributed to news media for publishing and inquiry.
- Tuesday, December 27, 2016—Announcement regarding the first round of public information booth meetings distributed for publishing and inquiry.
- Wednesday, April 5, 2017—Announcement of the initiation of the April 5 – 21, 2017 public comment period for the draft plan.

Internet

At the beginning of the plan development process, a website hosted on the Santa Clara County OES main website was created to keep the public posted on plan development milestones and to solicit relevant input (see Figure 3-6). The site's address (https://www.sccgov.org/sites/oes/SCCOAHMP20162017/Pages/home.aspx) was publicized in all press releases, mailings, surveys and public meetings. Information on the plan development process, the Working Group, the survey and phased drafts of the plan was made available to the public on the site throughout the process. Santa Clara County OES intends to keep a website active after the plan's completion to keep the public informed about successful mitigation projects and future plan updates.

Figure 3-6. Sample Page from Hazard Mitigation Plan Web Site

3.9.2 Public Involvement Results

Survey Outreach

Completed surveys were received from 2,092 respondents. Of these respondents, 99 percent indicated that they live in the Santa Clara County OA, 72 percent work in San Clara County, and 87 percent own property in the OA. Survey results were shared with the planning partners. Detailed survey results are provided in Appendix A of this volume. Key results are summarized as follows:

- Survey respondents ranked earthquake as the hazard of highest concern, followed by drought, and wildfire.
- The majority of respondents expect to receive information on immediate threats caused by hazards from the radio, followed by television, and the Santa Clara County Operational Area's alert system, AlertSCC.
- Respondents were overwhelmingly concerned about response resources for individuals with disabilities and others with access and functional needs.
- Respondents indicated concern about isolation and transportation gridlock during a major disaster.
- Approximately 45 percent and 38 percent of respondents were unaware if their residence was located in a high liquefaction zone or floodplain, respectively.

Public Meetings

By engaging the public through the public involvement strategy, the concept of mitigation was introduced to the public, and the Working Group received written feedback that was used in developing the plan. The Working Group answered multiple technical questions regarding the plan during all meetings, but no verbal comments were received on the plan. Table 3-3 summarizes details of contacts made during these events.

Table 3-3. Summary of Public Meetings

Date	Location	Number of Public Contacts
1/15/2017	Campbell Farmer's Market, East Campbell Avenue and North 1st Street, Campbell, CA	59 fliers distributed, 24 individual risk assessments conducted, 75+ contacts made regarding the plan
1/21/2017	Sunnyvale Farmer's Market, W. Washington Avenue and S. Murphy Avenue, Sunnyvale, CA	64 flyers distributed, 27 individual risk assessment conducted, 80+ contacts made regarding the plan

3.10 PLAN DEVELOPMENT CHRONOLOGY/MILESTONES

Table 3-4 summarizes important milestones in the plan update process.

Table 3-4. Plan Development Chronology/Milestones

Date	Event	Description
2016		
7/19	Stakeholder Kickoff	Planning partners convened to kick off the project.
8/24	Working Group Meeting #1	Review project timeline, establish Working Group ground rules, discuss state and previous plan.
9/7	Initial Press Release	Press release announcing the beginning of the plan update process and the Working Group meeting schedule.
9/14	Working Group Meeting #2	Discuss state and previous plan, discuss mission statement and goals.
10/12	Working Group Meeting #3	Confirm mission statement and goals, discuss objectives and critical facilities.
11/9	Working Group Meeting #4	Confirm objectives and critical facilities, discuss public outreach Phase 1 opportunities, confirm survey.
11/28	Survey Release	Coordinated jurisdictional release of the public survey via multiple social media platforms. Planning partners encouraged to link to the survey from their jurisdictional web pages.
12/14	Working Group Meeting #5	Review risk assessment results, discuss strengths, weaknesses, obstacles and opportunities for the Operational Area, review initial public survey results.
12/15	Annex Workshop #1	Guidance to planning partners on completing the jurisdictional annex, ranking risk, identifying local vulnerabilities, and selecting mitigation strategies.
12/19	Annex Workshop #2	Guidance to planning partners on completing the jurisdictional annex, ranking risk, identifying local vulnerabilities, and selecting mitigation strategies.
12/27	Press Release – Information Booths	Press release regarding location and time of the two farmer's market information booths in Campbell and Sunnyvale.
2017		
1/11	Working Group Meeting #6	Discuss plan maintenance, continued discussion of strengths, weaknesses, obstacles and opportunities, planning partner update.
1/15	Campbell Farmers Market – Information Booth	Hazard mitigation information booth as part of farmer's market. Residents provided with a mitigation flier that provided information on the project and advertised the project website and survey, property risk assessment, and general preparedness materials.
1/21	Sunnyvale Farmers Market – Information Booth	Hazard mitigation information booth as part of farmer's market. Residents provided with a mitigation flier that provided information on the project and advertised the project website and survey, property risk assessment, and general preparedness materials.
2/8	Working Group Meeting #7	Confirmed plan maintenance, discussed Operational Area initiatives, critical facilities, and California Environmental Quality Act compliance.
2/9	Jurisdictional Annex Process	Phase 3 annexes due to the Core Planning Group.
3/8	Working Group Meeting #8	Presented draft plan to the Working Group to finalize internal review. Finalized public comment period approach. Presentation on CDBG-DR.
4/5	Public Outreach	Initiation of the public comment period for the draft plan. Press release disseminated to all media outlets. Draft plan posted to the website with a narrated PowerPoint presentation.
4/21	Public Outreach	Conclusion of final public comment period.
4/28	Plan submittal	Final draft plan submitted to CalOES for review and approval.

4. SANTA CLARA COUNTY OPERATIONAL AREA PROFILE

4.1 GEOGRAPHIC OVERVIEW

The Santa Clara County Operational Area is located in north-central California in the southern portion of the San Francisco Bay area (see Figure 4-1). With its numerous natural amenities and one of the highest standards of living in the country, the OA has long been considered one of the best areas in the U.S. in which to live and work. The county is also referred to as “Silicon Valley.”

The Santa Clara County OA has a total area of 1,312 square miles. With a diverse population of more than 1.9 million residents (based on the 2016 census estimate), it is one of the largest counties in the state and encompasses 15 incorporated cities.

San José is the largest city, with over 1 million people, followed by Sunnyvale and Santa Clara; the west valley bedroom communities of Los Altos, Los Altos Hills, Los Gatos, Monte Sereno, and Saratoga; the high-tech communities of Campbell, Cupertino, Mountain View, and Palo Alto; industrial Milpitas, and the south county suburban expansion/rural interface areas of Gilroy, Morgan Hill, and their surrounding unincorporated areas. A significant portion of the county’s land area is unincorporated ranch and farmland.

The Santa Clara County OA has a rich culture of ethnic diversity, artistic endeavors, sports venues, and academic institutions. Numerous public and private golf courses are located throughout the OA and Santa Clara County operates 28 parks covering more than 50,000 acres, including lakes, streams, and miles of hiking and biking trails. The OA is home to three major universities—Stanford University, Santa Clara University, and San José State University—as well as several community colleges.

4.2 HISTORICAL OVERVIEW

The early inhabitants of Santa Clara County were the indigenous Ohlone People, thought to occupy the area at least 1,000 years before Spain began to colonize California in the 18th century.

Spanish settlers established the valley’s first mission and pueblo in Santa Clara and San José, respectively, and governed “El Llano de los Robles” (Plain of the Oaks), until the Mexican Revolution led to Mexican control from the 1820s through 1840s. In 1850, California was admitted to the United States, and Santa Clara County was incorporated as one of the state’s original 27 counties. Deriving its name from Mission Santa Clara, the county originally included much of what was Washington Township (part of Union City and Fremont) in what is now Alameda County. The current county boundaries were set in 1853 when Alameda County was established.

From 1850 to 1870, ranchers made a transition from raising cattle and sheep to cultivating hay and grain. French immigrants planted the first vineyards. Mercury mining flourished. California’s first colleges were founded in Santa Clara County. The coming of the railroad produced a small boom in real estate.

After 1870, orchards began displacing grain fields and vineyards. The Santa Clara Valley became the world’s leading producer of canned fruit and processed dried fruit. By the end of the 19th century, wealthy San Franciscans, such as Leland Stanford and James Lick, established farms and summer homes in the county.

Figure Placeholder

Figure 4-1. Santa Clara County Operational Area (Planning Area)

Santa Clara County remained pastoral until World War II, when many people gravitated to California to work in war-related industries. To accommodate the growing population, mass-produced housing spread across the Santa Clara Valley, and agricultural land was subdivided and developed for housing. Like much of the rest of the United States in the decades immediately following the war, development in the county shifted from largely agricultural to largely suburban.

At the same time, technology companies began to flourish in Santa Clara County, with significant support and encouragement from Stanford University. The Stanford Industrial Park, established in 1951, later became the Stanford Research Park and provided space for companies such as Hewlett-Packard, Eastman Kodak, General Electric and Lockheed. Related companies began to form around the region, and by the 1970s Santa Clara County and surrounding areas had become known as a center of high-technology development. The term silicon valley was coined in 1971, referring to the high concentration of companies in the area that are involved in making silicon semiconductors and the computers that rely on them. Technology industries remain central to the area economy to this day.

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. Santa Clara County has experienced 14 events (11 major disaster declarations, one emergency declaration, one fire management assistance declaration, and one fire suppression declaration) since 1950 for which presidential disaster declarations were issued. These events are listed in Table 4-1.

Table 4-1. Presidential Disaster Declarations

Type of Event	FEMA Disaster Number[a]	Date
Severe Winter Storms, Flooding, Mudslides	DR-4308	April 1, 2017
Severe Winter Storms, Flooding, and Mudslides	DR-4301	February 14, 2017
Summit Fire	FM-2766	May 22, 2008
Croy Fire	FS-2465	September 25, 2002
Severe Winter Storms and Flooding	DR-1203	February 9, 1998
Severe Storms, Flooding, Mud and Landslides	DR-1155	January 4, 1997
Severe Winter Storms, Flooding Landslides, Mud Flow	DR-1046	March 12, 1995
Severe Winter Storms, Flooding, Landslides, Mud Flows	DR-1044	January 10, 1995
Severe Freeze	DR-894	February 11, 1991
Loma Prieta Earthquake	DR-845	October 18, 1989
Severe Storms and Flooding	DR-758	February 21, 1986
Grass, Wildlands, and Forest Fires	DR-739	July 18, 1985
Coastal Storms, Floods, Slides, and Tornadoes	DR-677	February 9, 1983
Severe Storms, Flood, Mudslides, and High Tide	DR-651	January 7, 1982
Drought	EM-3023	January 20, 1977

a. DR = Disaster Declaration; EM = Emergency Declaration; FM = Fire Management; FS = Fire Suppression
Source: FEMA, 2016

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 have significant impacts on their communities. These events are also important to consider in establishing recurrence intervals for hazards of concern.

4.4 PHYSICAL SETTING

4.4.1 Geology and Topography

The OA’s topography is characterized by its location in the southern San Francisco Bay area. The Santa Clara Valley runs the entire length of the county from north to south, ringed by the rolling hills of the Diablo Range on the east, and the Santa Cruz Mountains on the west. Salt marshes and wetlands lie in the northwestern part of the county, adjacent to the waters of San Francisco Bay.

4.4.2 Soils

Prior to 1950 and as far back as the late 1800s, Santa Clara Valley was the scene of vibrant and productive agriculture. Many of the soils of the Santa Clara Valley are alluvial, deposited on fans or floodplains within the valley. The young, deep soils (Elder, Elpaloalto, Still, Stevens Creek, Landelspark, Botella, and Campbell) are naturally very fertile. Field crops were grown on the lower parts of the valley, and orchards spanned from the hills east of Milpitas and San José across the valley to Los Altos and Palo Alto. With the introduction of the electric water pump in the early 20th century, irrigation water from the plentiful ground-water supply became readily available on every farm, thus increasing productivity. The Santa Clara Valley became widely known for the production of high-quality orchard fruits, which were shipped across the United States.

Dams were constructed on major streams to store irrigation water and control flooding. As groundwater was rapidly pumped from a depth of several hundred feet, subsurface materials compacted and led to land subsidence. Subsidence damaged pipes and other in-ground structures, and levees were required to block tidewater from entering subsided land. The benefit of the control of streams and pumping of groundwater was a valley relatively free from flooding and high groundwater, an ideal condition for the rapid urban expansion that followed.

After World War II, urban growth in the San Francisco Bay area began to expand down to the south end of the bay and into the Santa Clara Valley. Subdivisions began to spring up as the development pace quickened after 1950. The first wave of development occurred on the soils along the El Camino Real corridor, where the alluvial fans were relatively level, with slopes of 2 percent or less. Development exploded in the 1960s and topsoil was moved to house lots was from the street areas. This type of subdivision construction continued until about 1980, when more shaping of house lots to control drainage began. By 1980, home construction was slowing because relatively level areas that were easy for construction were already developed.

After 1980, subdivision development moved into areas of alluvial fans and greater slopes, and lot-shaping became more common. After 1990, development moved into steep areas at the edge of the valley and the foothills. Soil disturbance can be severe in these areas, with more than 5 feet of cuts or fills. Fills may be materials from several feet below the soil surface, have a high content of clay or fragments, and be low in organic matter and fertility. Cut areas may have subsoil materials at the surface, which also may have a high content of clay or fragments and be low in organic matter and fertility. Many residents have modified the soil surface texture in garden areas with sandy materials and mulches. In areas of the basin soils (Hangerone, Clear Lake, and Embarcadero), clay surface and subsurface textures and slow internal drainage due to a high clay content are problems for gardens, ornamental plants, and lawns (USDA, 2015).

4.4.3 Climate

Table 4-2 summarizes normal climate date from 1981 through 2010 at the National Climatic Data Center weather station at San José. The Mediterranean climate of the OA remains temperate year round due to the area's geography and its proximity to the Pacific Ocean. The area is warm and dry much of the year. Rarely is the humidity uncomfortable, and the thermometer seldom drops below freezing. Rain is generally limited to winter and snow to the tops of local mountains.

Table 4-2. San José Normal Precipitation and Temperatures, 1981 – 2010

Months	Mean Precipitation (inches)	Minimum Temperature (F)	Maximum Temperature (F)
January	3.07	42.0	58.1
February	3.11	44.7	61.9
March	2.54	46.6	65.7
April	1.18	48.6	69.3
May	0.51	52.4	74.3
June	0.10	56.0	79.1
July	0.02	58.1	81.9
August	0.02	58.3	81.9
September	0.18	56.8	80.1
October	0.80	52.5	74.0
November	1.68	46.0	64.3
December	2.61	41.9	58.0
Annual	15.82	50.4	70.8

4.5 DEVELOPMENT PROFILE

4.5.1 Land Use

Table 4-3 shows current land use for unincorporated Santa Clara County; complete land use data was not available for municipalities in the OA. Land use information is analyzed in this plan for each identified hazard that has a defined spatial extent and location. For hazards that lack this spatial reference, the information in the table serves as a baseline estimate of land use and exposure. The distribution of land uses for the unincorporated county will change over time.

Table 4-3. Unincorporated Santa Clara County Present Land Use

Type of Land Use	Area (acres)	Percentage of Total Area
Agricultural	33,355.5	**5.53**
General / Institutional	5,381.3	**0.89**
Open Space	548,603.4	**90.88**
Low Density Residential	15,988.7	**2.65**
High Density Residential	68.6	**0.01**
Commercial	161.8	**0.03**
Industrial	85.0	**0.01**
Total	**603,644.5**	**100.00**

4.5.2 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, department operation centers, 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 Working Group meetings, stakeholder information requests, and the 2013 *State of California Multi-Hazard Mitigation Plan*. The Working Group created the categories for critical facilities and infrastructure listed in Table 4-4.

Table 4-4. Critical Facilities and Infrastructures in OA

Jurisdiction	Emergency Response / Public Health & Safety	Infrastructure Lifeline	Military Facilities	Recovery Facilities	Socioeconomic Facilities	Hazardous Materials	Total
Campbell	8	27	0	0	53	5	93
Cupertino	8	36	0	0	47	4	95
Gilroy	15	45	0	1	50	7	118
Los Altos	6	31	0	0	36	0	73
Los Altos Hills	1	48	0	0	6	0	55
Los Gatos	14	40	0	0	24	1	79
Milpitas	12	68	0	0	56	42	178
Monte Sereno	1	2	0	0	2	0	5
Morgan Hill	9	14	0	0	39	7	69
Mountain View	17	84	0	0	50	23	174
Palo Alto	19	71	0	0	95	22	207
San José	116	593	0	1	654	115	1479
Santa Clara (city)	19	79	0	0	103	94	295
Saratoga	7	33	0	0	30	0	70
Sunnyvale	16	81	0	0	86	49	232
Unincorporated County	20	248	1	2	51	5	327
Total	**288**	**1500**	**1**	**4**	**1382**	**374**	**3,549**

Although many facilities and assets of the Santa Clara County OA 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. 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.*

All critical facilities/infrastructure were analyzed in Hazus 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 summaries of the general types of critical facilities and infrastructure by local jurisdiction. Figure 4-2 and Figure 4-3 show the location of critical facilities and infrastructure in the OA. Due to the sensitivity of this information, a detailed list of facilities is not provided. The list is on file with Santa Clara County OES.

Figure Placeholder

Figure 4-2. Critical Facilities in Operational Area

Figure Placeholder

Figure 4-3. Critical Infrastructure in the Operational Area

4.5.3 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 DMA 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 five years within the OA and potential future development in the next five years, as identified by each jurisdiction, is addressed in the jurisdictional annexes located in Volume 2 of this plan.

The municipal planning partners have adopted general plans that govern land use decision and policy making for their jurisdictions. Decisions on land use will be governed by these programs. This plan will work together with these programs to support wise land use in the future by providing vital information on the risk associated with natural hazards in the OA. All municipal planning partners will incorporate this hazard mitigation plan in their general plans by reference. This will ensure that future development trends can be established with the benefits of the information on risk and vulnerability to natural hazards identified in this plan.

4.6 DEMOGRAPHICS

Some populations are at greater risk from hazard events because of decreased resources or physical abilities. Elderly people, for example, may be more likely to require additional assistance. Research has shown that people living near or below the poverty line, the elderly, women, children, ethnic minorities, renters, individuals with disabilities, and others with access and functional needs, all experience more severe effects from disasters than 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.

4.6.1 Population

Resident Population

Information about 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 California Department of Finance estimated the OA’s population at 1,927,888 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 OA from 2000 to 2016. Figure 4-4 shows the OA population change compared to that of the State of California. Between 2000 and 2015, California’s population grew by 14.8 percent (about 0.93 percent per year) while the OA’s population increased by 12.6 percent (0.79 percent per year).

Table 4-5. Recent Population Data

Jurisdiction	Population				
	2000	2005	2010	2015	2016
City of Campbell	38,138	37,406	39,349	41,986	42,584
City of Cupertino	50,546	53,632	58,302	58,038	58,185
City of Gilroy	41,464	45,782	48,821	54,324	55,170
City of Los Altos	27,693	27,381	28,976	30,513	31,353
Town of Los Altos Hills	7,902	7,852	7,922	8,595	8,658
Town of Los Gatos	28,592	28,070	29,413	31,157	31,376
City of Milpitas	62,698	62,177	66,790	74,140	75,521
City of Monte Sereno	3,483	3,324	3,341	3,445	3,475
City of Morgan Hill	33,556	35,011	37,822	42,382	43,645
City of Mountain View	70,708	70,629	74,066	76,712	77,925
City of Palo Alto	58,598	60,723	64,403	67,331	68,207
City of San José	894,943	901,159	945,942	1,030,053	1,042,094
City of Santa Clara	102,361	107,058	116,468	121,580	123,752
City of Saratoga	29,843	29,630	29,926	30,060	30,219
City of Sunnyvale	131,760	131,853	140,081	146,629	148,372
Unincorporated County	100,300	96,547	90020	87,029	87,352
Total	**1,682,585**	**1,698,234**	**1,781,642**	**1,903,974**	**1,927,888**

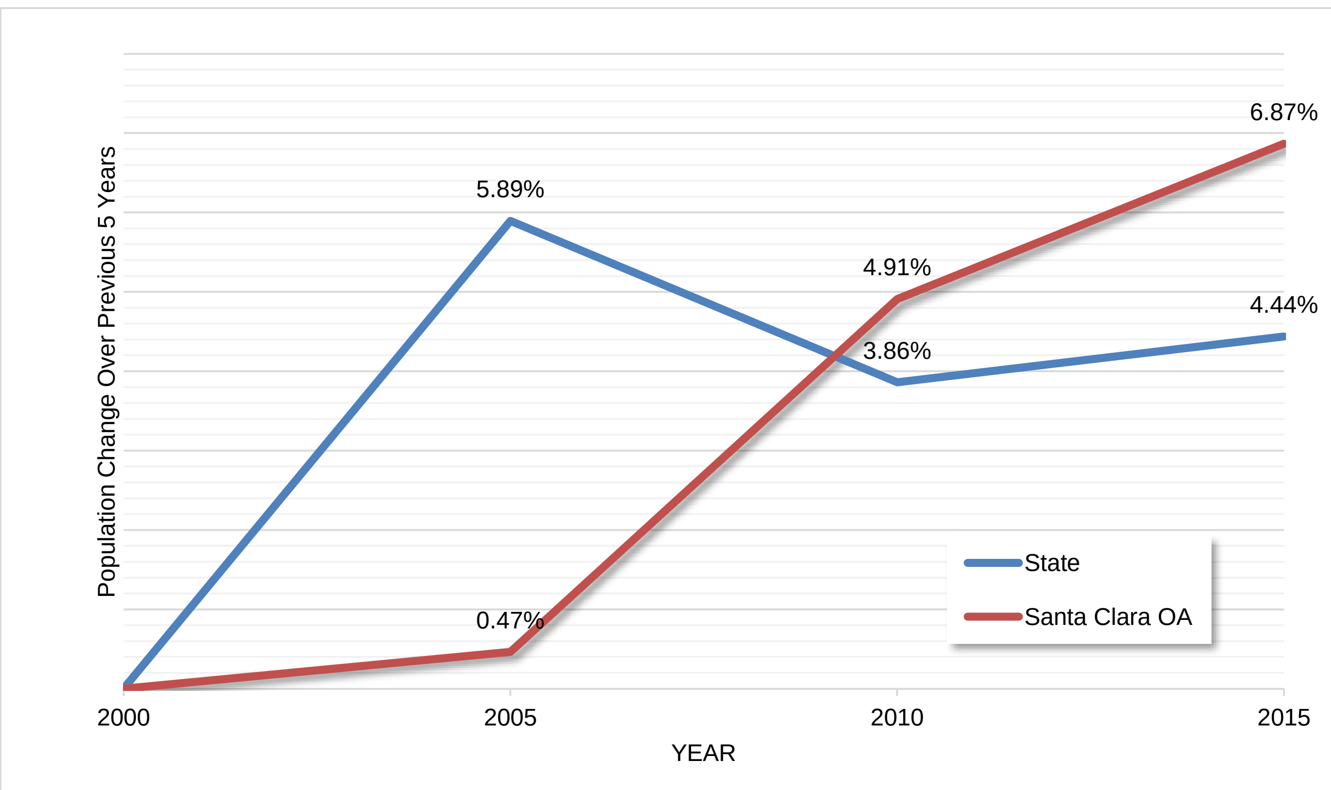


Figure 4-4. California and Santa Clara County OA Population Percentage Growth Comparison [2000-2015]

Daily Commuting Population

According to the California Employment Development Department, 208,965 daily commuters who worked in the Santa Clara County OA in 2013 lived in other locations. Most came from Alameda County, followed by San Mateo County and San Francisco County. Some commuters travel to the Santa Clara County OA from as far as Sacramento and Amador Counties. Conversely, 109,000 residents of the Santa Clara County OA commute outside of the OA daily. Figure 4-5 provides the county-to-county commuting estimates to the Santa Clara County OA from other counties.

Source: California Employment Development Department, 2015

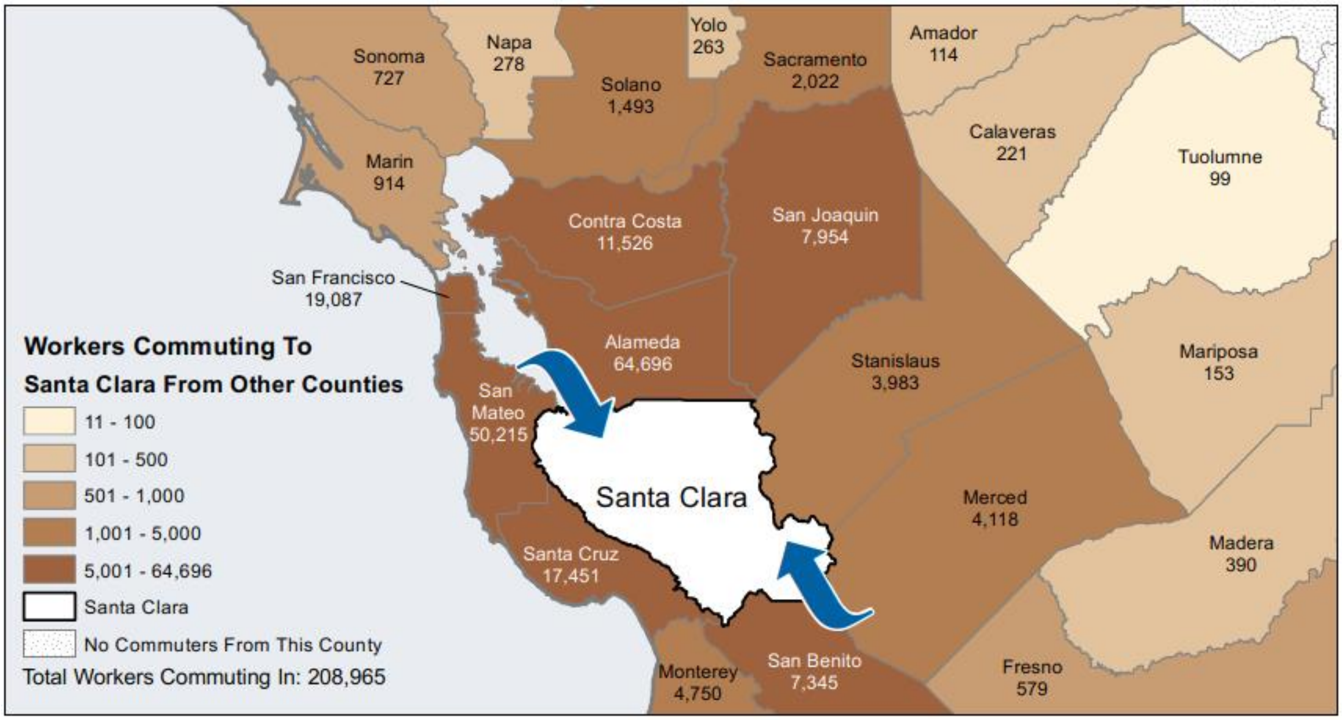


Figure 4-5. 2010 County-to-County Commuting Estimates

This large commuter contingent has impacts on planning for the OA'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.

The U.S. Census estimates that over 76 percent of workers in the OA commute alone (by car, truck or van) to work, and mean travel time to work is 27 minutes (the state average is 28 minutes).

4.6.2 Age Distribution

As a group, the elderly are more apt to lack the physical and economic resources necessary for response and resiliency for hazard events and are more likely to suffer health-related consequences making recovery slower. They are more likely to be vision, hearing, and/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. These facilities are typically identified as "critical facilities" by emergency managers because they require extra notice to implement evacuation. 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 due to 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 disaster events because of their young age and dependence on others for basic necessities. Additionally, very young children may be vulnerable to injury or sickness; this added 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 OA is illustrated in Figure 4-6. Based on U.S. Census 2010-2014 American Community Survey 5-Year Estimates, 11.7 percent of the OA's population is 65 or older, compared to the state average of 12.1 percent. The Census data also indicate that 33.4 percent of the over-65 population has disabilities of some kind and 8.6 percent have incomes below the poverty line. Children under 18 account for nearly 12 percent of individuals who are below the poverty line. An estimated 20 percent of the OA population is 14 or younger, compared to the state average of 20 percent.

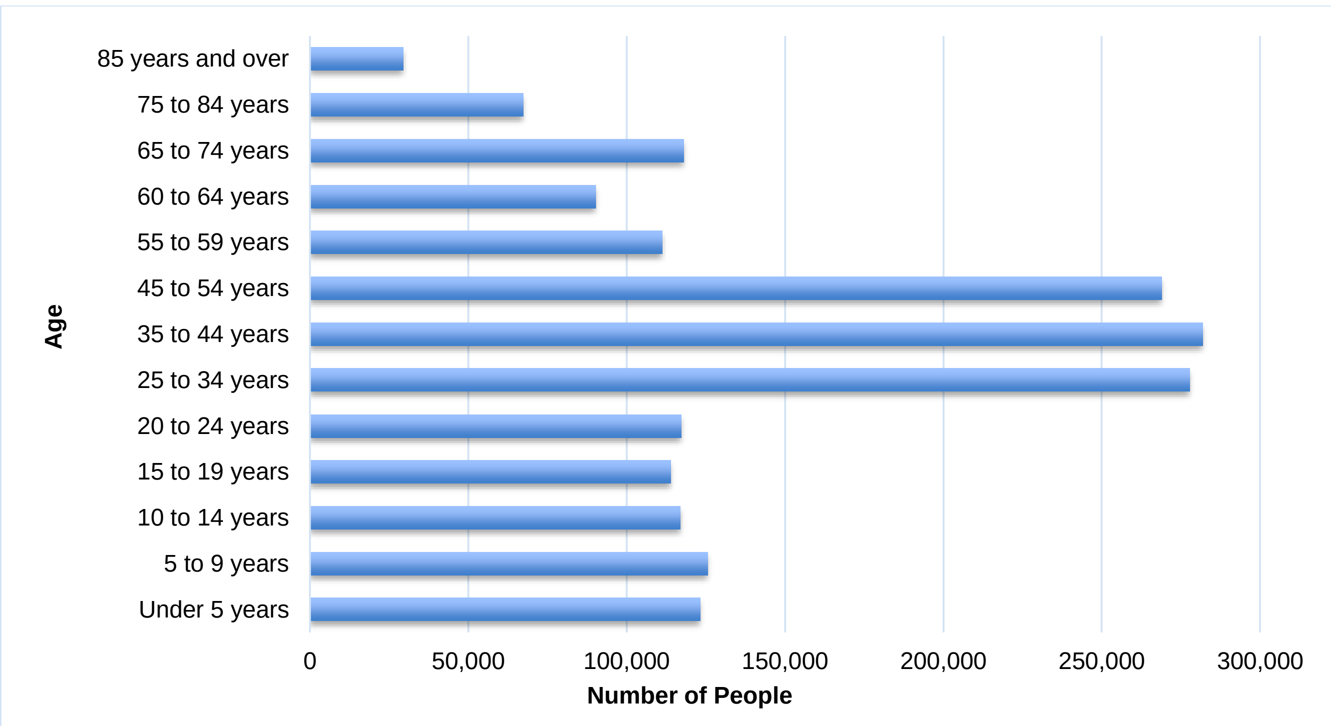


Figure 4-6. OA Age Distribution

4.6.3 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 event. Post-disaster recovery can be ineffective and is often characterized by cultural insensitivity. Since higher proportions of ethnic minorities live below the poverty line than the majority white population, poverty can compound vulnerability. According to the U.S. Census, the racial composition of the OA is predominantly white, at about 49 percent. The largest minority population is Asian, at 33 percent. Figure 4-7 shows the racial distribution in the OA.

The OA has a 37 percent foreign-born population. Other than English, the most commonly spoken languages in the OA are Asian languages. The census estimates 21 percent of the residents speak English "less than very well."

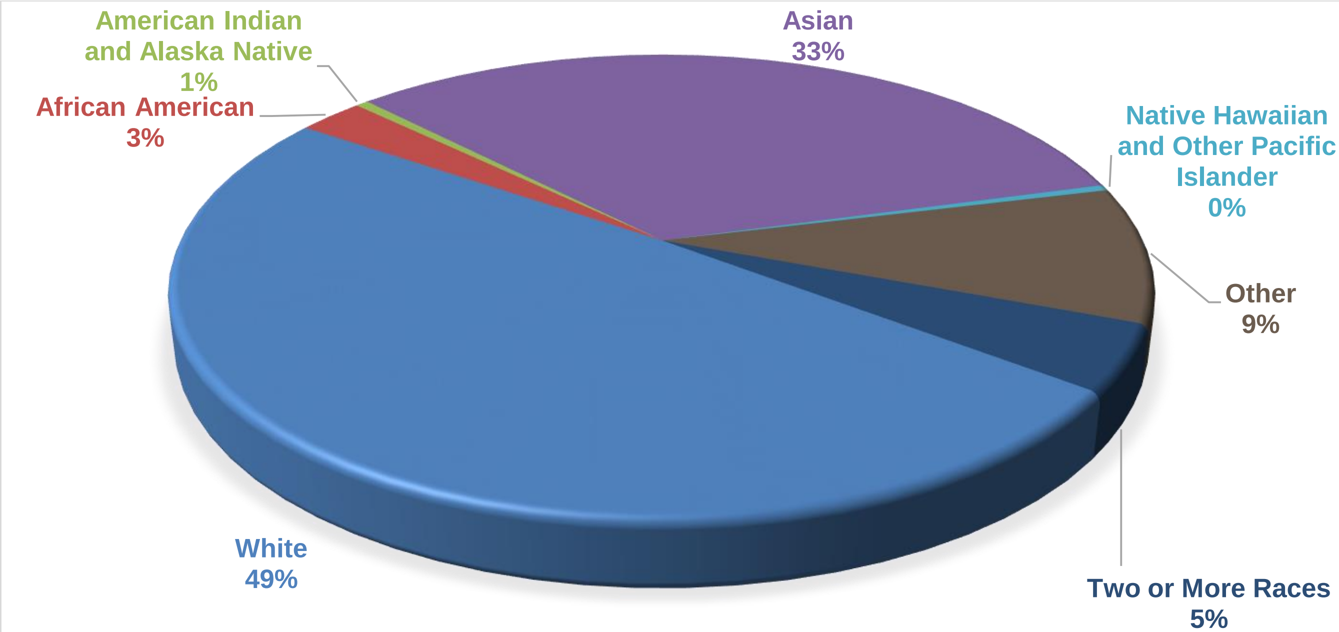


Figure 4-7. OA Race Distribution

4.6.4 Individuals with Disabilities or with Access or Functional Needs

The 2010 U.S. Census estimates that 54 million non-institutionalized Americans with disabilities live in the U.S. This equates to about one-in-five persons. Individuals with disabilities are more likely to have difficulty with resilience and responding to a hazard event than the general population. Local government may be 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 and incident managers to distinguish between functional and medical needs in order 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 2010-2014 American Community Survey 5-Year Estimates, there are 141,397 individuals with some form of disability in the OA.

4.7 ECONOMY

4.7.1 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 means that households living in poverty are automatically disadvantaged when confronting 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 other types of housing. In urban areas, the poor often live in older houses and apartment complexes, which are more likely to be made of un-reinforced masonry, a building type that is particularly susceptible to damage during earthquakes. Furthermore, residents below the poverty level are less likely to have insurance to compensate for losses incurred from natural disasters. This means that 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 impact people's decisions on evacuation. Individuals who cannot afford gas for their cars will likely decide not to evacuate.

Based on U.S. Census Bureau estimates, per capita income in the OA in 2015 was $46,631, and the median household income was $93,840. It is estimated that about 18 percent of households receive an income between $100,000 and $149,999 per year and over 15 percent of household incomes are above $150,000 annually. About 8 percent of the households in the OA make less than $25,000 per year and are therefore below the poverty level. The weighted average poverty threshold for a family of four in 2015 was $24,120; for a family of three, $19,096; for a family of two, $15,391 and for unrelated individuals, $12,082.

A living wage calculator developed at the Massachusetts Institute of Technology estimates the hourly living wage needed to support different types of families. The calculator takes 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 living wage calculator for 2015. Each hourly rate is adjusted per each working adult.

Table 4-6. Hourly Living Wage Calculation for Santa Clara County, California (2015)

Wage Level	One Adult	One Adult + 2 Children	Two Adults	Two Adults + One Child
Living Wage	$14.52	$33.63	$11.30	$15.83
Poverty Wage	$5.00	$10.00	$11.00	$4.00
Minimum Wage	$9.00	$9.00	$9.00	$9.00

4.7.2 Industry, Businesses and Institutions

The OA's economy is strongly based in the professional, scientific, and management, and administrative and waste management services industry (18.3 percent), followed by educational services and health care and social assistance, manufacturing, and retail trade. Public administration, wholesale trade and agriculture make up the smallest source of the local economy. Figure 4-8 shows the breakdown of industry types in the OA.

The OA benefits from a variety of business activity. Major businesses include Apple, Inc, Alphabet Inc. (Google), Netflix, Roku, Inc. Shockley Semiconductor Laboratory, eBay Inc., Cisco Systems Inc., Applied Materials Inc., Flextronics International, Intel Corp, Kaiser Permanente Medical Center, Liberty Tax Service, Lockheed Martin Space Systems, NASA, Phillips Lumileds Lighting Company, Santa Clara Valley Medical Center, and many others.

Major educational and research institutions in the OA include Stanford University, San José State University, Santa Clara University, Mission College, De Anza College, Foothill College, West Valley College, Mission College, Evergreen Valley College, San José City College and Gavilan College.

4.7.3 Employment Trends and Occupations

According to the American Community Survey, 67 percent of the OA's population is in the labor force. Of the working-age population group (ages 20-64), 40 percent of men and 60 percent of women are in the labor force.

Figure 4-9 compares California's and the Santa Clara County OA's unemployment trends from 2007 through 2014. The Santa Clara County OA's unemployment rate was lowest in 2007, at 4.7 percent. Unemployment rates peaked in 2010, at 11.1 percent , but have been on a downward trend ever since.

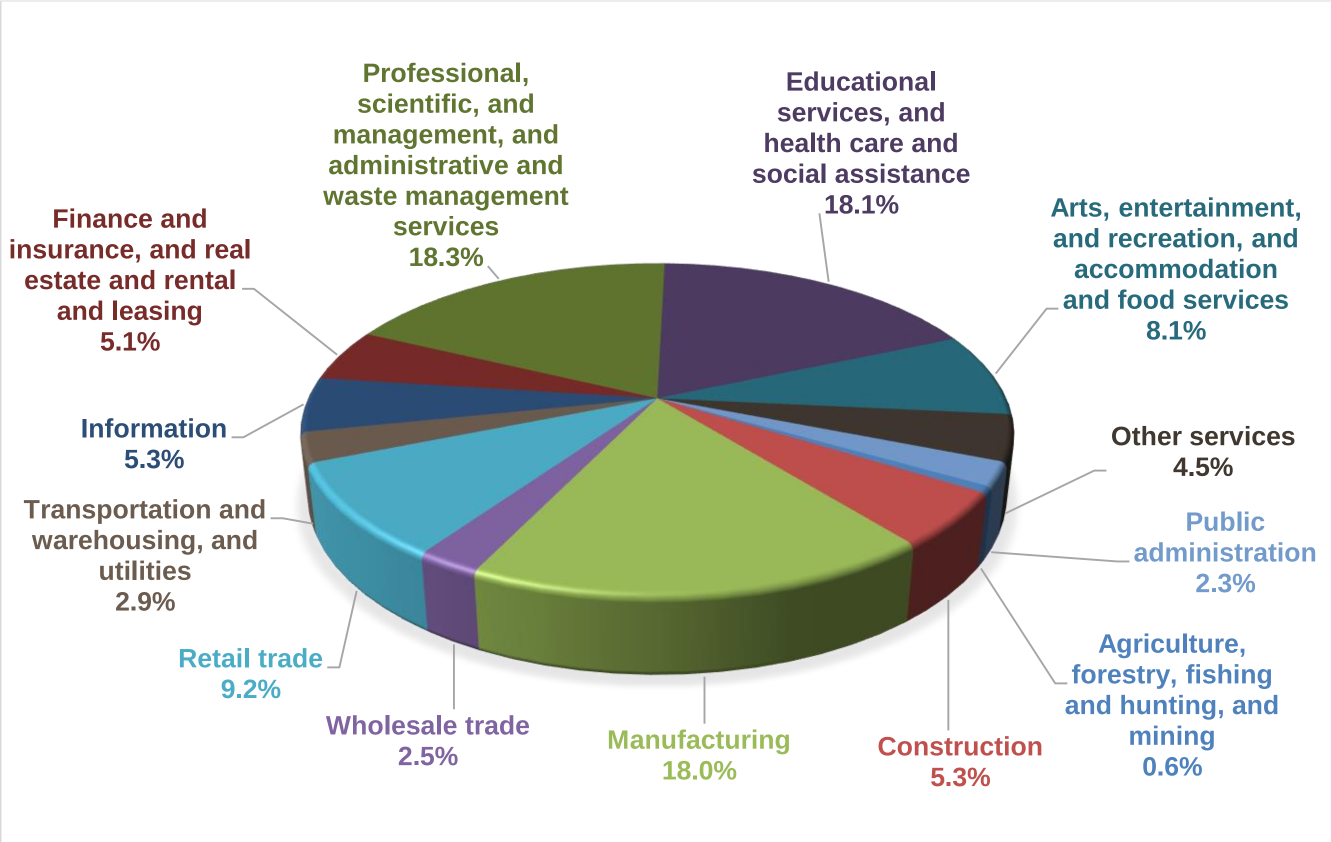


Figure 4-8. Industry in the OA

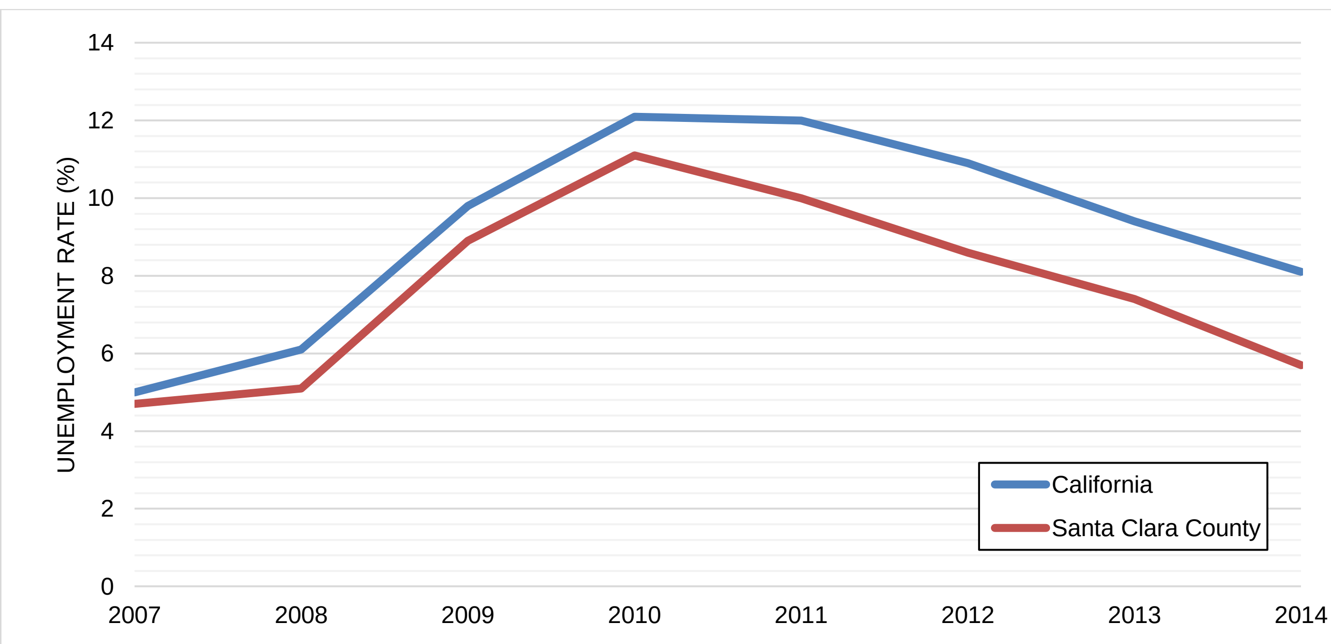


Figure 4-9. California and Santa Clara County OA Unemployment Rate

Management, business, science and arts, and sales and office occupations make up 70 percent of jobs in the OA. Management, business, science, and arts occupations make up 51 percent of the local working population. Other major occupations are sales and office (19 percent) and service (15 percent). Only about 15 percent of the employment in the OA is in production, transportation, and material moving and natural resources (see Figure 4-10). The largest employers are eBay Inc. and Cisco Systems Inc., both with over 10,000 employees. Nine other employers employ between 5,000 and 9,999 employees.

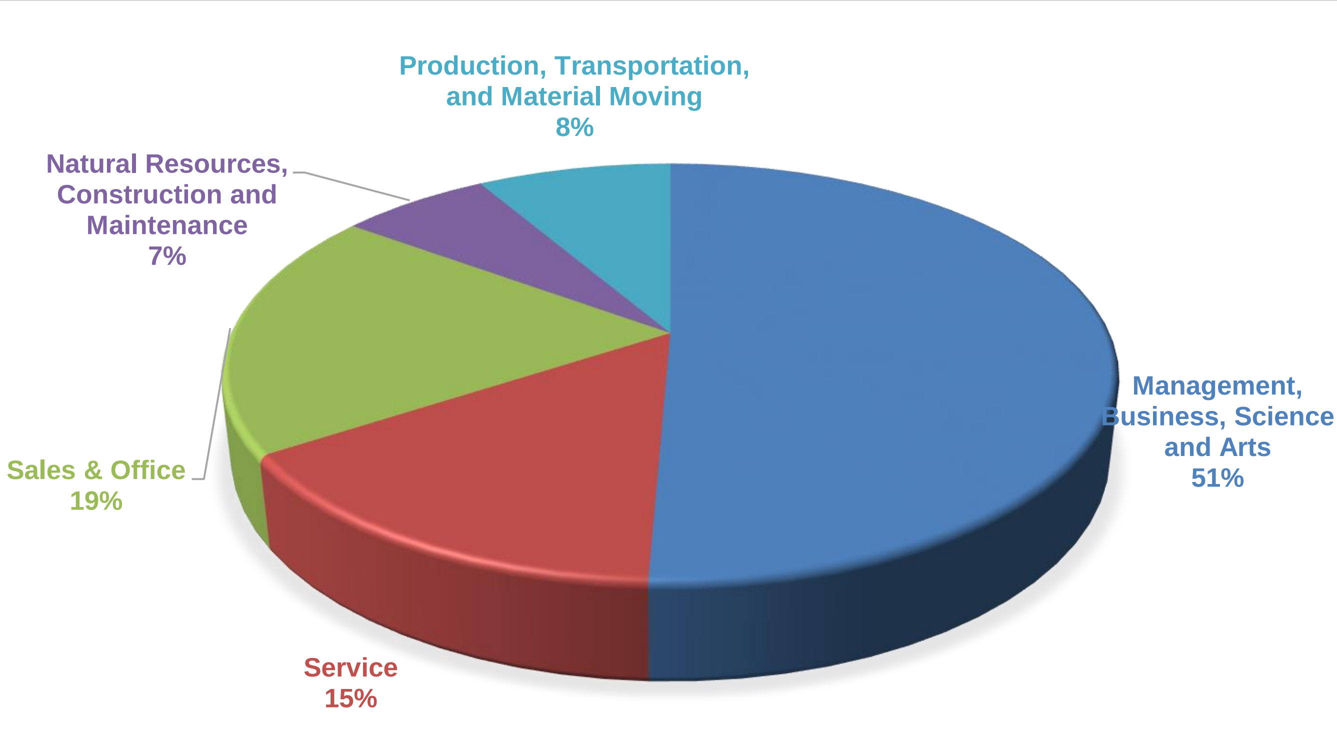


Figure 4-10. Occupations in the OA

4.8 LAWS AND ORDINANCES

Existing laws, ordinances and plans at the federal, state and local level can support or impact hazard mitigation actions 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 (44 CFR, Section 201.6(b)(3)). The following federal and state programs have been identified as programs that may interface with the actions identified in this plan. Each program enhances capabilities to implement mitigation actions or has a nexus with a mitigation action in this plan. Information presented in this section can be used in review local capabilities to implement the actions found in the jurisdictional annexes of Volume 2. Each planning partner has individually reviewed existing local plans, studies, reports, and technical information in its jurisdictional annex, presented in Volume 2.

4.8.1 Federal

Disaster Mitigation Act

The DMA 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 are available to communities. This plan is designed to meet the requirements of DMA, improving eligibility for future hazard mitigation funds.

National Environmental Policy Act

The National Environmental Policy Act (NEPA) requires federal agencies to consider the environmental impacts of proposed actions and reasonable alternatives to those actions, alongside technical and economic considerations. NEPA established the Council on Environmental Quality (CEQ), whose regulations (40 CFR Parts 1500-1508) set standards for NEPA compliance. Consideration and decision-making regarding environmental impacts must be documented in an environmental impact statement or environmental assessment. Environmental impact assessment requires the evaluation of reasonable alternatives to a proposed action, solicitation of input from organizations and individuals that could be affected, and an unbiased presentation of direct, indirect, and cumulative environmental impacts. FEMA hazard mitigation project grant applications require full compliance with applicable federal acts. Any action identified in this plan that falls within the scope of this act will need to meet its requirements.

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 in which 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 the designation of critical habitat for listed species. The ESA outlines procedures for federal agencies to follow when taking 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 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 (NOAA) Fisheries Service 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 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.

FEMA hazard mitigation project grant applications require full compliance with applicable federal acts. Any action identified in this plan that falls within the scope of this act will need to meet its requirements.

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 the development and implementation of strategies for achieving and maintaining water quality and other environmental goals is a hallmark of this approach.

FEMA hazard mitigation project grant applications require full compliance with applicable federal acts. Any action identified in this plan that falls within the scope of this act will need to meet its requirements.

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. Santa Clara County and most of the partner cities for this plan participate in the NFIP and have adopted regulations that meet the NFIP requirements. At the time of the preparation of this plan, all participating jurisdictions in the partnership were in good standing and in full compliance with the minimum requirements of the NFIP.

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). Any action identified in this plan that falls within the scope of this act will need to meet its requirements.

National Incident Management System

The National Incident Management System is a systematic approach for government, nongovernmental organizations, and the private sector to work together to manage incidents involving hazards. The system 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 the National Incident Management System 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.

Although participation is voluntary, federal departments and agencies are required to make adoption of NIMS by local and state jurisdictions a condition to receive federal preparedness grants and awards. The content of this plan is considered to be a viable support tool for any phase of emergency management. The NIMS program is considered as a response function, and information in this hazard mitigation plan can support the implementation and update of all NIMS-compliant plans within the planning area.

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.

FEMA hazard mitigation project grant applications require full compliance with applicable federal acts. Any action identified in this plan that falls within the scope of this act will need to meet its requirements.

Civil Rights Act of 1964

The Civil Rights Act of 1964 prohibits discrimination based on race, color, religion, sex or national origin and requires equal access to public places and employment. The act is relevant to emergency management and hazard mitigation in that it prohibits local governments from favoring the needs of one population group over another. Local government and emergency response must ensure the continued safety and well-being of all residents equally, to the extent possible. FEMA hazard mitigation project grant applications require full compliance with applicable federal acts. Any action identified in this plan that falls within the scope of this act will need to meet its requirements.

Rural Development Program

The mission of the U.S. Department of Agriculture (USDA) Rural Development Program is to help improve the economy and quality of life in rural America. The program provides project financing and technical assistance to help rural communities provide the infrastructure needed by rural businesses, community facilities, and households. The program addresses rural America's need for basic services, such as clean running water, sewage and waste disposal, electricity, and modern telecommunications and broadband. Loans and competitive grants are offered for various community and economic development projects and programs, such as the development of essential community facilities including fire stations. Some of the actions identified in this plan may be eligible for funding available under this program.

Community Development Block Grant Disaster Resilience Program

In response to disasters, Congress may appropriate additional funding for the U.S. Department of Housing and Urban Development Community Development Block Grant programs to be distributed as Disaster Recovery grants (CDBG-DR). These grants can be used to rebuild affected areas and provide seed money to start the recovery process. CDBG-DR assistance may fund a broad range of recovery activities, helping communities and neighborhoods that otherwise might not recover due to limited resources. CDBG-DR grants often supplement disaster programs of FEMA, the Small Business Administration, and the U.S. Army Corps of Engineers. Housing and Urban Development generally awards noncompetitive, nonrecurring CDBG-DR grants by a formula that considers disaster recovery needs unmet by other federal disaster assistance programs. To be eligible for CDBG-DR funds, projects must meet the following criteria:

- Address a disaster-related impact (direct or indirect) in a presidentially declared county for the covered disaster.
- Be a CDBG-eligible activity (according to regulations and waivers).
- Meet a national objective.

Incorporating preparedness and mitigation into these actions is encouraged, as the goal is to rebuild in ways that are safer and stronger. CDGB-DR funding is a potential alternative source of funding for actions identified in this plan.

Emergency Watershed Program

The USDA Natural Resources Conservation Service administers the Emergency Watershed Protection Program, which responds to emergencies created by natural disasters. Eligibility for assistance is not dependent on a national emergency declaration. The program is designed to help people and conserve natural resources by relieving imminent hazards to life and property caused by floods, fires, wind-storms, and other natural occurrences. The Emergency Watershed Protection is an emergency recovery program. Financial and technical assistance are available for the following activities (National Resources Conservation Service, 2016):

- Remove debris from stream channels, road culverts, and bridges.

- Reshape and protect eroded banks.
- Correct damaged drainage facilities.
- Establish cover on critically eroding lands.
- Repair levees and structures.
- Repair conservation practices.

This federal program could be a possible funding source for actions identified in this plan.

Presidential Executive Orders 11988 and 13690

Executive Order 11988 requires federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. It requires federal agencies to provide leadership and take action to reduce the risk of flood loss, minimize the impact of floods on human safety, health, and welfare, and restore and preserve the natural and beneficial values of floodplains. The requirements apply to the following activities (FEMA, 2015d):

- Acquiring, managing, and disposing of federal lands and facilities.
- Providing federally undertaken, financed, or assisted construction and improvements.
- Conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulation, and licensing.

Executive Order 13690 expands Executive Order 11988 and acknowledges that the impacts of flooding are anticipated to increase over time due to the effects of climate change and other threats. It mandates a federal flood risk management standard to increase resilience against flooding and help preserve the natural values of floodplains. This standard expands management of flood issues from the current base flood level to a higher vertical elevation and corresponding horizontal floodplain when federal dollars are involved in a project. The goal is to address current and future flood risk and ensure that projects funded with taxpayer dollars last as long as intended (Office of the Press Secretary, 2015). All actions identified in this plan will seek full compliance with all applicable presidential executive orders.

Presidential Executive Order 11990

Executive Order 11990 requires federal agencies to provide leadership and take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands. The requirements apply to the following activities (National Archives, 2016):

- Acquiring, managing, and disposing of federal lands and facilities.
- Providing federally undertaken, financed, or assisted construction and improvements.
- Conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulation, and licensing.

All actions identified in this plan will seek full compliance with all applicable presidential executive orders.

Emergency Relief for Federally Owned Roads Program

The U.S. Forest Service’s Emergency Relief for Federally Owned Roads Program was established to assist federal agencies with repair or reconstruction of tribal transportation facilities, federal lands transportation facilities, and other federally owned roads that are open to public travel and have suffered serious damage by a natural disaster over a wide area or by a catastrophic failure. The program funds both emergency and permanent repairs (Office of Federal Lands Highway, 2016). Eligible activities under this program meet some of the goals and objectives for this plan and the program is a possible funding source for actions identified in this plan.

U.S. Army Corps of Engineers Programs

The U.S. Army Corps of Engineers has several civil works authorities and programs related to flood risk and flood hazard management:

- Floodplain Management Services are 100-percent federally funded technical services such as development and interpretation of site-specific data related to the extent, duration and frequency of flooding. Special studies may be conducted to help a community understand and respond to flood risk. These may include flood hazard evaluation, flood warning and preparedness, or flood modeling.
- For more extensive studies, the Corps of Engineers offers a cost-shared program called Planning Assistance to States and Tribes. Studies under this program generally range from $25,000 to $100,000, with the local jurisdiction providing 50 percent of the cost.
- The Corps of Engineers has several cost-shared programs (typically 65 percent federal and 35 percent non-federal) aimed at developing, evaluating and implementing structural and non-structural capital projects to address flood risks at specific locations or within a specific watershed:
  - ❖ The Continuing Authorities Program for smaller-scale projects includes Section 205 for Flood Control, with a $7 million federal limit and Section 14 for Emergency Streambank Protection with a $1.5 million federal limit. These can be implemented without specific authorization from Congress.
  - ❖ Larger scale studies, referred to as General Investigations, and projects for flood risk management, for ecosystem restoration or to address other water resource issues, can be pursued through a specific authorization from Congress and are cost-shared, typically at 65 percent federal and 35 percent non-federal.
  - ❖ Watershed Management planning studies can be specifically authorized and are cost-shared at 50 percent federal and 50 percent non-federal.
- The Corps of Engineers provides emergency response assistance during and following natural disasters. Public Law 84-99 enables the Corps to assist state and local authorities in flood fight activities and cost share in the repair of flood protective structures. Assistance afforded under PL 84-99 is broken down in to the following categories:
  - ❖ Preparedness—The Flood Control and Coastal Emergency Act establishes an emergency fund for preparedness for emergency response to natural disasters; for flood fighting and rescue operations; for rehabilitation of flood control and hurricane protection structures. Funding for Corps of Engineers emergency response under this authority is provided by Congress through the annual Energy and Water Development Appropriation Act. Disaster preparedness activities include coordination, planning, training and conduct of response exercises with local, state and federal agencies.
  - ❖ Response Activities—PL 84-99 allows the Corps of Engineers to supplement state and local entities in flood-fighting for urban and other non-agricultural areas under certain conditions (Engineering Regulation 500-1-1 provides specific details). All flood-fight efforts require a Project Cooperation Agreement (PCA) signed by the public sponsor and a requirement for the sponsor to remove all flood-fight material after the flood has receded. PL 84-99 also authorizes emergency water support and drought assistance in certain situations and allows for "advance measures" assistance to prevent or reduce flood damage conditions of imminent threat of unusual flooding.
  - ❖ Rehabilitation—Under PL 84-99, an eligible flood protection system can be rehabilitated if damaged by a flood event. The flood system would be restored to its pre-disaster status at no cost to the federal system owner, and at 20-percent cost to the eligible non-federal system owner. All systems eligible for PL 84-99 rehabilitation assistance have to be in the Rehabilitation and Inspection Program prior to the flood event. Acceptable operation and maintenance by the public levee sponsor are verified by levee inspections conducted by the Corps on a regular basis. The Corps has the responsibility to

coordinate levee repair issues with interested federal, state, and local agencies following natural disaster events where flood control works are damaged.

All of these authorities and programs are available to the planning partners to support any intersecting mitigation actions.

4.8.2 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 geologists from the State of California 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. All seismic hazard mitigation actions identified in this plan will seek full compliance with the Alquist-Priolo Earthquake Fault Zoning Act.

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.

All municipal planning partners to this plan have general plans that are currently compliant with this law and have committed to integrating this mitigation plan with their general plans through provisions referenced below (AB-2140 and SB-379)

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.

Santa Clara County has 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 Management Program

The California Coastal Management Program under the California Coastal Act requires each city or county lying wholly or partly within the coastal zone to prepare a local coastal plan. The specific contents of such plans are not specified by state law, but they must be certified by the Coastal Commission as consistent with policies of the Coastal Act (Public Resources Code, Division 20). The Coastal Act has provisions relating to geologic hazards, but does not mention tsunamis specifically. Section 30253(1) of the Coastal Act states that new development shall minimize risks to life and property in areas of high geologic, flood, and fire hazard. Development should be prevented or limited in high hazard areas whenever possible. However, where development cannot be prevented or limited, land use density, building value, and occupancy should be kept at a minimum.

There are identified coastal zones in the Santa Clara County Operational Area, and affected planning partners have developed local coastal plans to address them. Any mitigation project identified in this plan that intersects the mapped coastal zone will be consistent with the recommendations of the local coastal plan.

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 CalOES.

- 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 as part of the safety element of its General Plan. The local hazard mitigation plan needs to include elements specified in this legislation. In addition, this bill requires CalOES to give preference for federal mitigation funding to cities and counties that have adopted local hazard mitigation plans. 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.

AB 2800: Climate Change: Infrastructure Planning

This California State Assembly bill, in effect through July 1, 2020, requires state agencies to take into account the current and future impacts of climate change when planning, designing, building, operating, maintaining, and investing in state infrastructure. The bill requires the agency to establish a climate-safe infrastructure working group by July 1, 2017, to examine how to integrate scientific data concerning projected climate change impacts into state infrastructure engineering.

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 1000 General Plan Amendments: Safety and Environmental Justice Elements

Senate Bill 1000 amends California's Planning and Zoning Law in two ways:

- The original law established requirements for initial revisions of general plan safety elements to address flooding, fire, and climate adaptation and resilience. It also required subsequent review and revision as necessary based on new information. Senate Bill 1000 specifies that the subsequent reviews and revision based on new information are required to address only flooding and fires (not climate adaptation and resilience).
- Senate Bill 1000 adds a requirement that, upon adoption or revision of any two other general plan elements on or after January 1, 2018, an environmental justice element be adopted for the general plan or environmental justice goals, policies and objectives be incorporated into other elements of the plan.

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. Senate Bill 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.

This update process for this hazard mitigation plan was conducted with the intention of full compliance with this bill. However, at the time of the update, there was no clear guidance from the state on what constitutes full compliance or what protocol is to be used to determine compliance. When such guidance has been established, the planning partners will submit this plan or its subsequent updates to the state for review and approval.

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. All municipal planning partners to this plan have adopted building codes that are in full compliance with the California State Building Code.

Standardized Emergency Management System

CCR Title 19 establishes the Standardized Emergency Management System to standardize the response to emergencies involving multiple jurisdictions. The system 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 the Standardized Emergency Management System 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. This hazard mitigation plan is considered to be a support document for all phases of emergency management, including those associated with SEMS.

State of California Multi-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 *State of California Multi-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.

Under 44 CFR Section 201.6, local hazard mitigation plans must be consistent with their state's hazard mitigation plan. In updating this plan, the Steering Committee reviewed the California State Hazard Mitigation Plan to identify key relevant state plan elements (see Section 3.8).

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.

4.8.3 Local

Plans, Reports and Codes

Plans, reports and other technical information were identified and provided directly by participating jurisdictions and stakeholders or were identified through independent research by the planning consultant. These documents were reviewed to identify the following:

- 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 in order to develop complementary and mutually supportive goals, objectives, and mitigation strategies that are consistent across local and regional planning and regulatory mechanisms:

- General Plans (Housing Elements, Safety Elements).
- 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 compiled an inventory and analysis of existing authorities and capabilities called a “capability assessment.” A capability assessment creates an inventory of a jurisdiction’s mission, programs and policies, and evaluates its capacity to carry them out. This assessment identifies potential gaps in the jurisdiction’s capabilities.

The Planning Partnership views all core jurisdictional capabilities as fully adaptable to meet a jurisdiction's needs. Every code can be amended, and every plan can be updated. Such adaptability is itself considered to be an overarching capability. If the capability assessment identified an opportunity to add a missing core capability or expand an existing one, then doing so has been selected as an action in the jurisdiction's action plan, which is included in the individual annexes presented in Volume 2 of this plan.

Capability assessments for each planning partner are presented in the jurisdictional annexes in Volume 2. The sections below describe the specific capabilities evaluated under the assessment.

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 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 provide the backbone for successfully developing a mitigation strategy; however, without appropriate personnel, the strategy may not be implemented. Administrative and technical capabilities focus on the availability of personnel resources responsible for implementing all the facets of hazard mitigation. These resources include technical experts, such as engineers and scientists, as well as personnel with capabilities that may be found in multiple departments, such as grant writers.

NFIP Compliance

Flooding is the costliest 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. Community participation in the NFIP opens up opportunity for additional 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 local flood management program, opportunities for improvement, and available grant funding opportunities.

Public Outreach Capability

Regular engagement with the public on issues regarding hazard mitigation provides an 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 can result in a more resilient community based on education and public engagement.

Participation in Other Programs

Other programs, such as the Community Rating System, StormReady, and Firewise, enhance a jurisdiction's ability to mitigate, prepare for, 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 in order to create 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.

Development and Permitting Capability

Identifying previous and future development trends is achieved through a comprehensive review of permitting since completion of the previous plan and in anticipation of future development. Tracking previous and future growth in potential hazard areas provides an overview of increased exposure to a hazard within a community.

Adaptive Capacity

An adaptive capacity assessment evaluates a jurisdiction's ability to anticipate impacts from future conditions. By looking at public support, technical adaptive capacity, and other factors, jurisdictions identify their core capability for resilience against issues such as sea level rise. The adaptive capacity assessment provides jurisdictions with an opportunity to identify areas for improvement by ranking their capacity high, medium or low.

Integration Opportunity

The assessment looked for opportunities to integrate this mitigation plan with the legal/regulatory capabilities identified. Capabilities were identified as integration opportunities if they can support or enhance the actions identified in this plan or be supported or enhanced by components of this plan. Planning partners considered actions to implement this integration as described in their jurisdictional annexes.

Santa Clara County Operational Area Hazard Mitigation Plan

PART 2—RISK ASSESSMENT

5. 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.
- Exposure identification—Estimate the total number of people and properties in the jurisdiction that are likely to experience a hazard event if it occurs.
- Vulnerability identification and loss estimation—Assess the impact of hazard events on the people, property, environment, economy and lands of the region, including estimates of 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 OA and meets requirements of the Disaster Mitigation Act (44 CFR, Section 201.6(c)(2)).

To protect individual privacy and the security of critical facilities, information on properties assessed is presented in aggregate, without details about specific individual personal or public properties.

5.1 IDENTIFIED HAZARDS OF CONCERN

The Core Planning Group considered the full range of natural hazards that could affect the OA 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 struck the OA or could do so. Anecdotal information regarding natural hazards and the perceived vulnerability of the OA's assets to them was also used. Based on the review, this plan addresses the following hazards of concern (presented in alphabetical order; the order of listing does not indicate the hazards' relative severity):

- Climate change/sea-level rise.
- Dam and levee failure.
- Drought.
- Earthquake.
- Flood.
- Landslide.
- Severe weather.
- Tsunami.
- Wildfire.

In addition to the hazards of concern for which full risk assessments were performed, other hazards of interest were identified for inclusion in this plan: intentional hazards, technological hazards, and epidemic and pandemic. These hazards are of interest because they present risk to the OA. However, no methodologies are currently available to perform risk assessments on them that are equivalent to those used for the natural hazards of concern addressed in detail in this plan.

5.2 HAZARD RISK RANKING

FEMA requires all hazard mitigation planning partners to have jurisdiction-specific mitigation actions based on local risk, vulnerability and community priorities (FEMA, 2011). This plan included a risk ranking protocol for each planning partner, in which "risk" was calculated by multiplying probability by impact on people, property and the economy. All planning partners ranked risk for their own jurisdictions following the same methodology. Numerical ratings of probability and impact were based on the hazard profiles and exposure and vulnerability evaluations presented in Chapters 6 through 13. Using that data, each planning partner ranked the risk of all the natural hazards of concern described in this plan except tsunami; the risk assessment demonstrated the low risk to the OA from the tsunami hazard, given the small portion of the area along the uppermost part of San Francisco Bay that would be affected. Other hazards of interest were not ranked for the following reasons:

- A key component of risk as defined for the planning effort is probability of occurrence. While it is possible to assign a recurrence interval for natural hazards because of historical occurrence, it is not feasible to assign recurrence intervals for the other hazards of interest, which lack such historical precedent.
- Federal hazard mitigation planning regulations do not require the assessment of non-natural hazards (44 CFR, 201.6). It is FEMA's position that this is a local decision.

The risk ranking at the planning partner scale was used to inform the action plan development process for each partner. Planning partners were directed to identify mitigation actions addressing hazards that, at a minimum, had a "high" or "medium" risk ranking (see Section 5.2.3). Actions that address hazards with a low or no hazard ranking are considered optional by this planning process.

Volume 2 presents the risk rankings for each planning partner. The following Operational Area-wide risk ranking was conducted via facilitated brainstorming sessions with the Core Planning Group. Estimates of risk were generated with data from Hazus using methodologies promoted by FEMA. The results are used in establishing mitigation priorities.

5.2.1 Probability of Occurrence

The probability of occurrence of a hazard is indicated by a probability factor based on 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 5-1 summarizes the probability assessment for each hazard of concern for this plan.

Table 5-1. Probability of Hazards

Hazard Event	Probability (high, medium, low)	Probability Factor
Dam and Levee Failure	Low	1
Drought	High	3
Flood	High	3
Earthquake	High	3
Landslide	High	3
Severe Weather	High	3
Wildfire	High	3

5.2.2 Impact

Hazard impacts were assessed in three categories: impacts on people, impacts on property and impacts on the local economy. Numerical impact factors were assigned as follows:

- People—Values were 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 impacted when a hazard event occurs. It should be noted that planners can use an element of subjectivity when assigning values for impacts on people. Impact factors were assigned as follows:
  - ❖ High—50 percent or more of the population is exposed to a hazard (Impact Factor = 3).
  - ❖ Medium—25 percent to 49 percent of the population is exposed to a hazard (Impact Factor = 2).
  - ❖ Low—25 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 were assigned based on the percentage of the total *property value exposed* to the hazard event:
  - ❖ High—30 percent or more of the total assessed property value is exposed to a hazard (Impact Factor = 3).
  - ❖ Medium—15 percent to 29 percent of the total assessed property value is exposed to a hazard (Impact Factor = 2).
  - ❖ Low—14 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 were 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 replacement value of the property exposed to the hazard. For some hazards, such as wildfire, landslide and severe weather, vulnerability was considered to be the same as exposure due to the lack of loss estimation tools specific to those hazards. Loss estimates separate from the exposure estimates were generated for the earthquake and flood hazards using Hazus.
  - ❖ High—Estimated loss from the hazard is 20 percent or more of the total exposed property value (Impact Factor = 3).
  - ❖ Medium—Estimated loss from the hazard is 10 percent to 19 percent of the total exposed property value (Impact Factor = 2).
  - ❖ Low—Estimated loss from the hazard is 9 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 hazard category were assigned a weighting factor to reflect the significance of the impact. These weighting factors are consistent with those typically used for measuring the benefits of hazard mitigation actions: impact on people was given a weighting factor of 3; impact on property was given a weighting factor of 2; and impact on the economy was given a weighting factor of 1.

Table 5-2, Table 5-3 and Table 5-4 summarize the impacts for each hazard.

Table 5-2. Impact on People from Hazards

Hazard Event	Impact (high, medium, low, no impact)	Impact Factor	Multiplied by Weighting Factor (3)
Dam and Levee Failure	High	3	9
Drought	No Impact	0	0
Flood	Medium	2	6
Earthquake	High	3	9
Landslide	Low	1	3
Severe Weather	Medium	2	6
Wildfire	Low	1	3

Table 5-3. Impact on Property from Hazards

Hazard Event	Impact (high, medium, low, no impact)	Impact Factor	Multiplied by Weighting Factor (2)
Dam and Levee Failure	High	3	6
Drought	Low	1	2
Flood	Medium	2	4
Earthquake	High	3	6
Landslide	Low	1	2
Severe Weather	Medium	2	4
Wildfire	Low	1	2

Table 5-4. Impact on Economy from Hazards

Hazard Event	Impact (high, medium, low, no impact)	Impact Factor	Multiplied by Weighting Factor (1)
Dam and Levee Failure	High	3	3
Drought	High	3	3
Flood	Low	1	1
Earthquake	High	3	3
Landslide	Low	1	1
Severe Weather	Low	1	1
Wildfire	Low	1	1

5.2.3 Risk Rating and Ranking

The risk rating for each hazard was determined by multiplying the probability factor by the sum of the weighted impact factors for people, property and economy, as summarized in Table 5-5. Based on these ratings, a priority of high, medium or low was assigned to each hazard. The hazard ranked as being of highest concern is earthquake, followed by flood and severe weather. Hazards ranked as being of medium concern are dam and levee failure, landslide, and wildfire. The hazard ranked as being of lowest concern is drought. Table 5-6 shows the hazard risk ranking.

Table 5-5. Hazard Risk Rating

Hazard Event	Probability Factor	Sum of Weighted Impact Factors	Total (Probability x Impact)
Dam and Levee Failure	1	18	18
Drought	3	5	15
Flood	3	6	39
Earthquake	3	18	54
Landslide	3	6	18
Severe Weather	3	11	33
Wildfire	3	6	18

Table 5-6. Hazard Risk Ranking

Hazard Ranking	Hazard Event	Category
1	Earthquake	High
2	Flood	High
3	Severe Weather	High
4	Dam and Levee Failure	Medium
5	Landslide	Medium
6	Wildfire	Medium
7	Drought	Medium

5.3 RISK ASSESSMENT TOOLS

5.3.1 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 when such datasets were available. These maps are included in the hazard profile chapters of this document.

5.3.2 Hazus

Overview

In 1997, 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 with new models for estimating potential losses from hurricanes and floods.

Hazus 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 datasets 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 provides default data for inventory, vulnerability, and hazards; the 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 OA:

- 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 OA.
- Level 2—More accurate estimates of losses require more detailed information about the OA. 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 OA.

5.4 RISK ASSESSMENT APPROACH

The risk assessments in this plan describe the risks associated with each identified hazard of concern. 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 Hazus were used for this assessment for the flood, earthquake, and Anderson Dam failure hazards. Outputs similar to those from Hazus were generated for other hazards, using data generated through GIS.

5.4.1 Dam Failure, Earthquake, and Flood

The following hazards were evaluated using Hazus:

- 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 OA was used to delineate flood hazard areas and estimate potential losses from the 10-percent-annual-chance, 1-percent-annual-chance and 0.2-percent-annual-chance flood events. To estimate damage that would result from a flood, Hazus 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.
- Dam Failure—A Level 2 analysis was run on the Anderson Dam inflow design flood using the flood methodology described above.
- Earthquake—A Level 2 analysis was performed to assess earthquake exposure and vulnerability for three scenario events and two probabilistic events:

  - ❖ A Magnitude-7.0 event on the Hayward Fault with an epicenter approximately 25 miles north of the City of Palo Alto.
  - ❖ A Magnitude-7.0 event on the Calaveras Fault with an epicenter approximately 25 miles north of the City of Milpitas.
  - ❖ A Magnitude-7.8 event on the San Andreas Fault with an epicenter approximately 148 miles northwest of the City of Palo Alto.
  - ❖ The standard Hazus 100- and 500-year probabilistic events.

5.4.2 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.

5.4.3 All Other Assessed Hazards

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.

5.5 SOURCES OF DATA USED IN HAZUS MODELING

5.5.1 Building and Cost Data

Replacement cost values and detailed structure information derived from parcel and tax assessor data provided by Santa Clara County were loaded into Hazus. When available, an updated inventory was used in place of the Hazus 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, 2017). It is calculated using the RS Means square foot cost for a structure, which is based on the Hazus occupancy class (i.e., 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 structures also factor into determining the square foot costs.

5.5.2 Hazus Data Inputs

The following hazard datasets were used for the Hazus Level 2 analysis conducted for the risk assessment:

- Flood—The effective Digital Flood Insurance Rate Map for the OA was used to delineate flood hazard areas and estimate potential losses from the 10-percent-annual-chance, 1-percent-annual-chance and 0.2-

percent-annual-chance flood events. Using the Digital Flood Insurance Rate Map floodplain boundaries and base flood elevation information, and the U.S. Geological Survey (USGS) 3-meter digital elevation model data, flood depth grids were generated and integrated into the Hazus model.

- Dam Failure—Dam inundation area data for the Anderson Dam provided by the Santa Clara Valley Water District, and the USGS 3-meter digital elevation model were used to develop depth grids that were integrated into the Hazus model.
- Earthquake—Earthquake shake maps and probabilistic data prepared by the USGS were used for the analysis of this hazard. A National Earthquake Hazard Reduction Program soils map from the California Department of Conservation, ABAG’s liquefaction susceptibility data and susceptibility to deep-seated landslides from the California Geological Survey were also integrated into the Hazus model.

5.5.3 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:

- Landslide—Susceptibility to deep-seated landslide data were provided by the California Geological Survey.
- Sea Level Rise—Sea level rise data were provided by the San Francisco Bay Conservation and Development Commission. A sea level rise of 6 feet above current mean higher high water was used for the exposure analysis.
- Dam Inundation—Dam inundation exposure areas for the Lexington, Searsville and Stevens Creek dams were provided by ABAG.
- Levee Inundation—Levee inundation exposure areas were defined with boundaries provided by Santa Clara County.
- Severe Storm—No GIS format severe storm area datasets were identified for the OA.
- Tsunami—Tsunami inundation map was prepared by California Department of Conservation in cooperation with the University of Southern California, California Geological Survey, and California Emergency Management Agency.
- Wildfire—Fire severity data was acquired from California Department of Forestry and Fire Protection (CAL FIRE).

5.5.4 Data Source Summary

Table 5-7 summarizes the data sources used for the risk assessment for this plan.

Table 5-7. Hazus Model Data Documentation

Data	Source	Date	Format
Property parcel data	Santa Clara County	2016	Digital (GIS) format
Building information such as area, occupancy, date of construction, and stories	Santa Clara County	2016	Digital (tabular) format
Building replacement cost	RS Means	2017	Paper format.
Population data	FEMA Hazus version 3.1, California Dept. of Finance	2010, 2016	Digital (GIS and tabular) format
Flood hazard data	FEMA	2016	Digital (GIS) format
Tsunami	ABAG (State of California)	2009	Digital (GIS) format
Earthquake shake maps	USGS Earthquake Hazards Program website	2012, 2014	Digital (GIS) format
Liquefaction susceptibility	ABAG, USGS	2006	Digital (GIS) format
National Earthquake Hazard Reduction Program	California Department of Conservation	2008	Digital (GIS) format
Dam Inundation Areas			
Anderson Dam	Santa Clara Valley Water District	2016	Digital (GIS) format
Lexington, Stevens Creek, Searsville Dams	ABAG	Unknown	Digital (GIS) format
Landslide	California Geological Survey	2011	Digital (GIS) format
Sea Level Rise	Adapting to Rising Tides - San Francisco Conservation and Development Commission	2017	Digital (GIS) format
Wildfire	CAL FIRE	2008	Digital (GIS) format
Digital Elevation Model	USGS	Downloaded 2016	Digital (GIS) format
Critical Facilities and Assets			
Emergency operation centers, airport facilities, bus facilities, light rail facilities, rail facilities, communication facilities, electric power facilities, potable water facilities, wastewater facilities	FEMA Hazus version 3.1 Default Critical Facilities Data	2016	Digital (GIS) format
Points of interest (city halls, community centers, other county facilities, child day care facilities)	Santa Clara County	2016	Digital (GIS) format
Santa Clara County critical facilities (fire stations, hospitals, skilled nursing facilities and clinics, police stations, public / private schools, universities and colleges)	Santa Clara County	2016	Digital (spreadsheet) format
Superfund sites (hazardous material sites)	Santa Clara County	2016	Digital (GIS) format
Toxic release inventory facilities (hazardous material facilities, designated communications centers, electric power and petroleum facilities)	Environmental Protection Agency (EPA)	2016	Digital (GIS) format
State and local bridges (highway bridges, light rail bridges, rail bridges, includes pedestrian bridges)	Santa Clara County	2016	Digital (GIS) format

5.6 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.
- Lack of a standardized model for assessing sea level rise impacts. Multiple models provide multiple results. Not all models were run in the development of the sea level rise analysis.

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, Santa Clara County will collect additional data to assist in estimating potential losses associated with other hazards.

6. DAM AND LEVEE FAILURE

6.1 GENERAL BACKGROUND

6.1.1 Dams

A dam is an artificial barrier that has the ability to store water, wastewater, or liquid-borne materials for many reasons—flood control, human water supply, irrigation, livestock water supply, energy generation, containment of mine tailings, recreation, or pollution control. Many dams fulfill a combination of these functions. They are an important resource in the United States (Association of State Dam Safety Officials, 2013).

Man-made dams can be classified according to the type of construction material used, the methods used in construction, the slope or cross-section of the dam, the way the dam resists the forces of the water pressure behind it, the means used for controlling seepage, and, occasionally, according to the purpose of the dam. The materials used for construction of dams include earth, rock, tailings from mining or milling, concrete, masonry, steel, timber, miscellaneous materials (plastic or rubber), and any combination of these materials (Association of State Dam Safety Officials, 2013).

More than a third of the country's dams are 50 or more years old. Approximately 14,000 of those dams pose a significant hazard to life and property if failure occurs. There are about 2,000 unsafe dams in the United States, located in almost every state.

Dam failures typically occur when spillway capacity is inadequate and excess flow overtops the dam, or when internal erosion (piping) through the dam or foundation occurs. Complete failure occurs if internal erosion or overtopping results in a complete structural breach, releasing a high-velocity wall of debris-filled water that rushes downstream damaging anything in its path (FEMA, 1996).

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).

Levee—A man-made structure, usually an earthen embankment or concrete floodwall, designed and constructed in accordance with sound engineering practices to contain, control, or divert the flow of water.

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

Levee Failure (Breach)—When part of a levee breaks away, leaving a large opening for water to flood the land protected by the levee.

Emergency Action Plan—A formal document that identifies potential emergency conditions at a dam and specifies actions to be followed to minimize property damage and loss of life. The plan specifies actions the dam owner should take to alleviate problems at a dam. It contains procedures and information to assist the dam owner in issuing early warning and notification messages to responsible downstream emergency management authorities of the emergency situation. It also contains inundation maps to show emergency management authorities the critical areas for action in case of an emergency. (FEMA, 2013a)

High Hazard Dam—Dams where failure or improper operation will probably cause loss of human life. (FEMA, 2004)

Significant Hazard Dam—Dams where failure or improper operation will result in no probable loss of human life but can cause economic loss, environmental damage or disruption of lifeline facilities, or can impact other concerns. Significant hazard dams are often located in rural or agricultural areas but could be located in areas with population and significant infrastructure. (FEMA, 2004)

6.1.2 Levees

Levees are man-made structures, usually an earthen embankment, designed and constructed to contain, control, or divert a flow of water in order to protect land from peak flood levels or to protect land that is below sea level. Santa Clara Valley Water District (SCVWD) maintains two types of levees in the OA:

- Levees designed to withstand peak flood levels that are caused by rapid snowmelt or intense rainfall and protect the lives and property behind them.
- Levees designed to withstand nominal water levels on a continuous basis as well as peak flood levels, such as the levees lining the Sacramento-San Joaquin River Delta on San Francisco Bay, which delivers irrigation and drinking water.

The U.S. Army Corps of Engineers operates, maintains, and evaluates flood protection levees to determine if they meet accreditation requirements. Most levees are owned by local communities and flood control districts that must ensure proper operation and maintenance of the levee system as well (FEMA, 2013c).

Levees, when functioning properly, reduce the risk of flooding for communities. However, an unexpected levee breach or failure can be catastrophic, with the flooding causing loss of life, emergency evacuations, and insufficient time to reduce damage to property.

6.1.3 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 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 U.S. dam failures are due to miscellaneous causes. Many dam failures in the United States have been secondary results of other disasters. The prominent causes are earthquakes, landslides, extreme storms, massive snowmelt, equipment malfunction, structural damage, foundation failures, and sabotage.

The most likely disaster-related causes of dam failure in the OA are earthquake, excessive rainfall, and landslides. Poor construction, lack of maintenance and repair, and deficient operational procedures are preventable or correctable by a program of regular inspections. Terrorism and vandalism are serious concerns that all operators of public facilities must plan for; these threats are under continuous review by public safety agencies.

6.1.4 Causes of Levee Failure

A levee breach occurs when part of a levee gives way, creating an opening through which floodwaters may pass. A breach may occur gradually or suddenly. The most dangerous breaches happen quickly during periods of high water. The resulting torrent can quickly swamp a large area behind the failed levee with little or no warning. When a levee system fails or is overtopped, severe flood damage can occur due to increased water surface elevation associated with levees and the resulting increase in water velocity.

Earthen levees can be damaged in several ways. For instance, strong river currents and waves can erode the surface. Trees growing on a levee can blow over, leaving a hole where the root wad and soil used to be. Burrowing animals, such as the California ground squirrel, the salt marsh harvest mouse, or the western burrowing owl can create holes that enable water to pass through a levee. If severe enough, any of these situations can lead to a zone of weakness that could cause a levee breach. In seismically active areas, earthquakes and ground shaking can cause a loss of soil strength, weakening a levee and possibly resulting in failure. Seismic activity can also cause levees to slide or slump, both of which can lead to failure.

No levee provides protection from events for which it was not designed, and levees require maintenance to continue to provide the level of protection they were designed and built to offer. Maintenance responsibility belongs to a variety of entities including local, state, and federal government and private landowners. Well-maintained levees may obtain certification through independent inspections. Levees may not be certified for maintaining flood protection when the levee owner does not maintain the levee or pay for an independent inspection. The impacts of an un-certified levee include higher risk of levee failure. In addition, insurance rates may increase because FEMA identifies on Flood Insurance Rate Maps that the structures are not certified to protect from a 1-percent annual chance flood event (FEMA, 2004).

6.1.5 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 requires a periodic engineering analysis of the majority of dams in the country; exceptions include the following:

- Dams under jurisdiction of the Bureau of Reclamation, Tennessee Valley Authority, or International Boundary and Water Commission.
- Dams constructed pursuant to licenses issued under the Federal Power Act.
- Dams that 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 National Dam Safety Program 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’s Division of Safety of Dams monitors 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, 2016).

U.S. Army Corps of Engineers Dam Safety Program

The U.S. Army Corps of Engineers 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. The Corps 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 (U.S. Army Corps of Engineers, Date Unknown). The Corps' National Inventory of Dams provides the most recent inspection dates for 22 high-hazard dams in Santa Clara County (see Table 6-1).

Table 6-1. Santa Clara County High Hazard Dam Inspection Dates

Santa Clara County Dam	Inspection Date	Santa County Dam	Inspection Date
Almaden	April 4, 2012	**Guadalupe**	April 4, 2012
Leroy Anderson	April 25, 2012	**Higuera**	August 9, 2011
Austrian	August 8, 2011	**James J. Lenihan**	April 3, 2012
Calero	April 4, 2012	**Kuhn**	April 23, 2012
Cherry Flat	April 23, 2012	**Lake Ranch**	August 9, 2011
Columbine	August 9, 2011	**North Fork**	January 26, 2012
Coyote	November 15, 2011	**Peabody**	January 26, 2012
Debell	January 26, 2012	**Stevens Creek**	November 14, 2011
Elmer J Chesbro	November 15, 2011	**Upper Howell**	August 8, 2011
Felt Lake	July 13, 2012	**Uvas**	November 15, 2011
Foothill Park	January 25, 2012	**Vasona Percolating**	April 3, 2012

Source: U.S. Army Corps of Engineers, 2016b

Federal Energy Regulatory Commission Dam Safety Program

The Federal Energy Regulatory Commission (FERC) cooperates with a large number of federal and state agencies to ensure and promote dam safety. More than 3,000 dams are part of regulated hydroelectric projects in the FERC program. Two-thirds of these are more than 50 years old. As dams age, concern about their safety and integrity grows, so oversight and regular inspection are important.

FERC 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 the terms and conditions of a license.

Every five years, an independent consulting engineer, approved by the FERC, must inspect and evaluate projects with dams higher than 32.8 feet (10 meters), or with a total storage capacity of more than 2,000 acre-feet.

FERC monitors and evaluates seismic research in geographic areas such as California where there are concerns about possibly seismic activity. This information is applied in investigating and performing structural analyses of hydroelectric projects. FERC also evaluates the effects of potential and actual large floods on the safety of dams. During and following floods, FERC visits dams and licensed projects, determines the extent of damage, if any, and directs any necessary studies or remedial measures the licensee must undertake. The FERC publication *Engineering Guidelines for the Evaluation of Hydropower Projects* guides the 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 if there is an actual or potential sudden release of water from a dam due to failure. The plans include operational procedures that may be used, such as reducing reservoir levels and reducing downstream flows, as well as procedures for notifying affected residents and agencies responsible for emergency management. These plans are frequently updated and tested to ensure that everyone knows what to do in emergency situations (FERC, 2016).

Corps of Engineers and FEMA Levee Oversight

The Corps and FEMA have differing roles and responsibilities related to levees. The Corps addresses a range of operation and maintenance, risk communication, risk management, and risk reduction issues as part of its responsibilities under the Levee Safety Program. FEMA addresses mapping and floodplain management issues related to levees, and it accredits levees as meeting requirements set forth by the National Flood Insurance Program.

Depending on the levee system, the Corps and FEMA may be involved with a levee sponsor and community independently or jointly. The two agencies' long-term goals are similar: to reduce risk and lessen the devastating consequences of flooding. Corps and FEMA partnering activities related to levees include the following:

- Joint meetings with levee sponsors and other stakeholders.
- Integration of levee information into the National Levee Database.
- State Silver Jackets teams.
- Sharing of levee information.
- Targeted task forces to improve program alignment.

Coordination between the Corps and FEMA on levees is now standard within many of each agency's policies and practices. Over the past several years, both agencies coordinated policies where appropriate; jointly participated in meetings with stakeholders; and participated in many multiagency efforts, such as the National Committee on Levee Safety, the Federal Interagency Floodplain Management Task Force, and the Silver Jackets Program.

The Silver Jackets is a program that provides an opportunity to consistently bring together multiple state, federal, tribal, and local agencies to learn from each other and apply their knowledge to reduce risk. The Program's primary goals include the following:

- Create or supplement a mechanism to collaboratively identify, prioritize, and address risk management issues and implement solutions.
- Increase and improve risk communication through a unified interagency effort.
- Leverage information and resources and provide access to national programs (FEMA's Risk MAP and the Corps' Levee Inventory and Assessment Initiative).
- Provide focused, coordinated hazard mitigation assistance in implementing high-priority actions such as those identified by state hazard mitigation plans.
- Identify gaps among agency programs and barriers to implementation, such as conflicting agency policies or authorities, and provide recommendations for addressing these issues.

National Committee on Levee Safety

Congress created the National Committee on Levee Safety to "develop recommendations for a national levee safety program, including a strategic plan for implementation of the program." The Committee adopted a vision of "an involved public and reliable levee systems working as part of an integrated approach to protect people and property from floods," and has been working toward this goal since October 2008 (National Committee on Levee Safety, 2010). The Committee is made up of representatives from state, regional, and local agencies; the private sector; the Corps; and FEMA.

California DWR Levee Repair Program

California initiated this program in 2006 after a state of emergency for heavy rainfall and runoff was declared and California's levee system was compromised. This allowed for $500 million of state funds to repair and evaluate state and federal levees. The project evaluated the stability of the levee system and implemented critically needed repairs to protect communities, farmlands, and infrastructure (California DWR, 2016).

6.2 HAZARD PROFILE

6.2.1 Past Events

According to the 2013 *State of California Multi-Hazard Mitigation Plan*, there have been nine dam failures in the state since 1950, none in the Bay Area. The most recent dam emergency occurred in February 2017 at Oroville Dam in northern California's Butte County when it was on the verge of overflow. The concrete spillway was damaged by erosion and a massive hole developed. The auxiliary spillway was used to prevent overtopping of the dam and it experiences erosion problems also. Evacuation orders were issued out of concern about a potential large uncontrolled release of water from Lake Oroville. Such a release was ultimately prevented, and evacuees returned to their homes.

Historically, overtopping caused two of the state's nine failures; the others were caused by seepage or leaks. One failure, the 1963 Baldwin Hills Dam Failure, resulted in three deaths because the leak turned into a washout. The historical record indicates that California has had about 45 failures of non-federal dams. The failures occurred for a variety of reasons, the most common being overtopping. Other reasons include shortcomings in the dams or an inadequate assessment of surrounding geomorphologic characteristics.

California's first notable dam failure was in 1883 in Sierra County; the most recent failure was in 1965. The most catastrophic event was the failure of the St. Francis Dam in Los Angeles County, which failed in 1928 and killed an estimated 450 people.

6.2.2 Location

According to DWR, there are 42 dams in the OA and 22 are classified as high-hazard dams, as listed in Table 6-2. All 22 are under the jurisdiction of the state. The Leroy Anderson Reservoir, referred to as the "Anderson Reservoir" is the largest of the 10 water district reservoirs and provides water supply to the OA.

The SCVWD manages approximately 100 miles of levees in Santa Clara County. About 50 miles provide 100-year flood protection and nearly 18 miles were constructed in partnership with the Corps (SCVWD, 2008). The Corps' National Levee Database lists seven levees in Santa Clara County, as shown in Table 6-3.

6.2.3 Frequency

Dam and levee failure events are infrequent and usually coincide with events that cause them, such as earthquakes, landslides and excessive rainfall and snowmelt. There is a "residual risk" associated with dams that remains after safeguards have been implemented. The residual risk is associated with events beyond those that the facility was designed to withstand. However, the probability of occurrence of any type of dam or levee failure event is considered to be low in today's regulatory and safety oversight environment.

Table 6-2. High Hazard Dams in the Santa Clara County OA

Name	National ID #	Water Course	Owner	Year Built	Dam Type	Crest Length (feet)	Height (feet)	Storage Capacity (acre-feet)	Drainage area (sq. mi.)
Almaden	72.004	Alamitos Creek	SCVWD	1936	Earth	500	110	62	12.50
Leroy Anderson, "Anderson Reservoir"	CA00294	Coyote River	SCVWD	1950	Earth	1,430	235	1,271	194.40
Austrian	622.013	Los Gatos Creek	San José Water Co.	1950	Earth	700	185	96	9.80
Calero	72.003	Calero Creek	SCVWD	1935	Earth	840	90	337	7.14
Cherry Flat	CA00158	Penitencia Creek	City of San José	1936	Earth	230	60	25	2.41
Columbine	CA00682	Offstream	San José Water Co.	1963	Earth	1,480	24	3	n/a
Coyote	CA00287	Coyote Creek	SCVWD	1936	Earth and Rock	980	140	635	120
DeBell	CA00686	Bodfish Creek Tributary	Private Entity	1952	Earth	580	53	8	0.72
Elmer J Chesbro	CA00806	Llagas Creek	SCVWD	1955	Earth and Rock	690	95	328	19.50
Felt Lake	CA00670	Trail Los Trancos Creek	Santa Clara	1930	Earth	590	67	40	0.20
Foothill Park	CA00868	Trail Los Trancos Creek	City of Palo Alto	1988	Earth	600	86	11	0.11
Guadalupe	CA00290	Guadalupe Creek	SCVWD	1935	Earth	695	142	75	6.00
Higuera	CA00687	South Calera Creek	Private Entity	1953	Earth	525	44	4	0.60
James J. Lenihan, "Lexington Reservoir"	CA00293	Los Gatos Creek	SCVWD	1953	Earth	810	208	450	27.70
Kuhn	CA00683	Trail Dry Creek	Private Entity	1947	Earth	312	67	5	0.10
Lake Ranch	CA00676	Beardsley Creek	San José Water Co.	1877	Earth	160	38	18	0.70
North Fork	CA00299	Pacheco Creek	Pacheco Pass Water District	1939	Earth	600	100	197	67.20
Peabody	CA00685	Trail Llagas Creek	Private Entity	1950	Earth	295	63	76	5.50
Stevens Creek	CA00292	Stevens Creek	SCVWD	1935	Earth	1,080	132	95	17.50
Upper Howell	CA00678	Rundell Creek	San José Water Co.	1878	Earth	640	36	243	13.00
Uvas	CA00807	Uvas Creek	SCVWD	1957	Earth	1,100	118	280	32.00
Vasona Percolating	CA01516	Pickle Canyon Creek	Private Entity	1935	Earth	1,00	34	58	44.20

Sources: California Division of Safety of Dams, 2017; Stanford University National Performance of Dams Program, 2017

Table 6-3. Levees in Santa Clara County

Levee Name	Counties Where System is Located	Levee Owner	Segment Length (miles)	Corps Program Levee
Uvas Creek-Left Bank	Santa Clara	SCVWD	2.19	Yes
King & Lyons	Alameda and Santa Clara	Alameda Flood Control and Water Conservation District	3.5	Yes
Guadalupe River – Right Bank	Santa Clara	SCVWD	6.9	No
Guadalupe River – Left Bank	Santa Clara	SCVWD	8.48	No
Coyote Creek, Santa Clara – Right Bank Bypass	Alameda and Santa Clara	SCVWD	0.43	Yes
Coyote Creek, Santa Clara – Right Bank	Santa Clara	SCVWD	4.9	Yes
Coyote Creek, Santa Clara – Left Bank	Santa Clara	SCVWD	6.72	Yes

Source: U.S. Army Corps of Engineers, 2016c

6.2.4 Severity

Dams upstream of towns and cities create a high risk potential for life and property, particularly in seismically active states such as California. Measure of extent or severity of a dam failure is through the classification of the dam. Two additional factors influence potential severity of a full or partial dam failure: the amount of water impounded; and the density, type, and value of downstream development and infrastructure. The SCVWD conducts seismic stability evaluations on its dams and applies recently adopted, more stringent, earthquake standards. The U.S. Army Corps of Engineers developed the classification system shown in Table 6-4 for the hazard potential of dam failures. This rating system is based only on the potential consequences of a dam failure; it does not take into account the probability of such failures.

Table 6-4. Corps of Engineers 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 the interruption of lifeline services due to project failure or operational disruption; for example, loss of critical medical facilities or access to them.
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 the project failure, beyond what would normally be expected for the magnitude flood event under which the failure occurs.

Source: U.S. Army Corps of Engineers, 1995

In the event of a levee failure, floodwaters may ultimately inundate the protected area landward of the levee. The extent of inundation is dependent on the flooding intensity. Failure of a levee during a 1-percent annual chance flood will inundate the 100-year floodplain previously protected by the levee. Residential and commercial buildings nearest the levee overtopping or breach location will suffer the most damage from the initial embankment failure flood wave. Landward buildings will be damaged by inundation (FEMA, 2004).

6.2.5 Warning Time

Warning time for dam failure varies depending on the cause of the failure. In events of extreme precipitation or massive snowmelt, evacuations can be planned with sufficient time. In the event of a structural failure due to earthquake, there may be 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 a partial breach as one or more monolith sections are forced apart by escaping water. The time of breach formation ranges from a few minutes to a few hours (U.S. Army Corps of Engineers, 1997).

Santa Clara County and its planning partners have established protocols for emergency warning and response through the County’s adopted emergency operations plan. The SCVWD Dam Safety Program maintains the operation of its dams and works with Santa Clara County Emergency Management to provide copies of the most recent dam emergency action plans and inundation maps, and uses this information to plan notification needs for downstream areas in the event of a failure.

Warning time for levee failures depends on the cause of the failure. A levee failure caused by structural failure can be sudden and occur with little to no warning. If heavy rains are impacting a levee system, communities located in the immediate danger zone can be evacuated before a failure occurs. If the levee failure is caused by overtopping, the community may or may not be able to recognize the impending failure and evacuate. If a levee failure occurs suddenly, evacuation may not be possible.

6.3 SECONDARY HAZARDS

Dam and levee failures can cause severe downstream flooding, depending on the magnitude of the failure. Other potential secondary hazards are landslides, bank erosion, and destruction of downstream habitat. Levee failures can also cause environmental incidents due to hazardous materials releases when floodwaters infiltrate facilities that store these types of materials.

6.4 EXPOSURE

Exposure and vulnerability to the dam failure hazard were assessed by use of spatial analysis. The consistency of the data available to support this risk assessment varied greatly within the OA. The level of analyses varied based on available data. A detailed exposure and vulnerability analysis was done for the Andersen Dam and for areas protected by levees.

Exposure-only analyses were completed for the James J. Lenihan Dam, Searsville Dam, and Stevens Creek Dam. This data was provided to the planning partnership for informational risk ranking purposes, but is not included in this comprehensive assessment due to data age and inaccuracies. The Working Group has identified acquisition of detailed information and data for additional dams as a priority need.

6.4.1 Population

All populations in a dam failure inundation zone would be exposed to the risk of a dam failure. The potential for loss of life is affected by the capacity and number of evacuation routes available to populations living in areas of potential inundation. The estimated population living in the mapped Anderson, Lexington, Searsville, and Stevens Creek Dam inundation areas is summarized in Table 6-5 and Table 6-6. The population within a levee failure inundation area is 1,775, which represent only 0.09 percent of the OA population (see Table 6-7).

6.4.2 Property

Based on assessor parcel data, the Hazus model estimated the Anderson Dam inundation area, which is the largest reservoir. The inundation boundaries for this dam cover a large portion of the OA. There are 91,601 structures within the mapped dam failure inundation areas in the OA. The value of exposed buildings in the OA was generated using Hazus and is summarized in Table 6-8. This methodology estimated $136 billion worth of building-and-contents exposure to dam failure inundation, representing 28.5 percent of the total replacement value of the OA. The number of exposed structures by land use type is summarized in Table 6-9.

Structures located in Lexington, Searsville, and Stevens Creek Dam inundation areas also were evaluated based on assessor parcel data, but the only available inundation boundary data for these dams—from ABAG (2006)—does not provide a detailed boundary. The approximate value of exposed buildings is summarized in Table 6-10, Table 6-11 and

Table 6-12. The approximate number of exposed structures by land use is summarized Table 6-13, Table 6-14 and Table 6-15.

Table 6-5. Population within Anderson and Lexington Dam Failure Inundation Areas

Jurisdiction	Anderson Dam		Lexington Dam	
	Population Exposed	Percentage of Total Population	Population Exposed	Percentage of Total Population
Campbell	0	0.0%	27,502	64.58%
Cupertino	0	0.0%	0	0.00%
Gilroy	9,220	16.7%	0	0.00%
Los Altos	0	0.0%	0	0.00%
Los Altos Hills	0	0.0%	0	0.00%
Los Gatos	0	0.0%	3,127	9.97%
Milpitas	4,406	5.8%	0	0.00%
Monte Sereno	0	0.0%	0	0.00%
Morgan Hill	26,584	60.9%	0	0.00%
Mountain View	0	0.0%	0	0.00%
Palo Alto	0	0.0%	0	0.00%
San José	316,294	30.4%	94,405	9.06%
Santa Clara (city)	21,109	17.1%	71,413	57.71%
Saratoga	0	0.0%	0	0.00%
Sunnyvale	366	0.2%	0	0.00%
Unincorporated County	5,232	6.0%	7,454	8.53%
Total	**383,210**	**19.9%**	**203,901**	**10.58%**

Note: The Anderson and Lexington Dam's inundation areas overlap in a small area in the Cities of Santa Clara and San José.

Table 6-6. Population within Searsville and Stevens Dam Failure Inundation Areas

Jurisdiction	Searsville Dam		Stevens Creek Dam	
	Population Exposed	Percentage of Total Population	Population Exposed	Percentage of Total Population
Campbell	0	0.00%	0	0.00%
Cupertino	0	0.00%	4,284	7.36%
Gilroy	0	0.00%	0	0.00%
Los Altos	0	0.00%	84	0.27%
Los Altos Hills	0	0.00%	0	0.00%
Los Gatos	0	0.00%	0	0.00%
Milpitas	0	0.00%	0	0.00%
Monte Sereno	0	0.00%	0	0.00%
Morgan Hill	0	0.00%	0	0.00%
Mountain View	0	0.00%	0	0.00%
Palo Alto	24,704	36.22%	0	0.00%
San José	0	0.00%	0	0.00%
Santa Clara (city)	0	0.00%	0	0.00%
Saratoga	0	0.00%	0	0.00%
Sunnyvale	0	0.00%	46,901	31.61%
Unincorporated County	14	0.02%	102	0.12%
Total	**24,718**	**1.28%**	**51,371**	**2.66%**

Note: Searsville and Stevens Creek Dam inundation areas do not overlap with any other dam inundation zones.

Table 6-7. Population within Levee Failure Inundation Area

Jurisdiction	Population Exposed	Percentage of Total Population
Campbell	0	0.00%
Cupertino	0	0.00%
Gilroy	0	0.00%
Los Altos	0	0.00%
Los Altos Hills	0	0.00%
Los Gatos	0	0.00%
Milpitas	0	0.00%
Monte Sereno	0	0.00%
Morgan Hill	0	0.00%
Mountain View	0	0.00%
Palo Alto	4	0.01%
San José	1,771	0.17%
Santa Clara (city)	0	0.00%
Saratoga	0	0.00%
Sunnyvale	0	0.00%
Unincorporated County	0	0.00%
Total	**1,775**	**0.09%**

Table 6-8. Exposure and Value of Structures in Anderson Dam Failure Inundation Areas

Jurisdiction	Number of Buildings Exposed[a]	Value Exposed[b]			Exposed Value as % of Total Replacement Value[b]
		Structure	Contents	Total	
Campbell	0	$0	$0	$0	0.0%
Cupertino	0	$0	$0	$0	0.0%
Gilroy	2,371	$2,426,314,807	$2,214,963,210	$4,641,278,017	34.6%
Los Altos	0	$0	$0	$0	0.0%
Los Altos Hills	0	$0	$0	$0	0.0%
Los Gatos	0	$0	$0	$0	0.0%
Milpitas	1,065	$738,770,581	$631,254,957	$1,370,025,538	7.2%
Monte Sereno	0	$0	$0	$0	0.0%
Morgan Hill	7,486	$4,747,494,356	$3,761,592,009	$8,509,086,365	76.2%
Mountain View	0	$0	$0	$0	0.0%
Palo Alto	0	$0	$0	$0	0.0%
San José	73,737	$57,089,646,257	$45,935,355,046	$103,025,001,303	48.3%
Santa Clara (city)	5,227	$6,577,993,232	$6,177,399,001	$12,755,392,232	29.4%
Saratoga	0	$0	$0	$0	0.0%
Sunnyvale	242	$1,248,782,606	$1,587,526,055	$2,836,308,662	6.6%
Unincorporated County	1,473	$1,499,517,135	$1,330,816,931	$2,830,334,066	11.2%
Total	**91,601**	**$74,328,518,973**	**$61,638,907,209**	**$135,967,426,182**	**28.5%**

a. Anderson Dam failure flooding hazard depth grids provided by SCVWD.
b. Values based on Santa Clara County tax assessor data received August 2016.
Note: The Anderson and Lexington Dam's inundation areas overlap in a small area in the Cities of Santa Clara and San José.

Table 6-9. Structures Exposed to Anderson Dam Failure by Land Use Type

Jurisdiction	Number of Structures in Dam Inundations Area							
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Campbell	0	0	0	0	0	0	0	**0**
Cupertino	0	0	0	0	0	0	0	**0**
Gilroy	2,064	198	82	8	9	1	9	**2,371**
Los Altos	0	0	0	0	0	0	0	**0**
Los Altos Hills	0	0	0	0	0	0	0	**0**
Los Gatos	0	0	0	0	0	0	0	**0**
Milpitas	1,015	25	22	0	1	2	0	**1,065**
Monte Sereno	0	0	0	0	0	0	0	**0**
Morgan Hill	6,904	364	181	18	11	4	4	**7,486**
Mountain View	0	0	0	0	0	0	0	**0**
Palo Alto	0	0	0	0	0	0	0	**0**
San José	68,750	3,419	1,344	13	139	25	47	**73,737**
Santa Clara (city)	4,597	236	388	0	5	1	0	**5,227**
Saratoga	0	0	0	0	0	0	0	**0**
Sunnyvale	75	39	127	1	0	0	0	**242**
Unincorporated County	1,128	93	24	208	10	7	3	**1,473**
Total	**84,533**	**4374**	**2168**	**248**	**175**	**40**	**63**	**91,601**

Table 6-10. Exposure and Value of Structures in Lexington Dam Failure Inundation Areas

Jurisdiction	Number of Buildings Exposed[a]	Value Exposed[b]			Exposed Value as % of Total Replacement Value[b]
		Structure	Contents	Buildings Exposed[a]	
Campbell	7,901	$4,604,158,781	$3,553,103,236	$8,157,262,017	72.95%
Cupertino	0	$0	$0	$0	0.00%
Gilroy	0	$0	$0	$0	0.00%
Los Altos	0	$0	$0	$0	0.00%
Los Altos Hills	0	$0	$0	$0	0.00%
Los Gatos	1,037	$733,314,896	$519,890,010	$1,253,204,906	11.50%
Milpitas	0	$0	$0	$0	0.00%
Monte Sereno	0	$0	$0	$0	0.00%
Morgan Hill	0	$0	$0	$0	0.00%
Mountain View	0	$0	$0	$0	0.00%
Palo Alto	0	$0	$0	$0	0.00%
San José	22,313	$17,615,261,921	$13,542,081,898	$31,157,343,819	14.60%
Santa Clara (city)	17,085	$16,609,952,520	$15,291,520,055	$31,901,472,575	73.51%
Saratoga	0	$0	$0	$0	0.00%
Sunnyvale	0	$0	$0	$0	0.00%
Unincorporated County	1,688	$657,884,576	$511,282,284	$1,169,166,860	4.61%
Total	50,024	**$40,220,572,694**	**$33,417,877,483**	**$73,638,450,178**	**15.45%**

a. Lexington Dam failure flooding hazard zones based on ABAG 2006 data.
b. Values based on Santa Clara County tax assessor data received August 2016.
Note: The Anderson and Lexington Dam's inundation areas overlap in a small area in the Cities of Santa Clara and San José.

Table 6-11. Exposure and Value of Structures in Searsville Dam Failure Inundation Areas

Jurisdiction	Number of Buildings Exposed[a]	Value Exposed[b]			Exposed Value as % of Total Replacement Value[b]
		Structure	Contents	Buildings Exposed[a]	
Campbell	0	$0	$0	$0	0.00%
Cupertino	0	$0	$0	$0	0.00%
Gilroy	0	$0	$0	$0	0.00%
Los Altos	0	$0	$0	$0	0.00%
Los Altos Hills	0	$0	$0	$0	0.00%
Los Gatos	0	$0	$0	$0	0.00%
Milpitas	0	$0	$0	$0	0.00%
Monte Sereno	0	$0	$0	$0	0.00%
Morgan Hill	0	$0	$0	$0	0.00%
Mountain View	0	$0	$0	$0	0.00%
Palo Alto	7,329	$5,425,794,045	$4,090,819,895	$9,516,613,940	36.92%
San José	0	$0	$0	$0	0.00%
Santa Clara (city)	0	$0	$0	$0	0.00%
Saratoga	0	$0	$0	$0	0.00%
Sunnyvale	0	$0	$0	$0	0.00%
Unincorporated County	27	$251,650,593	$368,421,855	$620,072,448	2.45%
Total	**7,356**	**$5,677,444,638**	**$4,459,241,749**	**$10,136,686,389**	**2.13%**

a. Searsville Dam failure flooding hazard zones based on ABAG 2006 data.
b. Values based on Santa Clara County tax assessor data received August 2016.
Note: Searsville and Stevens Creek Dam inundation areas do not overlap with any other dam inundation zones.

Table 6-12. Exposure and Value of Structures in Stevens Creek Dam Failure Inundation Areas

Jurisdiction	Number of Buildings Exposed[a]	Value Exposed[b]			Exposed Value as % of Total Replacement Value[b]
		Structure	Contents	Buildings Exposed[a]	
Campbell	0	$0	$0	$0	0.00%
Cupertino	1,207	$722,579,855	$421,324,629	$1,143,904,485	8.23%
Gilroy	0	$0	$0	$0	0.00%
Los Altos	29	$26,093,597	$21,653,678	$47,747,275	0.54%
Los Altos Hills	0	$0	$0	$0	0.00%
Los Gatos	0	$0	$0	$0	0.00%
Milpitas	0	$0	$0	$0	0.00%
Monte Sereno	0	$0	$0	$0	0.00%
Morgan Hill	0	$0	$0	$0	0.00%
Mountain View	1	$17,213,760	$17,213,760	$34,427,520	0.14%
Palo Alto	0	$0	$0	$0	0.00%
San José	0	$0	$0	$0	0.00%
Santa Clara (city)	0	$0	$0	$0	0.00%
Saratoga	0	$0	$0	$0	0.00%
Sunnyvale	9,766	$4,197,286,651	$2,425,247,372	$6,622,534,022	15.45%
Unincorporated County	22	$7,335,970	$3,667,985	$11,003,955	0.04%
Total	**11,025**	**$4,970,509,832**	**$2,889,107,424**	**$7,859,617,257**	**1.65%**

a. Stevens Creek Dam failure flooding hazard zones based on ABAG 2006 data
b. Values based on Santa Clara County tax assessor data received August 2016.
Note: Searsville and Stevens Creek Dam inundation areas do not overlap with any other dam inundation zones.

Table 6-13. Structures Exposed to Lexington Dam Failure by Land Use Type

Jurisdiction	Number of Structures in Dam Inundations Area							
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Campbell	7,179	528	169	0	22	1	2	**7,901**
Cupertino	0	0	0	0	0	0	0	**0**
Gilroy	0	0	0	0	0	0	0	**0**
Los Altos	0	0	0	0	0	0	0	**0**
Los Altos Hills	0	0	0	0	0	0	0	**0**
Los Gatos	974	56	0	2	4	0	1	**1,037**
Milpitas	0	0	0	0	0	0	0	**0**
Monte Sereno	0	0	0	0	0	0	0	**0**
Morgan Hill	0	0	0	0	0	0	0	**0**
Mountain View	0	0	0	0	0	0	0	**0**
Palo Alto	0	0	0	0	0	0	0	**0**
San José	20,520	1,441	279	0	41	10	22	**22,313**
Santa Clara (city)	15,552	815	668	0	21	2	27	**17,085**
Saratoga	0	0	0	0	0	0	0	**0**
Sunnyvale	0	0	0	0	0	0	0	**0**
Unincorporated County	1,607	78	0	0	2	0	1	**1,688**
Total	**45,832**	**2,918**	**1,116**	**2**	**90**	**13**	**53**	**50,024**

Table 6-14. Structures Exposed to Searsville Dam Failure by Land Use Type

Jurisdiction	Number of Structures in Dam Inundations Area							
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Campbell	0	0	0	0	0	0	0	**0**
Cupertino	0	0	0	0	0	0	0	**0**
Gilroy	0	0	0	0	0	0	0	**0**
Los Altos	0	0	0	0	0	0	0	**0**
Los Altos Hills	0	0	0	0	0	0	0	**0**
Los Gatos	0	0	0	0	0	0	0	**0**
Milpitas	0	0	0	0	0	0	0	**0**
Monte Sereno	0	0	0	0	0	0	0	**0**
Morgan Hill	0	0	0	0	0	0	0	**0**
Mountain View	0	0	0	0	0	0	0	**0**
Palo Alto	6,858	431	9	1	19	3	8	**7,329**
San José	0	0	0	0	0	0	0	**0**
Santa Clara (city)	0	0	0	0	0	0	0	**0**
Saratoga	0	0	0	0	0	0	0	**0**
Sunnyvale	0	0	0	0	0	0	0	**0**
Unincorporated County	3	1	0	0	0	0	23	**27**
Total	**6,861**	**432**	**9**	**1**	**19**	**3**	**31**	**7,356**

Table 6-15. Structures Exposed to Stevens Creek Dam Failure by Land Use Type

Jurisdiction	Number of Structures in Dam Inundations Area							
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Campbell	0	0	0	0	0	0	0	**0**
Cupertino	1,173	30	1	0	3	0	0	**1,207**
Gilroy	0	0	0	0	0	0	0	**0**
Los Altos	28	1	0	0	0	0	0	**29**
Los Altos Hills	0	0	0	0	0	0	0	**0**
Los Gatos	0	0	0	0	0	0	0	**0**
Milpitas	0	0	0	0	0	0	0	**0**
Monte Sereno	0	0	0	0	0	0	0	**0**
Morgan Hill	0	0	0	0	0	0	0	**0**
Mountain View	0	1	0	0	0	0	0	**1**
Palo Alto	0	0	0	0	0	0	0	**0**
San José	0	0	0	0	0	0	0	**0**
Santa Clara (city)	0	0	0	0	0	0	0	**0**
Saratoga	0	0	0	0	0	0	0	**0**
Sunnyvale	9,615	132	0	0	14	1	4	**9,766**
Unincorporated County	22	0	0	0	0	0	0	**22**
Total	**10,838**	**164**	**1**	**0**	**17**	**1**	**4**	**11,025**

6.4.3 Critical Facilities

GIS analysis determined that 1,001 of the OA's critical facilities (28.2 percent) are in the mapped Anderson Dam inundation area, as summarized in Table 6-16.

Table 6-16. Critical Facilities in Anderson Dam Failure Inundation Areas[a]

Jurisdiction	Emergency Response / Public Health & Safety	Infrastructure Lifeline	Military Facilities	Recovery Facilities	Socioeconomic Facilities	Hazardous Materials	Total
Campbell	0	0	0	0	0	0	0
Cupertino	0	0	0	0	0	0	0
Gilroy	7	21	0	0	13	3	44
Los Altos	0	0	0	0	0	0	0
Los Altos Hills	0	0	0	0	0	0	0
Los Gatos	0	0	0	0	0	0	0
Milpitas	0	17	0	0	6	5	28
Monte Sereno	0	0	0	0	0	0	0
Morgan Hill	5	13	0	0	32	7	57
Mountain View	0	0	0	0	0	0	0
Palo Alto	0	0	0	0	0	0	0
San José	45	365	0	1	207	85	703
Santa Clara (city)	4	28	0	0	17	42	91
Saratoga	0	0	0	0	0	0	0
Sunnyvale	1	0	0	0	0	6	7
Unincorporated County	3	60	0	0	7	1	71
Total	**65**	**504**	**0**	**1**	**282**	**149**	**1,001**

a. Due to data availability and quality, only Anderson Dam was used in this assessment

6.4.4 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 experience long periods of very stable flow conditions or saw-tooth flow patterns caused by releases followed by no releases. Water releases from dams usually contain very little suspended sediment; this can lead to scouring of river beds and banks.

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. This could result in destruction of downstream habitat and could have detrimental effects on many species of animals, especially endangered species such as salmon.

6.5 VULNERABILITY

6.5.1 Population

Vulnerable populations are all populations downstream from dam failures that are incapable of escaping the area within the allowable time frame. This population includes the elderly and young who may be unable to get themselves out of the inundation area. The vulnerable population also includes those who would not have adequate warning from a television or radio emergency warning system.

6.5.2 Property

Vulnerable properties are those closest to the dam inundation area. These properties would experience the largest, most destructive surge of water. Low-lying areas are also vulnerable since they are where the dam waters would collect. Transportation routes are vulnerable to dam inundation and have the potential to be wiped out, creating isolation issues. This includes all roads, railroads and bridges in the path of the dam inundation. Those that are most vulnerable are those that are already in poor condition and would not be 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 for the inundation areas.

It is estimated that there could be up to $36.6 billion in loss from an Anderson dam failure affecting the OA. This represents 27 percent of the total exposure within the inundation area, or 7.7 percent of the total replacement value of the OA. Table 6-17 summarizes the loss estimates for dam failure.

Table 6-17. Loss Estimates for Dam Failure

Jurisdiction	Estimated Loss Associated with Dam Failure[a]			Estimated Loss as % of Total Replacement Value
	Structure	Contents	Total	
Campbell	$0	$0	$0	0.0%
Cupertino	$0	$0	$0	0.0%
Gilroy	$123,414,912	$264,509,313	$387,924,224	2.9%
Los Altos	$0	$0	$0	0.0%
Los Altos Hills	$0	$0	$0	0.0%
Los Gatos	$0	$0	$0	0.0%
Milpitas	$3,264,371	$2,489,545	$5,753,917	0.0%
Monte Sereno	$0	$0	$0	0.0%
Morgan Hill	$953,794,167	$1,341,152,417	$2,294,946,584	20.6%
Mountain View	$0	$0	$0	0.0%
Palo Alto	$0	$0	$0	0.0%
San José	$13,319,285,267	$17,251,673,625	$30,570,958,892	14.3%
Santa Clara (city)	$1,107,372,297	$1,474,757,272	$2,582,129,569	5.9%
Saratoga	$0	$0	$0	0.0%
Sunnyvale	$48,225,722	$119,713,887	$167,939,609	0.4%
Unincorporated County	$271,263,851	$364,058,859	$635,322,709	2.5%
Total	**$15,826,620,586**	**$20,818,354,918**	**$36,644,975,504**	**7.7%**

a. Due to data availability and quality, only Anderson Dam was used in this assessment

It is estimated that there could be up to $6.3 billion in loss from a levee failure affecting the OA. This represents only 1.34 percent of the total replacement value of the OA. Table 6-18 summarizes the loss estimates for levee failure.

6.5.3 Critical Facilities

Critical facilities in the Anderson Dam’s inundation area would receive 13.4 percent damage to structures and 42.3 percent damage to contents during a dam failure event. The estimated time to restore these facilities to 100 percent of their functionality is 612 days. Critical facilities vulnerability was not available for the Lexington, Searsville, or Stevens Creek dam inundation areas.

Table 6-18. Loss Estimates for Levee Failure

Jurisdiction	Estimated Loss Associated with Levee Failure			Estimated Loss as % of Total Replacement Value
	Structure	Contents	Total	
Campbell	$0	$0	$0	0.00%
Cupertino	$0	$0	$0	0.00%
Gilroy	$0	$0	$0	0.00%
Los Altos	$0	$0	$0	0.00%
Los Altos Hills	$0	$0	$0	0.00%
Los Gatos	$0	$0	$0	0.00%
Milpitas	$0	$0	$0	0.00%
Monte Sereno	$0	$0	$0	0.00%
Morgan Hill	$0	$0	$0	0.00%
Mountain View	$302,501,709	$358,394,436	$660,896,145	2.64%
Palo Alto	$251,765,030	$273,275,192	$525,040,223	2.04%
San José	$946,889,058	$906,446,482	$1,853,335,540	0.87%
Santa Clara (city)	$144,539,498	$149,199,908	$293,739,407	0.68%
Saratoga	$0	$0	$0	0.00%
Sunnyvale	$1,420,567,856	$1,619,151,888	$3,039,719,744	7.09%
Unincorporated County	$0	$0	$0	0.00%
Total	**$3,066,263,151**	**$3,306,467,906**	**$6,372,731,058**	**1.34%**

Environment

The environment would be vulnerable to a number of risks in the event of dam failure. The inundation could introduce foreign elements into local waterways, resulting in destruction of downstream habitat and detrimental effects on many species of animals, especially endangered species such as coho salmon. The extent of the vulnerability of the environment is the same as the exposure of the environment.

6.6 FUTURE TRENDS IN DEVELOPMENT

Land use in the OA will be directed by general plans adopted under state law. The safety elements of the general plans establish standards and plans for the protection of the community from hazards. Dam and levee failure are currently not addressed as stand-alone hazards in the safety elements, but flooding is. Municipalities participating in this plan have established comprehensive policies regarding sound land use in identified flood hazard areas. Most of the areas vulnerable to the more severe impacts from dam and levee failure intersect the mapped flood hazard areas. Flood-related policies in the general plans will help to reduce the risk associated with dam and levee failure hazard for all future development in the OA.

6.7 SCENARIO

An earthquake in the region could lead to liquefaction of soils around a dam. This could occur without warning during any time of the day. A terrorist or other intentional attack also could cause a catastrophic failure of a dam that impacts the OA. While the probability of dam failure is very low, the probability of flooding associated with changes to dam operational parameters in response to climate change is higher. Dam designs and operations are developed based on hydrographs with historical record. If these hydrographs experience significant changes over time due to the impacts of climate change, the design and operations may no longer be valid for the changed condition. This could have significant impacts on dams that provide flood control. Specified release rates and impound thresholds may have to be changed. This would result in increased discharges downstream of these facilities, thus increasing the probability and severity of flooding.

6.8 ISSUES

The most significant issue associated with dam failure involves the properties and populations in the inundation zones. Flooding as a result of a dam failure would significantly impact these areas. There is often limited warning time for dam failure. These events are frequently associated with other natural hazard events such as earthquakes, landslides or severe weather, which limits their predictability and compounds the hazard. Important issues associated with dam failure hazards include the following:

- Federally regulated dams have an adequate level of oversight and sophistication in the development of emergency action plans for public notification in the unlikely event of failure. However, the protocol for notification of downstream citizens of imminent failure needs to be tied to local emergency response planning.
- Mapping for federally regulated dams is already required and available; however, mapping for non-federal-regulated dams that estimates inundation depths is needed to better assess the risk associated with dam failure from these facilities. 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 emergency action plans 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. For non-federal-regulated dams, mapping of dam failure scenarios 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.
- The concept of residual risk associated with structural flood control projects should be considered in the design of capital projects and the application of land use regulations.
- Addressing security concerns and the need to inform the public of the risk associated with dam failure is a challenge 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 NFIP, so flood insurance coverage in these areas is not common.

7. DROUGHT

7.1 GENERAL BACKGROUND

Drought is a significant decrease in water supply relative to what is “normal” in a given location. A normal phase in the climate cycle of most geographical regions, drought originates from a deficiency of precipitation over an extended period of time, usually a season or more. This leads to a water shortage for some activity, group or environmental sector.

Determination of when drought begins is based on impacts on water users and assessments of the available water supply, including water stored in surface reservoirs or groundwater basins. Different water agencies have different criteria for defining drought. Some issue drought watch or drought warning announcements. The California water code does not include a statutory definition of drought; however, analysis of the code indicates that legal matters most frequently focus on drought conditions during times of water shortages (California Code of Regulations (CCR), 2016).

DEFINITIONS

Drought—The cumulative impacts of several dry years on water users. It can include deficiencies in surface and subsurface water supplies and generally impacts health, wellbeing, and quality of life.

Agricultural Drought—Not enough soil moisture to meet the needs of a particular crop at a particular time.

Hydrological Drought—Deficiencies in surface and subsurface water supplies.

Socioeconomic Drought—Drought impacts on health, well-being, and quality of life.

7.1.1 Monitoring Drought

The National Oceanic and Atmospheric Administration (NOAA) has developed several indices to measure drought impacts and severity and to map their extent and locations:

- 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 7-1 shows this index for the week ending October 1, 2016.
- The Palmer Drought Index measures the duration and intensity of long-term drought-inducing circulation patterns. Long-term drought is cumulative, so the intensity of drought during a given month depends on current weather plus the cumulative weather of previous months. The Palmer Drought Index responds rapidly as weather patterns change quickly. Figure 7-2 shows this index for October 2016.
- The Palmer Z Index measures short-term drought on a monthly scale. Figure 7-3 shows this index for August 2016.
- The hydrological impacts of drought (e.g., reservoir levels, groundwater levels, etc.) take longer to develop and it takes longer to recover from them. The Palmer Hydrological Drought Index is a long-term index to quantify hydrology effects. The Palmer Hydrological Drought Index responds more slowly to changing conditions than the Palmer Drought Index. Figure 7-4 shows this index for August 2016.
- While the Palmer indices consider precipitation, evapotranspiration and runoff, the Standardized Precipitation Index considers only precipitation. In the Standardized Precipitation Index, an index of zero indicates the median precipitation amount; the index is negative for drought and positive for wet conditions. The Standardized Precipitation Index is computed for time scales ranging from one month to 24 months. Figure 7-5 shows the 24-month Standardized Precipitation Index map for January 2013 through December 2015.

Note: The following graphics represent snapshots in time of parameters that can change daily. They are provided only as examples of the type and level of detail of mapping available on the drought hazard.

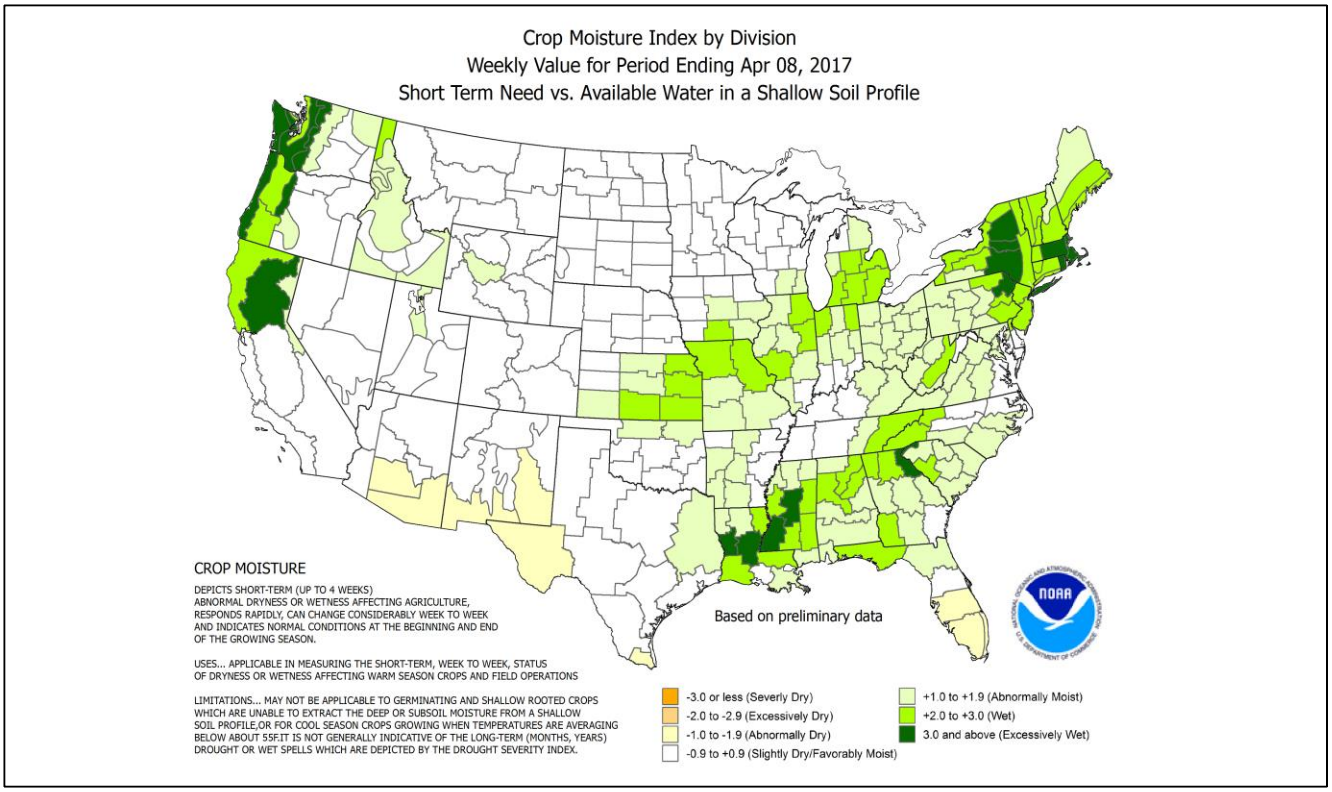


Figure 7-1. Palmer Crop Moisture Index for Week Ending April 8, 2017

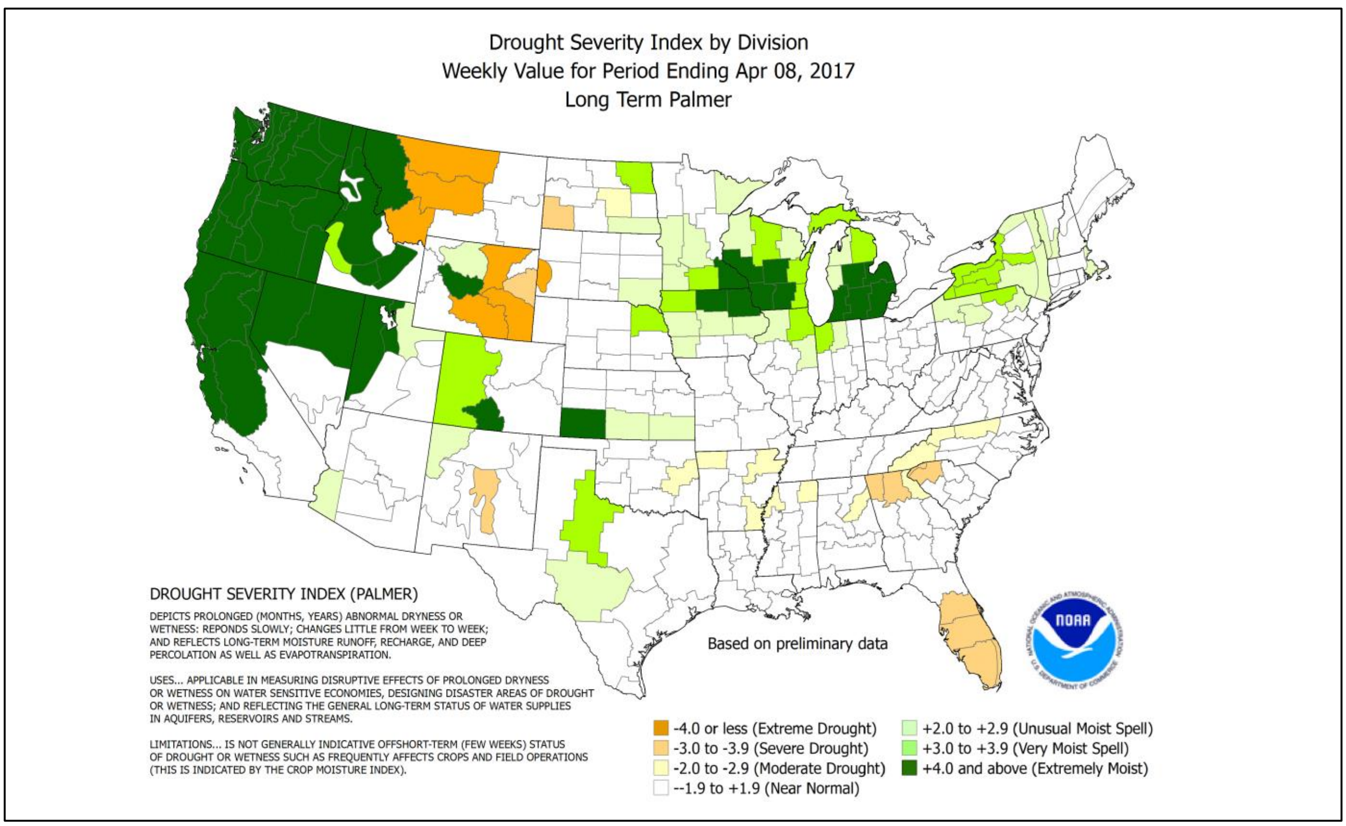


Figure 7-2. Palmer Drought Index for April 8. 2017

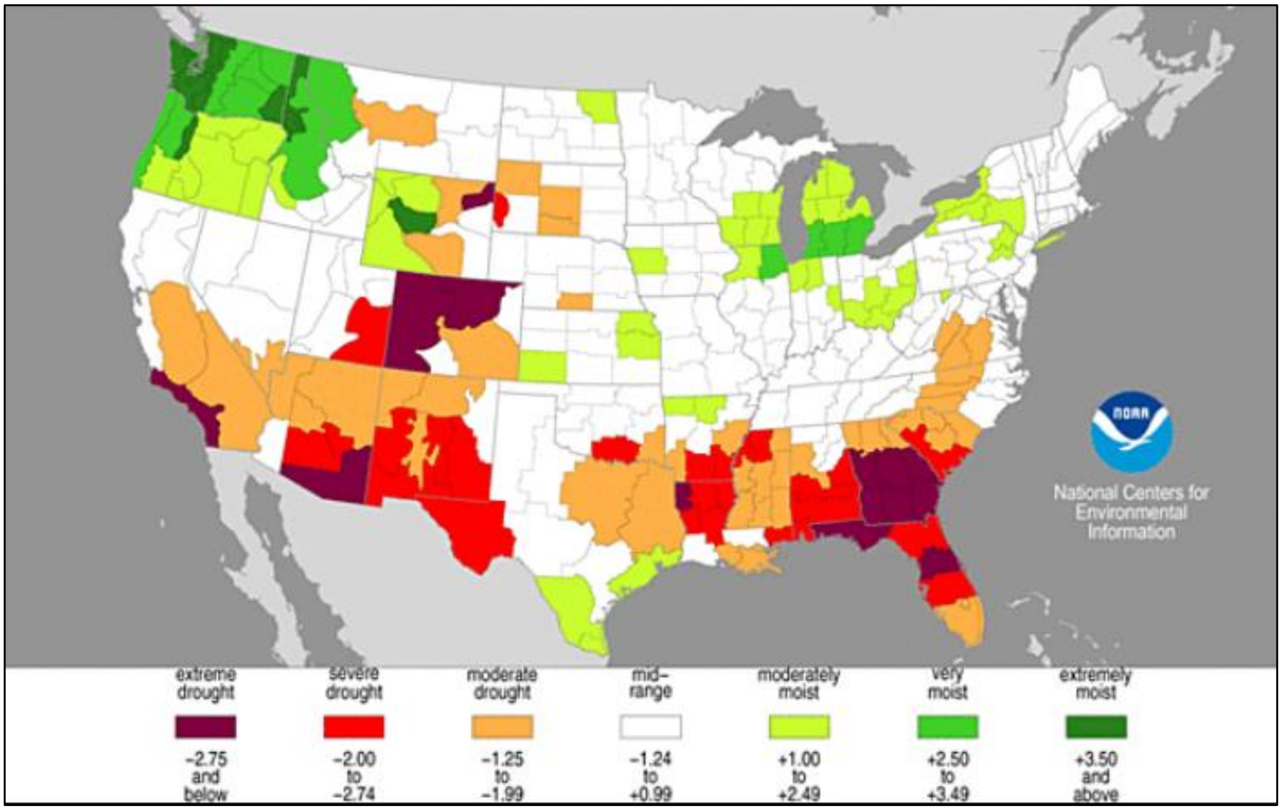


Figure 7-3. Palmer Z Index Short-Term Drought Conditions for March 2017

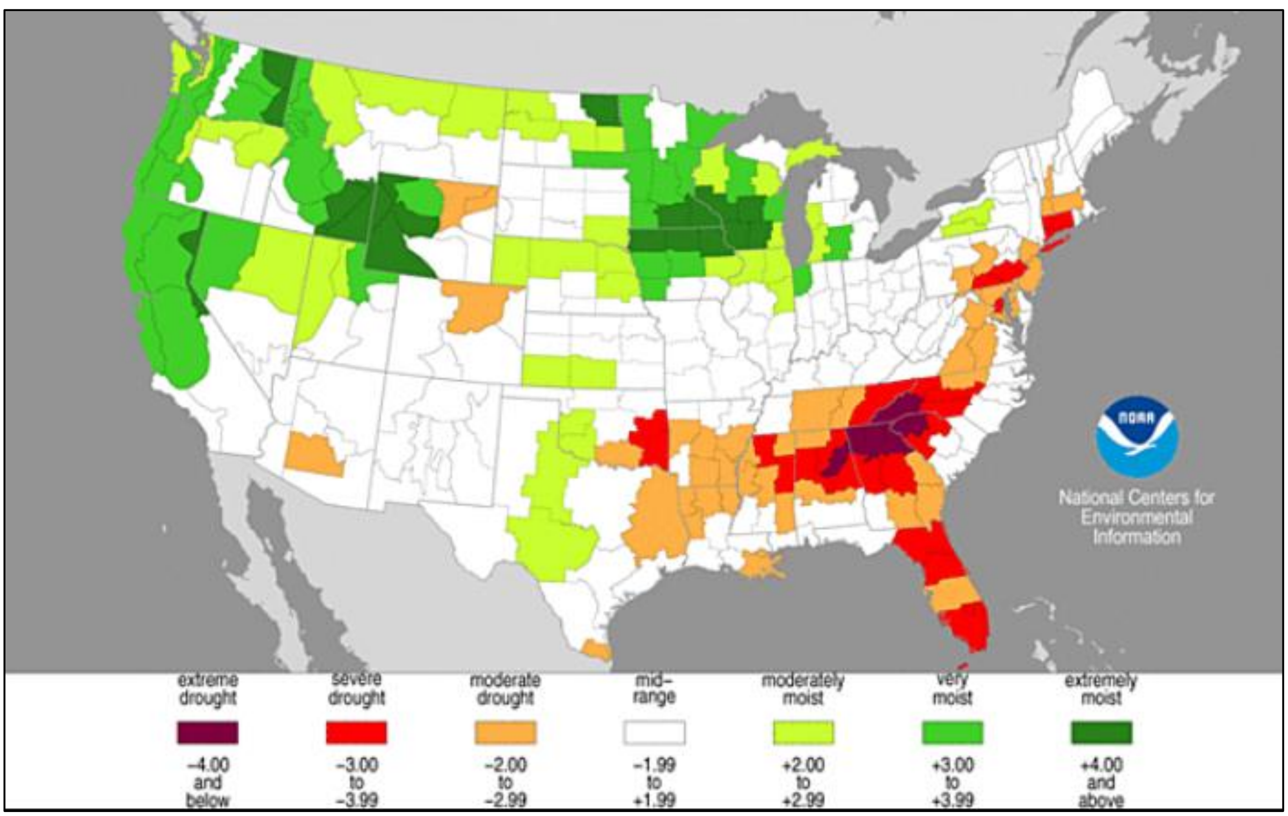


Figure 7-4. Palmer Hydrological Drought Index Long-Term Hydrologic Conditions for March 2017

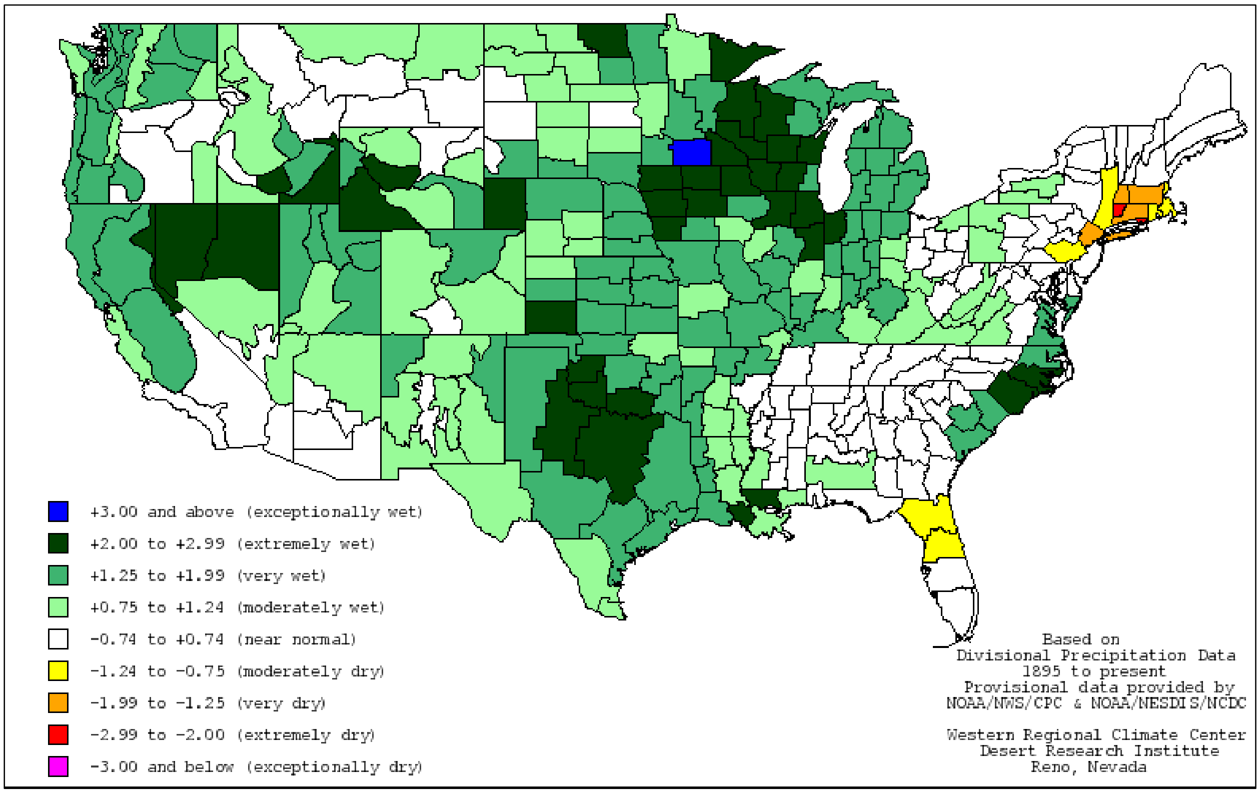


Figure 7-5. 24-Month Standardized Precipitation Index through the end of March 2017

7.1.2 Normal Precipitation in California

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. 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, and 15 inches in Santa Clara County. In extremely dry years, these annual totals can fall to as little as one half, or even one third of these amounts.

The Sierra Nevada snowpack serves as the primary agent for replenishing water in the San Francisco Bay area, including Santa Clara 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.

7.1.3 Water Supply Strategy

The Bay Area Water Supply Conservation Agency (BAWSCA) is the main water provider for much of the Bay Area, allowing SCVWD to manage the 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. The Hetch-Hetchy System was so-named because 85 percent of its water comes from Sierra Nevada snowmelt stored in the Hetch-Hetchy reservoir along the Tuolumne River in Yosemite National Park; the remaining 15 percent of water in this system comes from runoff in the Alameda and Peninsula watersheds (BAWSCA, 2016).

BAWSCA developed a two-phase, long-term water supply strategy for customers throughout the Bay Area, as outlined in the 2015 *Long-Term Reliable Water Supply Strategy Phase II Final Report*. Purposes of its strategy are as follows:

- Quantifying water supply reliability needs of BAWSCA member agencies through 2040.
- Identifying water supply management programs or programs that can be developed to meet those regional water reliability needs.
- Developing an implementation plan for the water supply strategy.

This strategy recognized that drought-year shortfalls could be significant, but determined 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 noted that the impacts of water shortages would be regional and could lead to secondary detrimental economic effects. To address this concern, the strategy focused on identifying options for filling all or part of the drought-year supply shortfall, and investigating and potentially implementing actions that seem most beneficial.

BAWSCA also developed a *Water Conservation Implementation Plan*, focusing on the following objectives (BAWSCA, 2009):

- Help BAWSCA member agencies evaluate potential water savings and cost-effectiveness associated with implementing additional water conservation measures beyond their commitments of 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.

The Santa Clara Valley Water District (SCVWD) is the wholesale water and groundwater management agency throughout Santa Clara County, relying on local retailers (municipalities and private companies) to deliver water throughout the County (SCVWD, 2016). In the Santa Clara County OA, the following districts and cities are members of BAWSCA: SCVWD, Gilroy, Mountain View, Palo Alto, San José, City of Santa Clara, and Sunnyvale (SCVWD, 2016). The following are the retailer water providers for each municipal planning partner

- Campbell—San José Water Company.
- Cupertino—San José Water Company and California Water Service Company.
- Gilroy—Gilroy Community Services Department.
- Los Altos—California Water Service Company.
- Los Altos Hills—Purissima Hills Water District and California Water Service Company.
- Los Gatos—San José Water Company.
- Milpitas—City of Milpitas Community Services.
- Monte Sereno—San José Water Company.
- Morgan Hill—City of Morgan Hill.
- Mountain View—City of Mountain View Public Works.
- Palo Alto—City of Palo Alto Utilities Department.
- San José—San José Water Company, Great Oaks Water Company, and San José Municipal Water System.
- Santa Clara City—City of Santa Clara Water Department.
- Saratoga—San José Water Company.
- Sunnyvale—City of Sunnyvale Public Works Department and California Water Service Company.

The SCVWD has its own water supply strategy outlined in the *SCVWD 2012 Water Supply and Instructure Master Plan* (Water Master Plan 2012). The Water Master Plan 2012 outlines a water supply strategy with three key elements:

- Secure existing supplies and facilities.
- Optimize the use of existing supplies and facilities.
- Expand water use efficiency efforts.

Some County residents have domestic wells on their property. The South Central Regional Office of California DWR monitors wells for Santa Clara County to help protect groundwater quality (DWR, 2016). Under Ordinance 90-1, as of July 1, 2013, a person must obtain a permit from SCVWD to perform any well activities.

7.1.4 Water Supply Infrastructure

Figure 7-6 shows the SCVWD water supply system. Santa Clara County receives 55 percent of its water supply from the San Francisco Bay-Delta watershed. Of this water, 40 percent comes directly through the Delta watershed or water conveyance systems (State Water Project) and 15 percent is from the Hetch-Hetchy System. Another 30 percent of the County's supply is local, from natural groundwater, reservoirs to groundwater, and reservoirs to drinking water treatment plans. Five percent is recycled water, primarily used for irrigation, industry, and agriculture. The last 10 percent is savings needed.

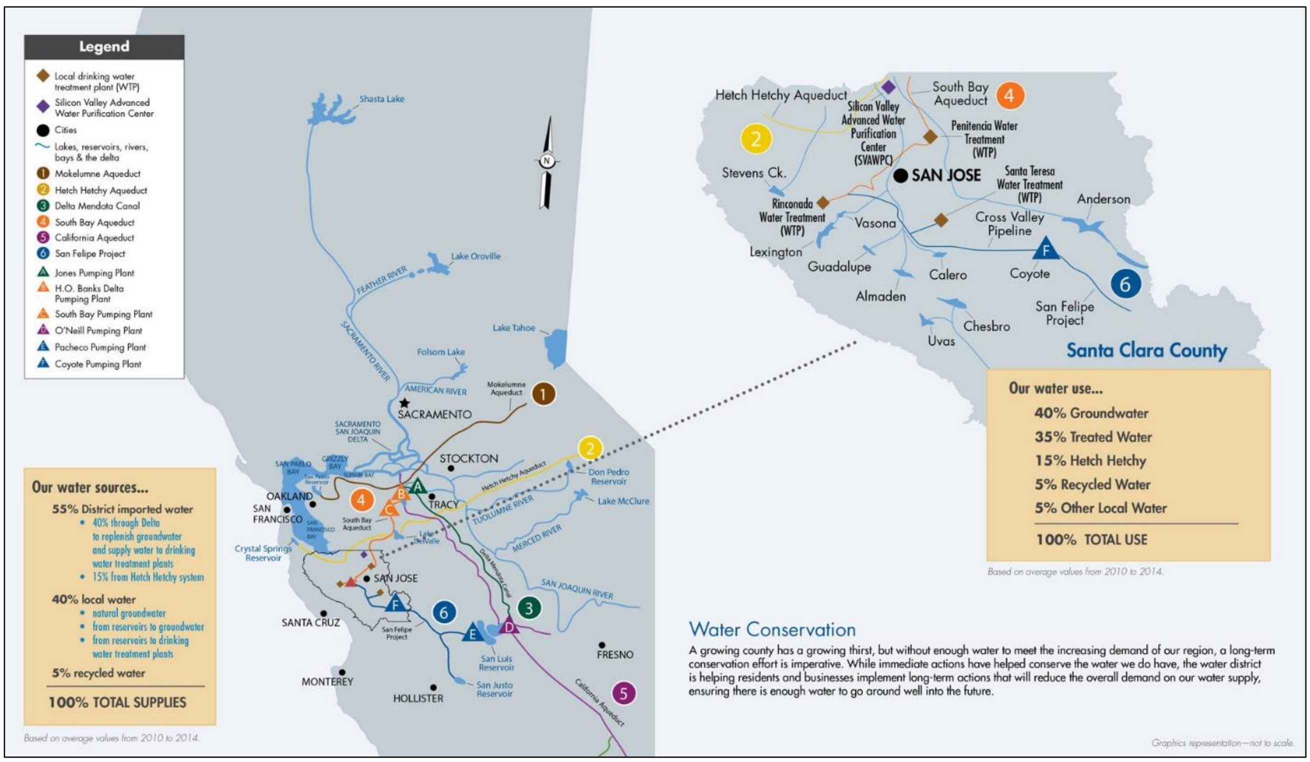


Figure 7-6. Santa Clara Valley Water District System Water Supply

The Hetch-Hetchy Water System was approved in 1913 under the Raker Act, which allowed use of federal lands 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 7-7 shows the Hetch-Hetchy Water System. Figure 7-8 shows the local, imported, and other water sources for the municipalities (SCVWD, 2016).

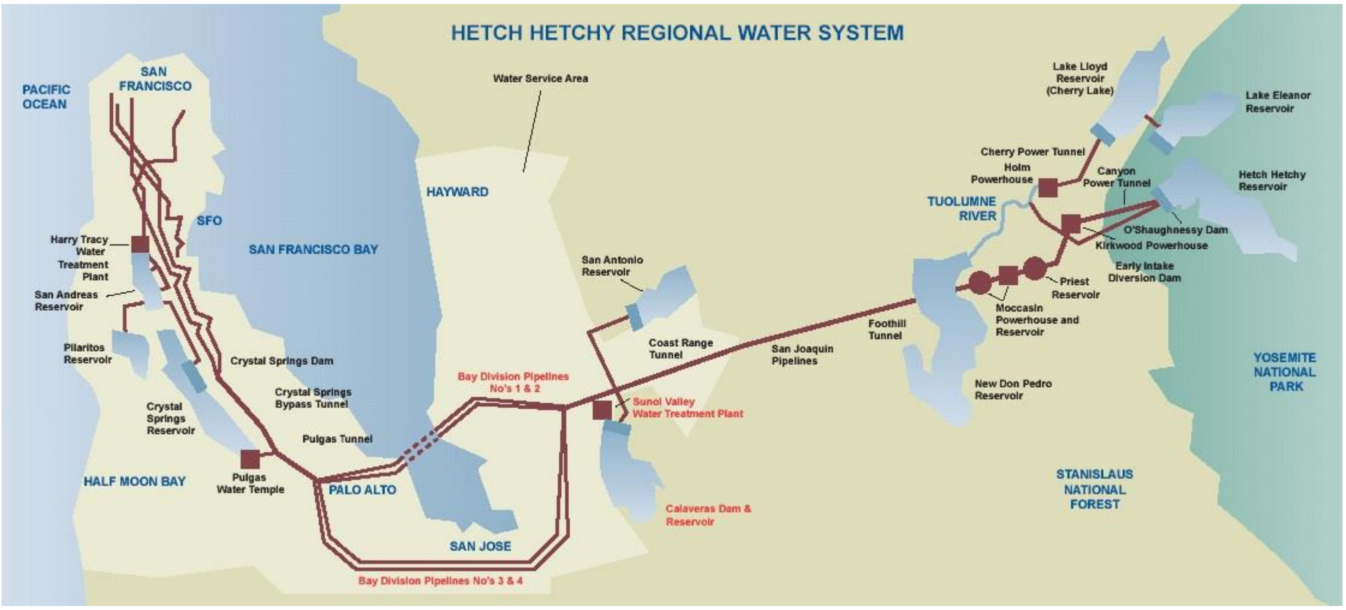


Figure 7-7. Hetch-Hetchy Water System

	Local water			Imported water			Other
	Natural groundwater	From reservoirs to replenish groundwater	From reservoirs to drinking water treatment plants	Thru Delta to replenish groundwater	Thru Delta to drinking water treatment plants	From Hetch Hetchy	Recycled
Alviso						●	●
Campbell	●	●	●	●	●		
Cupertino	●	●	●	●	●		
Gilroy	●	●		●			●
Los Altos	●	●	●	●	●		
Los Altos Hills	●	●	●	●	●	●	
Los Gatos	●	●	●	●	●		
Milpitas			●		●	●	
Monte Sereno	●	●	●	●	●		
Morgan Hill	●	●		●			
Mountain View	●	●	●	●	●	●	●
Palo Alto						●	●
San Jose	●	●	●	●	●	●	●
San Martin	●	●		●			
Santa Clara	●	●	●	●	●	●	●
Saratoga	●	●	●	●	●		
Sunnyvale	●	●	●	●	●	●	●

Santa Clara Valley Water District

Figure 7-8. Santa Clara County Municipal Water Source

7.1.5 Responses to Defined Drought Stages

The SCVWD defined drought stages in the *2010 Urban Water Management Plan* (Chapter 6.0, Water Shortage Contingency Planning), along with the following outreach and water savings measures associated with each stage:

- Stage 1, Normal—The SCVWD continues ongoing outreach strategies aimed toward achieving long-term water conservation goals. Messages at this stage focus on services and rebate programs the SCVWD provides to facilitate water use efficiency for residents, agricultural operations and businesses. While the other stages are more urgent, success in Stage 1 is vital to achieving long-term water use reduction goals.
- Stage 2, Alert—Communication tactics that are employed in Stage 1 may be augmented with additional funding to reach more people with an increased frequency and urgency. Additional communication tools can be employed to further broaden awareness and promote immediate behavioral changes. Specific implementation plans will be developed when a worsening of the water shortage condition has occurred and up to 10-percent water usage reduction is suggested. Supplemental funding may be identified to augment budgeted efforts, which normally will be set based on an assumption that the county is in Stage 1. Based on historical hydrology and management and operations of SCVWD supplies, it is estimated that groundwater storage would be in Stage 2 one out of every 10 years.
- Stage 3, Severe—As the severity of a water shortage increases, the intensity of communications efforts may also increase. Messages are modified to reflect the more dire circumstances. The messages conveyed change to correspond to the call for immediate actions to save water and a 10- to 20-percent water usage reduction is suggested. Based on historical hydrology and management and operations of SCVWD supplies, it is estimated that in one out of every 15 years groundwater storage would be in Stage 3.
- Stage 4, Critical—In this stage, retailers and cities would be encouraged to enforce their water shortage plans, which could include fines for repeated violations and a 20- to 40-percent water usage reduction would be suggested. Stage 4 strengthens and expands the Stage 3 activities, including further expansion of outreach efforts and opening a drought information center.
- Stage 5, Emergency—Stage 5 of the water shortage contingency plan designates and reserves up to 150,000 acre-feet in surface and groundwater storage for emergency conditions to ensure availability of water to meet essential public health and safety requirements. Up to a 50-percent water usage reduction would be suggested and the Emergency Operations Center would be activated.

Participating municipality retail water providers’ drought contingency measures are described in the municipal annexes in Volume 2 of this hazard mitigation plan.

7.2 HAZARD PROFILE

Droughts originate from a deficiency of precipitation resulting from an unusual weather pattern. Such patterns can be short-term, lasting for a few weeks or months, or long-term, lasting for many months or for years. It is possible for a region to experience a long-term circulation pattern that produces drought, and to have short-term changes in this long-term pattern that result in short-term wet spells. Likewise, it is possible for a long-term wet circulation pattern to 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.

7.2.1 Past Events

Statewide Droughts

California DWR has state hydrologic data from as far back as the early 1900s. These data indicate occurrences of multi-year droughts from 1912 to 1913, 1918 to 1920, and 1922 to 1924. Between 1954 and 2016, California experienced one FEMA-declared emergency (EM) classified as a drought: FEMA Declaration EM-3023 in 1977, which applied to 58 California counties, including Santa Clara County (FEMA, 2016). During the last 40 years, four prolonged periods of drought in California have impacted Santa Clara County (CalOES, 2013):

- 1976 to 1977 Drought—California had one of its most severe droughts 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 across the state. Only 37 percent of normal Sacramento Valley runoff was received. Over $2.6 billion in crop damage was recorded in 31 counties. Santa Clara County was included in FEMA-3023-EM-CA declaration on January 20, 1977.
- 1987 to 1992 Drought—California received precipitation well below average levels for four consecutive years. While the Central Coast was most affected, the Sierra Nevadas in Northern California and the Central Valley were also affected. Water suppliers did not begin to experience shortages until the third or fourth years of the drought. Reservoir storage provided a buffer against drought impacts during the initial years of the drought. In 1991, the State Water Project sharply decreased deliveries to water suppliers, including the San Francisco Bay Area. The SCVWD implemented drought contingency measures such as rationing and mandatory conservation to reach its 25 percent reduction goal. By February 1991, all 58 counties in California were suffering under drought conditions that affected urban, rural, and agricultural areas. Some counties had declared local drought emergency, but Santa Clara County was not included.
- 2007 to 2009 Drought—A governor's executive order proclaimed a statewide drought emergency on June 4, 2008 after spring 2008 was the driest spring on record, with low snowmelt runoff. On February 27, 2009, after the largest court-ordered water restriction in state history up to that time, a state of emergency was proclaimed for the entire state as the severe drought conditions continued. Santa Clara County received about half of its water through the Sacramento-San Joaquin River Delta, which was already significantly limited that year because of pumping restrictions mandated under the Endangered Species Act. Water deliveries through the Delta were cut by about 20 to 30 percent. The SCVWD had mandatory water conservation and rationing measures in effect to reduce usage by 15 percent.
- 2012 to Present Drought—California's current drought has set several records. From 2012 to 2014, it ranked as the driest three consecutive years for statewide precipitation. New climate records were set in 2014 for statewide average temperatures and for record-low water allocations from State Water Project and Central Valley Project contractors. A statewide drought emergency was declared in January 2014. Minimum annual precipitation records were set for many communities in 2013. Executive orders and regulations called for water conservation and management. A new law requires retail urban water suppliers with more than 3,000 customers to establish rules defining "excessive water use" and impose those rules during drought emergencies.

Reported Local Drought Impacts

The National Drought Mitigation Center developed the Drought Impact Reporter as a national drought impact database for the United States. Information comes from a variety of sources: on-line, drought-related news stories and scientific publications, members of the public who visit the website and submit a drought-related impact for their region, members of the media, and members of relevant government agencies. The database is being populated beginning with the most recent impacts and working backward in time.

The Drought Impact Reporter contains information on 144 impacts from droughts that affected Santa Clara County from 2006 through September 2016. The following are the categories and reported number of impacts. Note that some impacts have been assigned to more than one category.

- Agriculture—28.
- Business and Industry—5.
- Energy—2.

- Fire—16.
- Plants and Wildlife—33.
- Relief, Response, and Restrictions—87.
- Society and Public Health—61.
- Tourism and Recreation—6.
- Water Supply and Quality—88.

The following are summaries of incidents from the Drought Impact Reporter that impacted Santa Clara County:

- April 3, 2009—A mandatory reduction in water use of 15 percent was ordered for the SCVWD because reservoirs contained only 64 percent of their capacity in March 2009. Residents responded by lowering their water use by 18 percent. Persistent drought spurred the board to extend the mandatory water restrictions through June 30, 2010.
- January 30, 2014—The California Department of Fish and Wildlife closed some rivers and streams in Monterey, Santa Cruz and Santa Clara Counties to fishing to protect salmon and steelhead populations while river flows are low.
- March 21, 2014—The SCVWD informed seven cities and companies that they would receive just 80 percent of their requested treated drinking water through the end of the year. Roughly 1.5 million people in San José, Mountain View, Sunnyvale, Cupertino, Milpitas and Santa Clara were affected. The San José Water Company responded by pumping more groundwater from its 100 or so wells throughout the county and strongly urged water conservation.
- March 23, 2014— The SCVWD reduced water releases from Anderson Dam from 14 cubic feet per second (cfs) to 9 cfs, due to drought. With less water, Coyote Creek nearly dried up.
- February 29, 2015—Groundwater withdrawals in the SCVWD during 2014 amounted to nearly 84,000 acre-feet, exceeding groundwater use in 2013. The SCVWD's 10 reservoirs hold only 68,000 acre-feet, about 81 percent of what was used in 2014.
- May 5, 2015—About 100 members of city councils, school boards and other local bodies came together at the Santa Clara Convention Center to discuss ways to encourage water conservation by all members of the public.
- August 8, 2015— Eight miles of the 14-mile Guadalupe River in San José went dry for a few months, contributing to the absence or deaths of fish and other wildlife. Water releases from four upstream SCVWD reservoirs were halved because years of drought had slashed reservoir storage. Twelve of the about 30 primary miles of Coyote Creek were also dry.
- August 8, 2015—One hundred tons of trash were removed from Los Gatos Creek and the Guadalupe River over a two-year period. Drought lowered water levels, making it easier to access and collect trash along the waterways.
- August 25, 2015—A large microcystis bloom developed in the Sacramento-San Joaquin Delta. Microcystis is a type of blue-green algae that can produce toxins that are lethal to fish and people in high concentrations, though such concentrations were not currently present. The algae bloom was observed in the central and north parts of the Delta. Scientists monitoring the bloom were unsure of its cause but suggested that it was produced through a combination of factors related to the warmer, slower water flow due to the drought. Roughly 25 million people from Napa to San Diego to some extent rely on fresh water from the Delta, as do about 3 million acres of irrigated farmland.
- July to November 2015—The SCVWD added $4.6 million to its landscape conversion rebate program. While the expanded budget of $22.8 million had been nearly spent for the year, the district was looking for additional funds to continue the rebates. The SCVWD paid rebates for the removal of 2.9 million square feet in 2015, with another 3.5 million square feet approved and in progress. The added $4.6 million will allow another 2 million square feet to be converted, totaling 8 million square feet.
- July 2016—Coyote Lake was closed on July 18 for the remainder of 2016 after the water level was drawn down below the bottom of the boat ramp. Water from the lake was being used for drinking water in Santa

Clara County. The SCVWD would normally be using water from its primary source, the Sacramento-San Joaquin Delta, or the San Luis Reservoir, but both had higher than normal levels of algae, giving the water a taste and smell that customers did not appreciate. In late June, the water district turned to Coyote Lake and Anderson Lake. Drought was thought to be playing a role in the presence of algae in the Delta and the San Luis Reservoir.

- September 26, 2016—The Loma wildfire burned a dozen homes, 16 other structures and nearly 4,500 acres northwest of Morgan Hill in Santa Clara County, according to the California Department of Forestry and Fire Protection.

U.S. Department of Agriculture Disaster Declarations

The U.S. Department of Agriculture (USDA) Farm Service Agency provides assistance for natural disaster losses resulting from drought, flood, fire, freeze, tornadoes, pest infestation, and other natural disasters. The USDA Secretary of Agriculture is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in contiguous counties. Between 2012 and 2016, the period for which data was available, California has been included in 61 USDA disaster declarations. Santa Clara County was included in 12 of these declarations in relation to drought:

- S3248, S3379 and S3452 in 2012.
- S3547, S3558 and S3569 in 2013.
- S3626, S3637, and S3743 in 2014.
- S3784 and S3943 in 2015.
- S3952 in 2016.

7.2.2 Location

Drought is a regional phenomenon. A drought that affects the OA would affect all aspects of the environment and the community simultaneously and has the potential to directly or indirectly impact every person in the county as well as adversely affect the local economy.

7.2.3 Frequency

Historical drought data regarding Santa Clara County indicate four significant droughts over the last 40 years, with drought occurring in 12 of those 40 years. Based on risk factors and this history, droughts likely will continue to occur in the Santa Clara County OA. Moreover, as temperatures increase, probability of future droughts will likely increase as well. Therefore, droughts likely will occur in Santa Clara County at varied severities in the future, even after conclusion of the current drought.

7.2.4 Severity

The severity of a drought depends on the degree of moisture deficiency, the duration, and the 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. Drought can have a widespread impact on the environment and the economy, although it typically does not result in loss of life or damage to property, as do other natural disasters. Drought affects agriculture, business and industry, energy, fire, plants, tourism and recreation, and water supply and quality. The National Drought Mitigation Center uses three categories to describe drought impacts:

- Economic Impacts—These impacts of drought cost people or businesses money. They include farmers' loss of crops, costs for irrigation or drilling new wells to address low water supply, lost business for companies that sell boats or fishing equipment, and water companies' costs for additional water supplies.
- Environmental Impacts—Plants and animals depend on water. When a drought occurs, their food supply can shrink and their habitat can be damaged.

- Social Impacts—Social impacts include public safety, health, conflicts between people when there is not enough water to go around, and changes in lifestyle.

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 a reduction in groundwater levels and problems such as reduced pumping capacity or wells going dry. Shallow wells are more susceptible than deep wells. Reduced replenishment of groundwater affects streams. Much of the flow in streams comes from groundwater, especially during the summer when there is less precipitation and after snowmelt ends. Reduced groundwater levels mean that even less water will enter streams when steam flows are lowest.

7.2.5 Warning Time

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

Scientists at this time do not know how to predict drought more than a month in advance for most locations. Predicting drought depends on the ability to forecast precipitation and temperature. Anomalies of precipitation and temperature may last from several months to several decades; California is currently finishing a several-year-long drought, while other areas in the United States may undergo droughts 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 the accumulated influence of weather systems on the global scale.

7.3 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, which caused serious damage to aquatic life, irrigation, and power production by heavy silting of streams, reservoirs, and rivers.

Drought also is often accompanied by extreme heat, exposing people to the risk 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 include 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 effects linger for some time or may even become permanent. Wildlife habitat, for example, may be degraded through the loss of wetlands, lakes, and vegetation. However, many species will eventually recover from this temporary aberration. The degradation of landscape quality, including increased soil erosion, may lead to a 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.

Tree mortality is a key secondary impact of drought. Drought can affect a tree's ability to generate pitch, which it uses to defend itself against infestation by insects such as the bark beetle. Prolonged periods of drought, such as the one just experienced by the State of California, can cause extensive damage to trees. Since May 2016, the U.S. Forest Service has identified 36 million new dead trees, bringing the total estimate of dead trees in California to 62 million (Tree Mortality Task Force, 2017). Removal of dead trees can be costly and challenging, which can add to the financial impacts of drought. These impacts are not instantaneous, and sometimes are not felt by communities for many years following a drought. Figure 7-9 shows the extent and location of tree mortality within the planning based on studies by California's Tree Mortality Task Force.

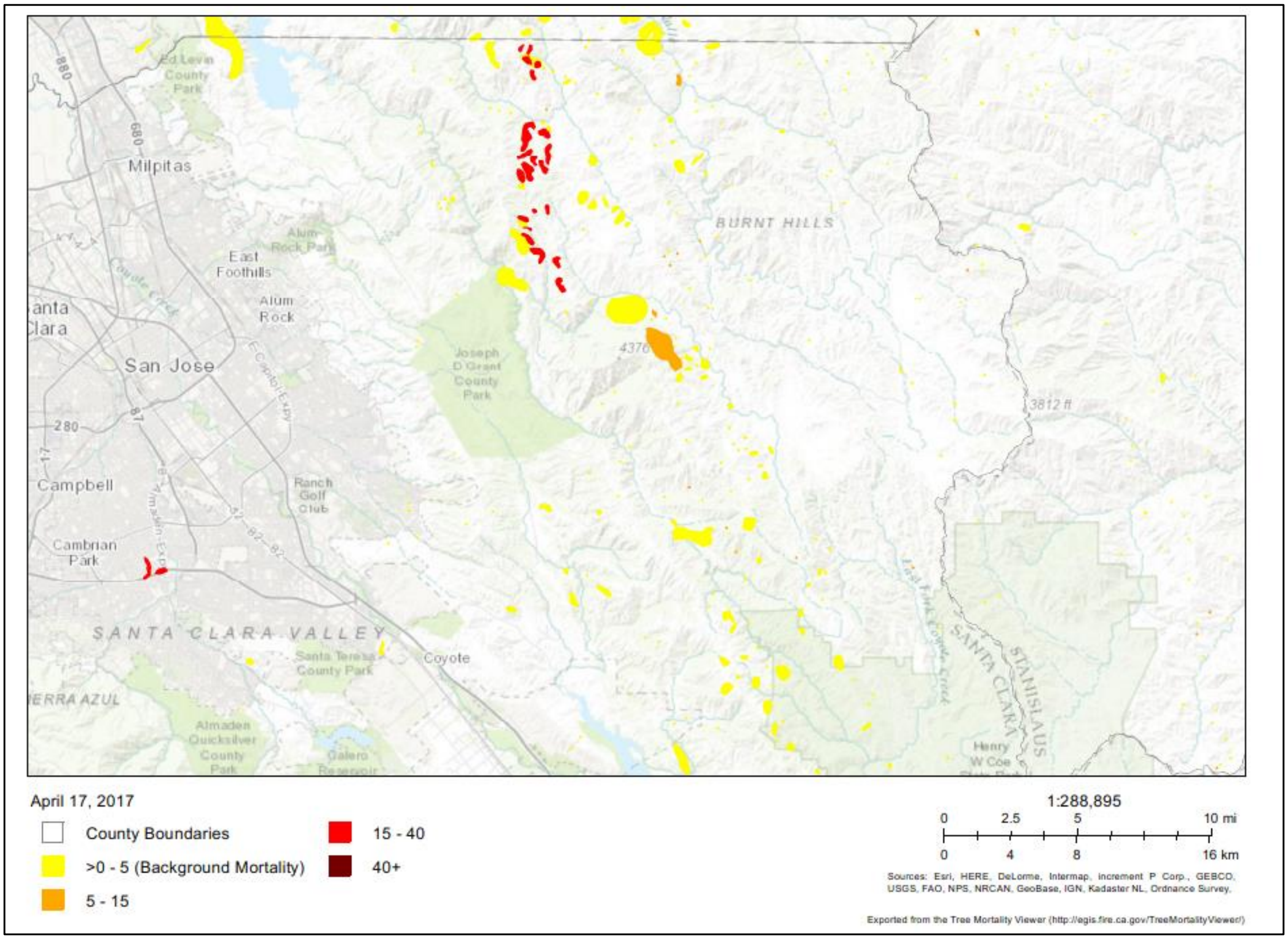


Figure 7-9. Santa Clara County Tree Mortality Exposure

Significant depletion of groundwater supplies—from drought, excessive groundwater pumping or both—can lead to subsidence, which is the downward collapse of the land surface when groundwater aquifers lack the water to support the weight of the ground. Compaction of aquifer systems is the greatest cause of subsidence in California. Although this is typically due to groundwater pumping rather than drought, drought creates a need for greater groundwater pumping as freshwater sources disappear. Drought-induced subsidence is not as common as wildfire or extreme heat, but it can significantly impact the local environment, floodplain/wetlands and water supply, and it typically is irreversible. It may cause wetlands to change size and shape, migrate to lower elevations, or disappear entirely. Rivers may change course, and patterns of erosion and deposition may change (CA Water Science Center, 2016). The SCVWD has conducted aquifer recharge efforts for years trying to recover groundwater levels and halt subsidence issues (USGS, 2017).

7.4 EXPOSURE

Drought can affect a wide range of economic, environmental, and social activities. Its impacts can span many sectors of the economy because water is integral to the ability to produce goods and provide services. The impacts can reach well beyond the area undergoing physical drought. Vulnerability of an activity to drought depends on its water demand and the water supplies available to meet the demand.

California's 2005 Water Plan and subsequent updates indicate that water demand in the state will increase through 2030. The Department of Water Resources predicts a modest decrease in agricultural water use, but an urban water use increase of 1.5 to 5.8 million acre-feet per year (DWR, 2005). The 2013 update to the Water Plan explores measures, benchmarks, and successes in increasing agricultural and urban water use efficiency.

7.5 VULNERABILITY

7.5.1 Population

The entire population of the Santa Clara County OA is vulnerable to drought. Drought can affect people's health and safety, including health problems related to low water flows, poor water quality, or dust. Droughts can also lead to loss of human life (National Drought Mitigation Center, 2016). Other possible impacts include recreational risks; effects on air quality; diminished living conditions related to energy, air quality, and hygiene; compromised food and nutrition; and increased incidence of illness and disease (Centers for Disease Control and Prevention, 2012). Droughts can also lead to reduced local firefighting capabilities.

The SCVWD, 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. Provisions and measures have been taken to analyze and account for anticipated water shortages. With coordination from its cities, the SCVWD has the ability to minimize and reduce impacts on residents and water consumers in the Santa Clara County OA.

7.5.2 Property

No structures will be directly affected by drought conditions, though some structures may become vulnerable to wildfires, which are more likely following years of drought. Droughts can also have significant impacts on landscapes, which could cause a financial burden to property owners. However, these impacts are not considered critical in planning for impacts from the drought hazard.

7.5.3 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 the risk to the OA'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.

7.5.4 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 the loss of wetlands, lakes and vegetation. However, many species will eventually recover from this temporary aberration. The degradation of landscape quality, including increased soil erosion, may lead to a 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.

7.5.5 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 (FEMA, 1997). Agriculture production has been a significant and growing factor in Santa Clara County, especially as agricultural effects on the economy start to normalize (after a period of decline).

Evaluation of direct effects (i.e., excluding indirect and induced spending benefits) can occur based on information conveyed in USDA reports. According to the 2012 Census of Agriculture, 1,003 farms were present in Santa Clara County, encompassing 229,927 acres of total farmland, including 38,398 acres of cropland and 165,547 acres of pastureland. The average farm size was 229 acres.

Santa Clara County farms had a total market value of products sold of $243.8 million ($233.4 million in vegetable crops including nursery and greenhouse; and $10.4 million in cattle, layers, and horses, and related products), averaging $243,100 per farm. The Census indicated that 562 farm operators reported farming as their primary occupation (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 Santa Clara County OA.

7.6 FUTURE TRENDS IN DEVELOPMENT

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.

7.7 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 Santa Clara 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 Santa Clara County also relies, triggering social and political conflicts. The higher density population of the Bay Area increases likelihood of such conflicts. Additionally, the longer drought conditions last in or near the OA, the greater the effect on the local economy; water-dependent industries especially will undergo setbacks.

7.8 ISSUES

The Core Planning Group has identified the following drought-related issues:

- Identification and development of alternative water supplies.

- Utilization of groundwater recharge techniques to stabilize the groundwater supply.
- The probability of increased drought frequencies and durations due to climate change.
- The promotion of active water conservation even during non-drought periods.
- Monitoring of implementation and benefits of the *Long-Term Reliable Water Supply Strategy* projects, *Water Conservation Implementation Plan* projects, and water system capital improvement 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.
- Regular occurrence of drought or multiyear droughts that may limit the Operational Area's ability to successfully recover from or prepare for more occurrences-particularly noteworthy due to longevity of the current ongoing drought.

.

8. EARTHQUAKE

8.1 GENERAL BACKGROUND

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.

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.

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.

An earthquake is the vibration of the earth's surface following a release of energy in the earth's crust. This energy can be generated by a sudden dislocation 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. In the process of breaking, vibrations called "seismic waves" are generated. These waves travel outward from the source of the earthquake at varying speeds.

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. Aftershocks are common after a large earthquake. In fact, relieving stress can increase stress in other parts of the affected fault and other faults.

California is seismically active because of movement of the North American Plate, east of the San Andreas Fault, and the Pacific Plate to the west, which includes the state's coastal communities. Movement of the tectonic plates against one another creates stress, which is released as energy that moves through the earth as seismic waves.

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.

8.1.1 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 over five 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. Casualties generally result from falling objects and debris, because earthquakes shake, damage or demolish furnishings and buildings and other structures. Disruption of communications and internet, electrical power, gas, sewer and water services should be expected in the affected area. Earthquakes may trigger dam failures and landslides. Their damage may cause fires and releases of hazardous material, compounding the disastrous effects.

8.1.2 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

An earthquake's magnitude is a measure of the energy released at the source of the earthquake. It is commonly expressed by ratings on either of two scales (Michigan Tech University, 2016):

- The **Richter scale** measures magnitude of earthquakes based on the amplitude of the largest energy wave released by the earthquake. Richter scale readings are suitable for smaller earthquakes; however, because it is a logarithmic scale, the scale does not distinguish clearly the magnitude of large earthquakes above a certain level. Richter scale magnitudes and corresponding earthquake effects are as follows:
    - 2.5 or less—Usually not felt, but can be recorded by seismograph.
    - 2.5 to 5.4—Often felt, but causes only minor damage.
    - 5.5 to 6.0—Slight damage to buildings and other structures.
    - 6.1 to 6.9—May cause a lot of damage in very populated areas.
    - 7.0 to 7.9—Major earthquake; serious damage.
    - 8.0 or greater—Great earthquake; can totally destroy communities near the epicenter.
- A more commonly used magnitude scale today is the **moment magnitude (M_W) scale**. The moment magnitude scale is based on the total moment release of the earthquake (the product of the distance a fault moved and the force required to move it). Moment magnitude roughly matches the Richter scale but provides more accuracy for larger magnitude earthquakes. The scale is as follows:
    - 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—$M_W < 3$.

Intensity

For an earthquake, intensity varies across the area. Intensity will be larger near the fault rupture, in the direction of the rupture, and in sedimentary basins. Currently the most commonly used intensity scale is the modified Mercalli intensity scale, with ratings defined as follows (USGS, 1989):

- I – Not felt except by a very few under especially favorable conditions.
- II – Felt only by a few persons at rest, especially on upper floors of buildings.

- III – Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it is an earthquake. Standing cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
- IV – Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like a heavy truck striking building. Standing cars rocked noticeably.
- V – Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
- VI – Felt by all; many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
- VII – Damage negligible in buildings of good design and construction; slight in well-built ordinary structures; considerable in poorly built or badly designed structures. Some chimneys broken.
- VIII – Damage slight in specially designed structures; considerable damage in ordinary buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
- IX – 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 – Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.

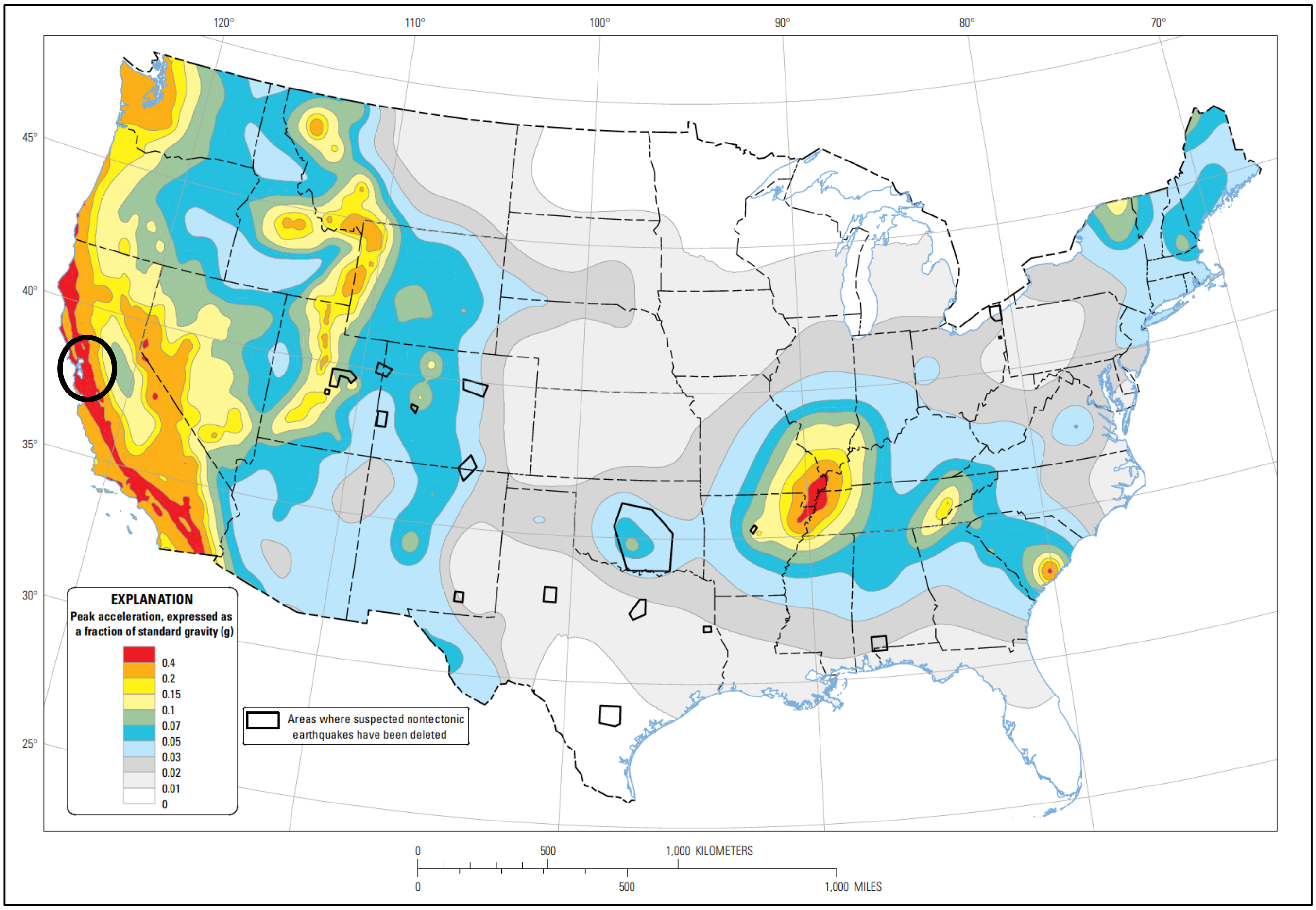
8.1.3 Ground Motion

Earthquake hazard assessment is also based on expected ground motions. During an earthquake when the ground is shaking, it experiences acceleration. The peak ground acceleration (PGA) is the largest increase in velocity recorded by a particular station during an earthquake. PGA indicates the severity of an earthquake and is a measure of how hard the earth shakes, or accelerates, in a given geographic area. It is measured in g (the acceleration due to gravity), expressed as a percentage of that acceleration (%g). Horizontal and vertical PGA varies with soil or rock type. Instruments called accelerographs record levels of ground motion due to earthquakes at stations throughout a region. These readings are recorded by state and federal agencies that monitor and predict seismic activity. Earthquake hazard 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.

National maps of earthquake shaking hazards, which have been produced since 1948, provide information for creating and updating seismic design requirements for building codes, insurance rate structures, earthquake loss studies, retrofit priorities and land use planning. After thorough review of the studies, professional organizations of engineers update the seismic-risk maps and seismic design requirements contained in building codes (Brown et al., 2001). The USGS updated the National Seismic Hazard Maps in 2014. New seismic, geologic, and geodetic information on earthquake rates and associated ground shaking were incorporated into these revised maps. The 2014 map, shown in Figure 8-1, represents the best available data as determined by the USGS.

Building codes that include seismic provisions specify the horizontal force due to lateral acceleration that a building should be able to withstand during an earthquake. Buildings, bridges, highways and utilities built to meet modern seismic design requirements are typically able to withstand earthquakes better, with less damage and disruption. PGA values are directly related to these lateral forces that could damage “short period structures” (e.g. single-family dwellings). Longer-period response components determine the lateral forces that damage taller structures with longer natural periods (apartment buildings, factories, high-rises, bridges). Table 8-1 lists damage potential and perceived shaking by PGA factors, compared to the Mercalli scale.

Source: USGS, 2014



Note: The black circle indicates the approximate vicinity of Santa Clara County

Figure 8-1. Peak Acceleration (%g) with 10% Probability of Exceedance in 50 Years

Table 8-1. 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

8.1.4 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 in which 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 and shallow water table.

A program called the National Earthquake Hazard Reduction Program (NEHRP) creates maps based on soil characteristics to help identify locations subject to liquefaction. Table 8-2 summarizes NEHRP soil classifications. NEHRP Soils B and C typically can sustain ground shaking without much effect, dependent 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 8-2. 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 the 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, 2016e).

8.2 HAZARD PROFILE

The Bay region is located within the active boundary between the Pacific and the North American tectonic plates. The western edge of the Santa Clara County OA is on the Pacific Plate, which is constantly moving northwest past the North American Plate at a rate of about 2 inches per year (CalOES, 2013). Earthquakes in the San Francisco Bay region result from strain energy constantly accumulating across the region because of the motion of the Pacific Plate relative to the North American Plate. The San Andreas Fault, on which earthquakes of magnitude 7.8 and 7.9 have occurred in historical time, including the 1906 San Francisco earthquake, is the fastest slipping fault along the plate boundary.

8.2.1 Past Events

The last major earthquake with an epicenter in the Santa Clara County OA was the 1984 Morgan Hill Earthquake (Magnitude 6.2). The epicenter of the 1989 Loma Prieta Earthquake (Magnitude 7.1) was just a few miles outside the OA. Since then, there have been no significant seismic events in Santa Clara County (ABAG, 2016). 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.

The Morgan Hill Earthquake of April 24, 1984, was a moderate size earthquake on the Calaveras Fault. It caused moderate damage that extended southward from the epicenter. In the Santa Clara County OA, where most of the damage occurred, more than 550 structures experienced minor damage. Major structural damage was mainly confined to a small area on two streets in the Jackson Oaks subdivision east of Morgan Hill. There were numerous reports of fires resulting from the earthquake. Minor damage was also reported in San Martin and Coyote. Twenty seven people were injured (ABAG, 2010). This event led to a FEMA major disaster declaration (DR-845).

The Loma Prieta Earthquake on October 17, 1989, occurred near Loma Prieta in the Santa Cruz Mountains along the San Andreas Fault. Thousands of landslides across the area blocked roads and highways, impacting rescue efforts and damaging structures. In Santa Clara County, collapsed and damaged buildings were reported in Gilroy, Los Gatos, and San José (Santa Clara HMP, 2011).

California has been included in 12 FEMA major disaster (DR) or emergency (EM) declarations for earthquakes. Santa Clara County was included in only one declaration: DR-845 for the Loma Prieta Earthquake, which occurred in 1989. The declaration for this event covered Alameda, Contra Costa, Marin, Monterey, Sacramento, San Benito, San Francisco, San Joaquin, San Mateo, Santa Clara, Santa Cruz, and Solano Counties. Figure 8-2 and Table 8-3 summarize recent earthquakes of magnitude of 5.0 or greater within a 100-mile radius of the OA.

Source: USGS, 2016d

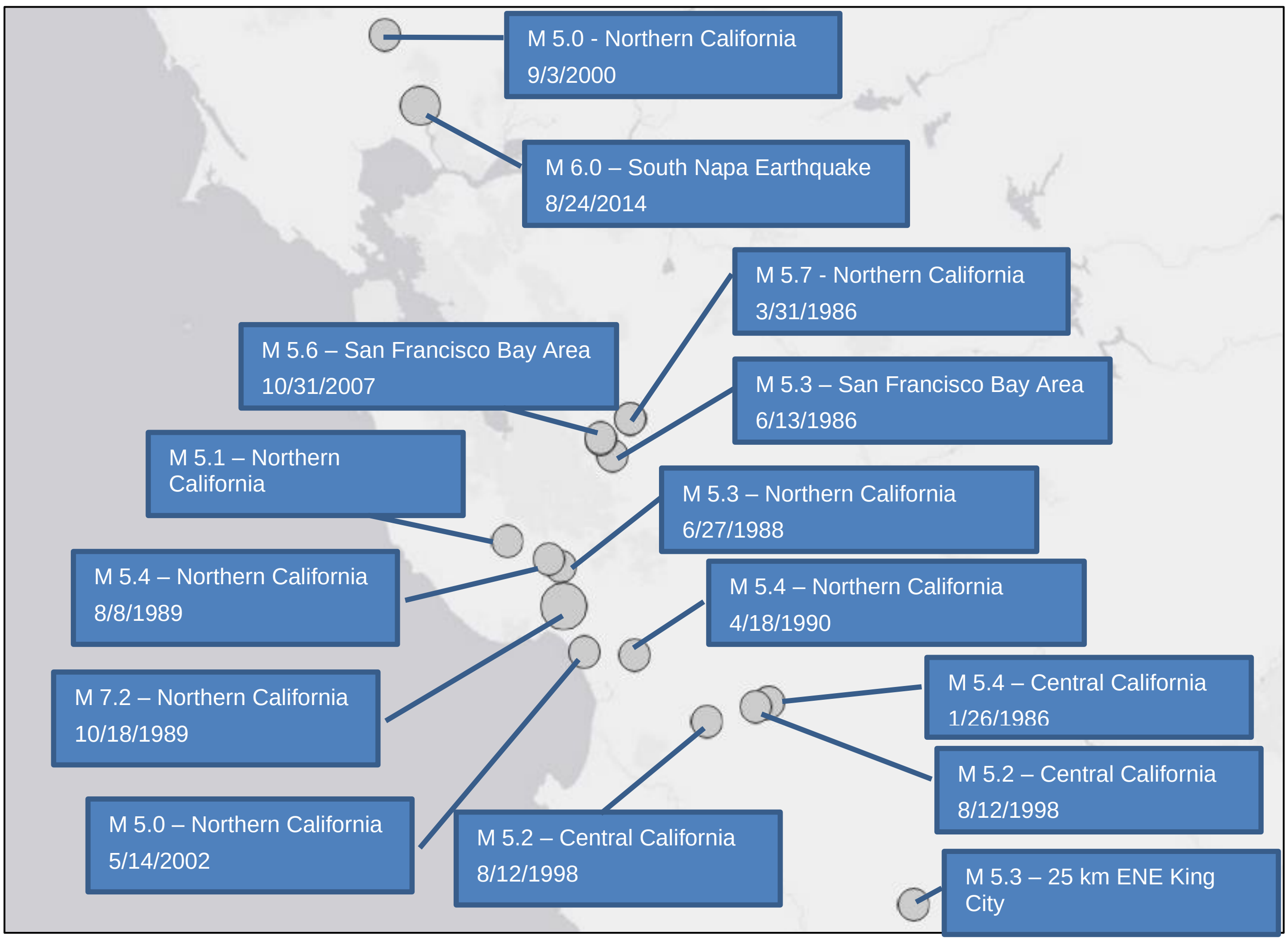


Figure 8-2. Recent Earthquakes Within 100-mile Radius of the OA

Table 8-3. Recent Earthquakes Magnitude 5.0 or Larger Within 100-mile Radius of the OA

Date	Magnitude	Epicenter Location
8/24/2014	6.0	South Napa Earthquake
10/21/2012	5.3	28 km east-northeast of King City, CA
10/31/2007	5.6	San José, California
5/14/2002	5	Northern California
9/3/2000	5	Northern California
8/12/1998	5.2	Central California
4/18/1990	5.4	Northern California
10/18/1989	7.2	Northern California
8/8/1989	5.2	Central California
6/27/1989	5.3	Northern California
6/13/1988	5.3	San Francisco Bay area, California
2/20/1988	5.1	Central California
3/31/1986	5.6	Northern California
1/26/1986	5.4	Central California

8.2.2 Location

Santa Clara County is exposed to major regional faults: Hayward, Calaveras, and San Andreas. The Hayward and Calaveras faults are in the central portion of Santa Clara County and present the greatest earthquake threat to the OA. The San Andreas Fault is on the northwestern boundary of the OA and runs through hills separating Santa Clara County from Santa Cruz County. The primary seismic hazard for the OA is potential ground shaking from these three large faults (ABAG, 2016). The Greenville fault in the northeastern portion of the county presents less risk than these three major faults. Figure 8-3 provides location and probability of area fault lines. Specific probabilities associated with the three major faults are described in the following sections.

Hayward Fault

The Hayward Fault runs parallel to and east of the San Andreas Fault. It extends from San José about 74 miles northward along the base of the East Bay Hills to San Pablo Bay. The Hayward Fault extends through some of the Bay Area’s most populated areas. Communities on or near the fault include San José, Oakland, Fremont, Richmond, Berkeley, Hayward, San Leandro, San Lorenzo, El Cerrito, Emeryville, Kensington and Milpitas. Among other sites, the fault runs directly under the now-abandoned old city hall in downtown Hayward, the University of California-Berkeley football stadium, the Mira Vista Golf Course near Berkeley, Lake Temescal, Contra Costa College, and Port Pinole Shoreline Regional Park. The Hayward Fault is a right-lateral slip fault.

The Hayward Fault is becoming a hazard priority throughout the Bay Area because of its increased chance for activity and its intersection with multiple highly populated areas and critical infrastructure. The probability of experiencing a Magnitude 6.7 or greater earthquake along the Hayward Fault in the next 30 years is 33 percent. An earthquake of this magnitude has regional implications for the entire Bay Area, as the Hayward Fault crosses transportation and resource infrastructure, such as multiple highways and the Hetch-Hetchy Aqueduct. Disruption of the Hetch-Hetchy system has the potential to severely impair water service to the Santa Clara County OA.

An important difference between the Hayward and San Andreas faults is “aseismic creep.” The San Andreas Fault is locked in many places; much of its energy is released in the form of earthquakes. However, creep occurs in spots along the Hayward Fault. The ground moves a few millimeters each year, pulling apart sidewalks, pipelines and other structures that sit astride the fault. At Memorial Stadium at the University of California Berkeley, which was built in 1923, creep has caused the two sides of the stadium to be offset more than a foot, requiring retrofitting with expansion joints. Creep accounts for a small part of the total motion that takes place on a fault over geologic time; earthquakes account for the rest. (California Department of Conservation, 2017).

Source is USGS. https://pubs.usgs.gov/fs/2016/3020/fs20163020.pdf

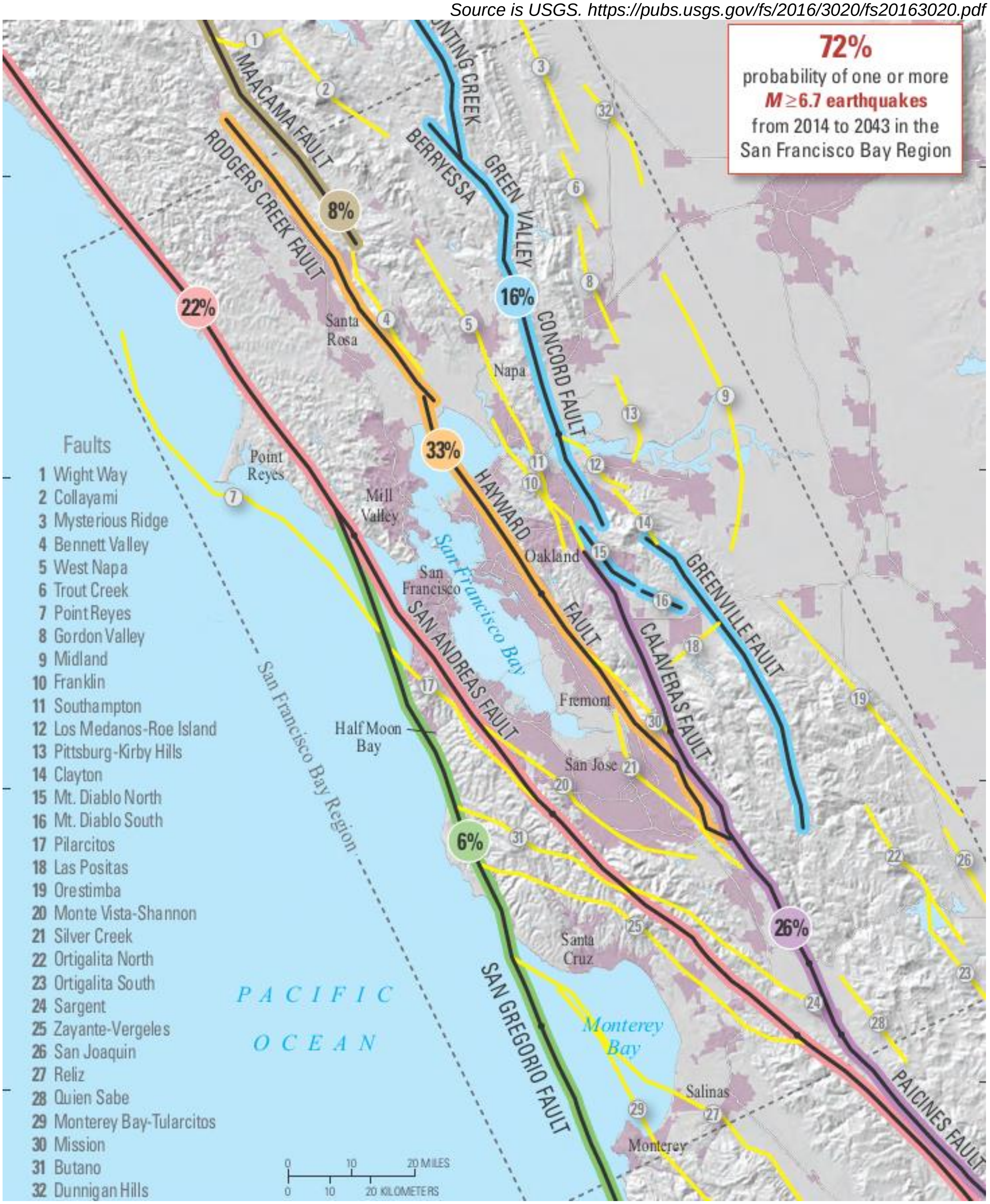


Figure 8-3. Significant Known Faults in the Bay Area

Calaveras Fault

The Calaveras Fault is a major branch of the San Andreas Fault, located to the east of the Hayward Fault. It extends 76 miles from the San Andreas Fault near Hollister to Danville at its northern end. The Calaveras Fault is one of the most geologically active and complex faults in the Bay Area (USGS, 2003). The probability of experiencing a Magnitude 6.7 or greater earthquake along the Calaveras Fault in the next 30 years is 26 percent.

San Andreas Fault

The San Andreas Fault extends 810 miles from the East Pacific rise in the Gulf of California through the Mendocino fracture zone off 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. It 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. The northern segment extends northwest from Hollister, through Santa Clara County, to its ultimate junction with the Mendocino fracture zone and the Cascadia subduction zone in the Pacific Ocean. The probability of experiencing a Magnitude 6.7 or greater earthquake along the San Andreas Fault within the next 30 years is 22 percent.

Maps of Earthquake Impact on the OA

The impact of an earthquake is largely a function of the following components:

- Surface fault rupture
- Ground shaking (ground motion accelerations)
- Liquefaction (soil instability).

Impacts vary with 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 OA, as described in the sections below.

Probabilistic Seismic Hazard Map

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. Figure 8-4 and Figure 8-5 show the estimated ground motion for the 100-year and 500-year probabilistic earthquake ground motions in the OA.

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 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 sites, and variations in the propagation of seismic waves from the earthquake due to complexities in the structure of the earth's crust. A shake map shows the extent and variation of ground shaking in a region immediately following significant earthquakes.

Figure Placeholder

Figure 8-4. 100-Year Probabilistic Earthquake Scenario Peak Ground Acceleration

Figure Placeholder

Figure 8-5. 500-Year Probabilistic Earthquake Scenario Peak Ground Acceleration

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.

There are two types of scenario ground motion maps: a ShakeMap of median shaking for a fault rupture; and a map of simulated ground motions for a specified earthquake hypocenter and fault rupture. The latter is more like an earthquake event and presents more variability in ground motions than a scenario shake map.

Earthquake scenario maps describe the expected ground motions and effects of hypothetical large earthquakes for a region. The following scenarios were chosen for this plan:

- A Magnitude 7.0 on the Hayward Fault with an epicenter approximately 25 miles north of the City of Palo Alto. Figure 8-6 shows the simulated ground motion map.
- A Magnitude 7.0 on the Calaveras Fault with an epicenter approximately 25 miles north of the City of Milpitas. Figure 8-7 shows the scenario ShakeMap.
- A Magnitude 7.8 on the San Andreas Fault with an epicenter approximately 148 miles northwest of the City of Palo Alto. Figure 8-8 shows the scenario ShakeMap.

NEHRP Soil Maps

NEHRP soil types define the locations that will be significantly impacted 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 8-9 shows NEHRP soil classifications in the Santa Clara County OA.

Liquefaction Maps

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 8-10 shows the liquefaction susceptibility in the Santa Clara County OA.

Alquist-Priolo Zone Maps

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 12 miles below the ground surface in California. If an earthquake is large enough, the fault rupture will travel to the ground surface, potentially destroying structures built across its path (CalOES, 2013).

California's Alquist-Priolo Zone maps define 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 structures will not be located on an active fault. The Santa Clara County OA is located in a designated Alquist-Priolo Zone for the Hayward Fault (California Department of Conservation, 2010).

Alquist-Priolo maps were referenced, but not specifically used, in the assessment of risk for this plan. 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. Alquist-Priolo maps are available to the public on the California Department of Conservation website.

Figure Placeholder

Figure 8-6. Hayward M7.0 Fault Scenario Peak Ground Acceleration

Figure Placeholder

Figure 8-7. Calaveras M7.0 Fault Scenario Peak Ground Acceleration

Figure Placeholder

Figure 8-8. San Andreas M7.8 Fault Scenario Peak Ground Acceleration

Figure Placeholder

Figure 8-9. National Earthquake Hazard Reduction Program Soil Classifications

Figure Placeholder

Figure 8-10. Liquefaction Susceptibility

8.2.3 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 has created ground motion maps based on current information about fault zones. These maps show the PGA that has a certain probability (2 percent or 10 percent) of being exceeded in a 50-year period. The maps were most recently updated in 2014 with new seismic, geologic, and geodetic information on earthquake rates and ground shaking, representing the best currently available data. The 2014 map for California shows that for Santa Clara County, the PGA with a 10-percent probability of exceedance in 50 years is 0.4g (see Figure 8-11).

The USGS estimated in 2016 that there is a 72-percent probability of at least one earthquake before 2043 with a magnitude of 6.7 or greater that could cause widespread damage in the San Francisco Bay area (USGS, 2015). California's state hazard mitigation plan (CalOES, 2013) cites projections that in the next 30 years there is more than a 99-percent probability of a Magnitude 6.7 earthquake in California and a 94-percent probability of a Magnitude 7.0 earthquake. Probabilities for earthquakes on major fault lines in the San Francisco Bay Area have been estimated by the USGS in its 2016 report, as summarized in Table 8-4.

Table 8-4. Earthquake Probabilities for the San Francisco Bay Area Region, 2014-2043

Fault	Probability of One or More M≥6.7 Quake 2014-2043
Hunting Creek	16%
Green Valley	16%
Concord	16%
Greenville	16%
Berryessa	16%
Calaveras	26%
Maacama	8%
Rodgers Creek Fault	33%
Hayward	33%
San Andreas	22%
San Gregorio	6%

Source: USGS, 2015

8.2.4 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" 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.

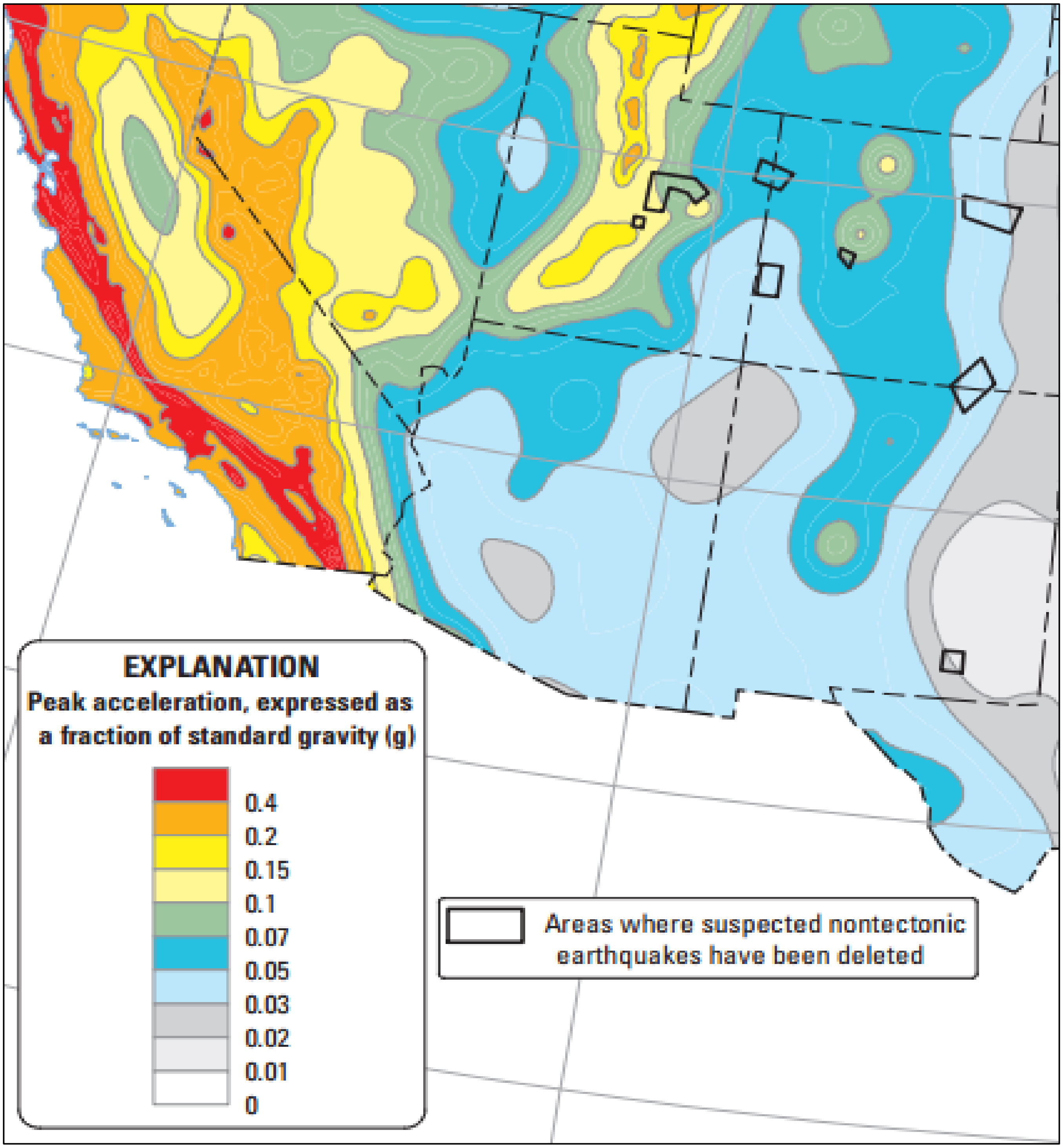


Figure 8-11. Peak Ground Acceleration with 10-percent Probability of Exceedance in 50 Years

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. Recovery, repair, and rebuilding time for each household would be lengthy because of the number of homes that would need repair or replacement.

8.2.5 Warning Time

There is no current reliable way to predict the day or month that an earthquake will occur at any given location. Research and beta testing are being done with warning systems that use telecommunications that can travel faster than an earthquake's high energy waves, called S waves. The warning is generated by a rupture at an earthquake's hypocenter and telecommunicated to provide a warning for shaking before the S waves arrive. These potential earthquake early warning systems could give up to approximately 40 seconds' notice of peak earthquake shaking. 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.

8.3 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. 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 three days, destroying much of the city and leaving 250,000 people homeless (Michigan Tech University, no date).

8.4 EXPOSURE

8.4.1 Population

The entire population of the OA is potentially exposed to direct and indirect impacts from earthquakes. The degree of exposure is dependent on many factors, including the age and construction type of the structures people live in, the soil type their homes are constructed on, their proximity to fault location, etc. Whether directly impacted or indirectly impact, 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 impact populations that suffered no direct damage from an event itself.

8.4.2 Property

According to Santa Clara County Tax Assessor records, there are 464,223 buildings in the OA, with a total replacement value of $477 billion. Since all structures in the OA are susceptible to earthquake impacts to varying degrees, this total represents the property exposure to seismic events. Table 8-5 shows the exposure value breakdown by municipality with the OA.

Table 8-5. Earthquake Exposure by Municipality

Jurisdiction	Total # of Buildings	Total Building Value—Structure and Contents
Campbell	11,987	$11,181,660,749
Cupertino	16,413	$13,890,786,985
Gilroy	13,144	$13,401,505,586
Los Altos	10,981	$8,825,187,782
Los Altos Hills	2,970	$3,242,710,721
Los Gatos	10,407	$10,893,322,460
Milpitas	18,242	$19,146,882,365
Monte Sereno	1,218	$872,909,228
Morgan Hill	11,974	$11,160,393,427
Mountain View	18,891	$25,062,452,472
Palo Alto	20,209	$25,777,115,586
San José	235,552	$213,377,474,752
Santa Clara (city)	28,809	$43,398,577,930
Saratoga	10,830	$8,143,761,638
Sunnyvale	31,915	$42,852,045,398
Unincorporated County	20,681	$25,352,649,992
Total	**464,223**	**$476,579,437,071**

8.4.3 Critical Facilities and Infrastructure

All critical facilities in the OA are exposed to the earthquake hazard. Table 4-4 lists the number of each type of facility by jurisdiction. Hazardous materials releases can occur during an earthquake from fixed facilities or transportation-related incidents. Transportation corridors can be disrupted during an earthquake, leading to the release of materials to the surrounding environment. Facilities holding hazardous materials are of particular concern because of possible isolation of neighborhoods surrounding them. During an earthquake, structures storing these materials could rupture and leak into the surrounding area or an adjacent waterway, having a disastrous effect on the environment, or emit chemicals in a toxic plume.

8.4.4 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.

8.5 VULNERABILITY

Earthquake vulnerability data was generated using a Level 2 Hazus analysis. Once the location and size of a hypothetical earthquake are identified, Hazus estimates the intensity of the ground shaking, the number of buildings damaged, the number of casualties, the damage to transportation systems and utilities, the number of people displaced from their homes, and the estimated cost of repair and clean up.

8.5.1 Population

There are estimated to be 34,006 people in 7,803 households living on soils with high to very high liquefaction potential in the OA, or about 1.8 percent of the total population. Impacts on persons and households in the OA were estimated for the 100-year and 500-year shaking from earthquakes and the three scenario events through the Level 2 Hazus analysis. Table 8-6 summarizes the results.

Table 8-6. Estimated Earthquake Impact on Persons

Scenario	Number of Displaced Households	Number of Persons Requiring Short-Term Shelter
100-Year Shaking from Earthquakes	14,823	9,185
500-Year Shaking from Earthquakes	54,146	34,220
San Andreas ShakeMap Scenario	6,798	3,742
Calaveras ShakeMap Scenario	1,204	805
Hayward ShakeMap Scenario	7,258	4,403

The 100-year shaking results are less than the 500-year shaking results because stronger shaking occurs less often and is more likely to occur in a 500-year period than a 100-year period. The results for the Hayward fault simulation are larger than those for the San Andrea scenario because a simulation is more like a real event with more variable ground shaking than a ShakeMap, and stronger ground motions cause more damage. Therefore, it should not be concluded that a Hayward fault earthquake would be more damaging than a San Andreas fault earthquake in Santa Clara county. The relativity of these results is similar in the following property damage assessments.

8.5.2 Property

Building Age

Table 8-7 identifies significant milestones in building and seismic code requirements that directly affect the structural integrity of development. Using these time periods, the Core Planning Group used Hazus to identify the number of structures in the OA by date of construction.

Table 8-7. Age of Structures in OA

Time Period	Number of Current OA Structures Built in Period	Significance of Time Frame
Pre-1933	17,185	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	6,416	In 1940, the first strong motion recording was made.
1941-1960	111,973	In 1960, the Structural Engineers Association of California published guidelines on recommended earthquake provisions.
1961-1975	139,907	In 1975, significant improvements were made to lateral force requirements.
1976-1994	107,185	In 1994, the Uniform Building Code was amended to include provisions for seismic safety.
1994 - present	81,557	Seismic code is currently enforced.
Total	**464,223**	

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. Approximately 17.6 percent of the OA's structures were constructed after the Uniform Building Code was amended in 1994 to include seismic safety provisions.

Approximately 3.7 percent were built before 1933 when there were no building permits, inspections, or seismic standards.

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.

Loss estimation and vulnerability analyses based on models with specified fragility curves for soft-story construction in the OA are not currently not available to support quantitative analyses of risk. There are qualitative reports on risk available within the OA. These reports were not used for this analysis due to their lack of quantitative data. 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 the Santa Clara County OA. This type of data will need to be generated to support future risk assessments of the earthquake hazard.

Unreinforced Masonry Buildings

Unreinforced masonry 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. Unreinforced masonry 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 the Santa Clara County OA, unreinforced masonry buildings 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 unreinforced masonry buildings. 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 unreinforced masonry buildings.

According to ABAG, housing units in unreinforced masonry 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 analysis for the 100-year and 500-year earthquakes and the three scenario events. Table 8-8 through Table 8-12 show the results for two types of property loss:

- Structural loss, representing damage to building structures.
- Non-structural loss, representing the value of lost contents and inventory, relocation, income loss, rental loss, and wage loss.

Table 8-8. Loss Estimates for 100-Year Probabilistic Earthquake

Jurisdiction	Estimated Loss Associated with Earthquake			% of Total Replacement Value
	Structure	Contents	Total	
Campbell	$505,996,427	$169,701,861	$675,698,288	6.0%
Cupertino	$472,758,374	$149,906,631	$622,665,005	4.5%
Gilroy	$987,983,263	$335,108,563	$1,323,091,826	9.9%
Los Altos	$214,771,634	$69,176,386	$283,948,020	3.2%
Los Altos Hills	$47,488,693	$15,366,287	$62,854,981	1.9%
Los Gatos	$409,842,678	$128,919,536	$538,762,214	4.9%
Milpitas	$1,463,680,416	$545,788,776	$2,009,469,193	10.5%
Monte Sereno	$20,976,126	$6,568,989	$27,545,114	3.2%
Morgan Hill	$632,735,072	$231,755,018	$864,490,090	7.7%
Mountain View	$977,754,443	$366,874,887	$1,344,629,330	5.4%
Palo Alto	$765,915,867	$264,705,357	$1,030,621,224	4.0%
San José	$12,478,614,024	$4,258,371,674	$16,736,985,698	7.8%
Santa Clara (city)	$2,233,949,303	$853,038,669	$3,086,987,972	7.1%
Saratoga	$232,740,429	$71,128,743	$303,869,171	3.7%
Sunnyvale	$2,293,623,291	$866,490,416	$3,160,113,707	7.4%
Unincorporated County	$1,195,998,097	$428,631,176	$1,624,629,273	6.4%
Total	**$24,934,828,136**	**$8,761,532,969**	**$33,696,361,106**	**7.1%**

Table 8-9. Loss Estimates for 500-Year Probabilistic Earthquake

Jurisdiction	Estimated Loss Associated with Earthquake			% of Total Replacement Value
	Structure	Contents	Total	
Campbell	$1,438,806,333	$501,460,207	$1,940,266,541	17.4%
Cupertino	$1,493,375,153	$481,454,968	$1,974,830,121	14.2%
Gilroy	$2,125,578,652	$766,191,462	$2,891,770,114	21.6%
Los Altos	$660,942,324	$213,836,429	$874,778,753	9.9%
Los Altos Hills	$269,561,245	$83,572,523	$353,133,768	10.9%
Los Gatos	$1,565,681,355	$499,357,070	$2,065,038,425	19.0%
Milpitas	$3,453,277,477	$1,336,817,335	$4,790,094,811	25.0%
Monte Sereno	$81,828,223	$26,022,814	$107,851,037	12.4%
Morgan Hill	$1,556,183,963	$598,989,430	$2,155,173,394	19.3%
Mountain View	$2,714,834,855	$999,369,227	$3,714,204,082	14.8%
Palo Alto	$3,121,522,448	$1,119,984,940	$4,241,507,389	16.5%
San José	$30,697,874,311	$10,721,388,274	$41,419,262,585	19.4%
Santa Clara (city)	$6,109,242,405	$2,436,086,086	$8,545,328,491	19.7%
Saratoga	$782,305,711	$237,727,257	$1,020,032,967	12.5%
Sunnyvale	$5,502,290,870	$2,099,320,754	$7,601,611,623	17.7%
Unincorporated County	$3,747,240,300	$1,352,454,448	$5,099,694,748	20.1%
Total	**$65,320,545,625**	**$23,474,033,224**	**$88,794,578,850**	**18.6%**

Table 8-10. Loss Estimates for San Andreas Fault Scenario Earthquake

Jurisdiction	Estimated Loss Associated with Earthquake			% of Total Replacement Value
	Structure	Contents	Total	
Campbell	$288,381,593	$91,939,187	$380,320,780	3.4%
Cupertino	$394,938,108	$121,571,712	$516,509,820	3.7%
Gilroy	$419,064,648	$117,867,975	$536,932,623	4.0%
Los Altos	$168,040,477	$60,915,166	$228,955,644	2.6%
Los Altos Hills	$73,012,402	$26,086,665	$99,099,067	3.1%
Los Gatos	$551,147,772	$160,453,296	$711,601,068	6.5%
Milpitas	$217,482,059	$84,942,479	$302,424,538	1.6%
Monte Sereno	$25,384,893	$7,985,652	$33,370,545	3.8%
Morgan Hill	$167,134,435	$55,290,307	$222,424,742	2.0%
Mountain View	$729,409,216	$250,935,763	$980,344,980	3.9%
Palo Alto	$822,534,220	$277,726,356	$1,100,260,576	4.3%
San José	$3,651,329,465	$1,178,457,733	$4,829,787,198	2.3%
Santa Clara (city)	$937,119,157	$318,839,374	$1,255,958,531	2.9%
Saratoga	$275,758,169	$87,183,818	$362,941,987	4.5%
Sunnyvale	$1,070,982,765	$349,525,192	$1,420,507,957	3.3%
Unincorporated County	$936,808,771	$326,396,017	$1,263,204,788	5.0%
Total	**$10,728,528,152**	**$3,516,116,691**	**$14,244,644,843**	**3.0%**

Table 8-11. Loss Estimates for Hayward Fault Scenario Earthquake

Jurisdiction	Estimated Loss Associated with Earthquake			% of Total Replacement Value
	Structure	Contents	Total	
Campbell	$145,652,171	$57,004,474	$202,656,645	1.8%
Cupertino	$157,615,283	$63,067,552	$220,682,835	1.6%
Gilroy	$155,997,953	$58,596,414	$214,594,367	1.6%
Los Altos	$105,557,744	$39,945,699	$145,503,444	1.6%
Los Altos Hills	$18,928,887	$7,258,126	$26,187,013	0.8%
Los Gatos	$75,310,084	$28,707,690	$104,017,775	1.0%
Milpitas	$1,324,794,294	$457,349,460	$1,782,143,754	9.3%
Monte Sereno	$4,498,438	$1,533,500	$6,031,938	0.7%
Morgan Hill	$62,285,836	$26,761,682	$89,047,518	0.8%
Mountain View	$472,591,853	$177,400,300	$649,992,154	2.6%
Palo Alto	$393,537,058	$150,658,781	$544,195,839	2.1%
San José	$7,036,459,632	$2,307,273,557	$9,343,733,189	4.4%
Santa Clara (city)	$1,262,160,116	$513,816,830	$1,775,976,946	4.1%
Saratoga	$61,159,729	$22,344,258	$83,503,988	1.0%
Sunnyvale	$919,597,590	$330,574,618	$1,250,172,208	2.9%
Unincorporated County	$316,852,862	$122,271,622	$439,124,484	1.7%
Total	**$12,512,999,531**	**$4,364,564,564**	**$16,877,564,096**	**3.5%**

Table 8-12. Loss Estimates for Calaveras Fault Scenario Earthquake

Jurisdiction	Estimated Loss Associated with Earthquake			% of Total Replacement Value
	Structure	Contents	Total	
Campbell	$41,154,055	$20,587,484	$61,741,540	0.6%
Cupertino	$35,648,046	$18,035,203	$53,683,249	0.4%
Gilroy	$375,692,676	$118,641,437	$494,334,113	3.7%
Los Altos	$15,658,147	$8,570,989	$24,229,136	0.3%
Los Altos Hills	$3,450,136	$1,723,990	$5,174,126	0.2%
Los Gatos	$24,305,779	$12,714,053	$37,019,832	0.3%
Milpitas	$346,665,577	$129,750,710	$476,416,287	2.5%
Monte Sereno	$1,299,175	$684,311	$1,983,486	0.2%
Morgan Hill	$248,724,109	$84,812,585	$333,536,695	3.0%
Mountain View	$84,101,436	$44,618,612	$128,720,048	0.5%
Palo Alto	$56,714,344	$32,020,983	$88,735,327	0.3%
San José	$2,356,423,562	$931,175,892	$3,287,599,454	1.5%
Santa Clara (city)	$290,057,384	$147,835,571	$437,892,955	1.0%
Saratoga	$13,423,753	$6,859,950	$20,283,703	0.2%
Sunnyvale	$219,546,926	$113,196,728	$332,743,654	0.8%
Unincorporated County	$318,804,780	$122,154,165	$440,958,945	1.7%
Total	**$4,431,669,885**	**$1,793,382,664**	**$6,225,052,549**	**1.3%**

A summary of the property-related loss results is as follows:

- For a 100-year probabilistic earthquake shaking, the estimated damage potential is $33.7 billion, or 7.1 percent of the total replacement value for the OA.
- For a 500-year probabilistic earthquake shaking, the estimated damage potential is $88.8 billion, or 18.6 percent of the total replacement value for the OA.
- For a 7.0-magnitude event on the San Andreas Fault, the estimated damage potential is $14.2 billion, or 3 percent of the total replacement value for the OA.
- For a 7.0-magnitude event on the Hayward Fault, the estimated damage potential is $16.9 billion or 3.5 percent of the total replacement value for the OA.
- For a 7.8-magnitude event on the Calaveras Fault, the estimated damage potential is $6.2 billion, or 1.3 percent of the total replacement value for the OA.

The Hazus analysis also estimated the amount of earthquake-caused debris in the OA for the 100-year and 500-year earthquakes and the three scenario events, as summarized in Table 8-13.

Table 8-13. Estimated Earthquake-Caused Debris

Scenario	Debris to Be Removed (tons)
100-Year Earthquake	8,341.19
500-Year Earthquake	21,207.49
San Andreas Fault Scenario	4,044.37
Hayward Fault Scenario	4,270.05
Calaveras Fault Scenario	1,203.24

8.5.3 Critical Facilities and Infrastructure

Level of Damage

Hazus 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 category in the OA. The analysis was performed for the 100-year and 500-year events and for all three fault scenarios. Results are summarized in Table 8-14 through Table 8-18.

Table 8-14. Estimated Damage to Critical Facilities from 100-Year Earthquake

Type of Critical Facility	Damage Probabilities (%)				
	None	Slight	Moderate	Extensive	Complete
Emergency Response / Public Health & Safety	59.01%	30.28%	8.75%	1.52%	0.42%
Infrastructure Lifeline	79.27%	10.18%	4.90%	3.89%	1.73%
Military Facilities	5.29%	58.86%	23.57%	9.58%	2.67%
Recovery Facilities	10.23%	23.93%	34.44%	23.62%	7.76%
Socioeconomic Facilities	36.79%	33.26%	24.07%	4.58%	1.28%
Hazardous Materials	17.65%	14.23%	38.53%	21.04%	8.51%
Overall	**34.7%**	**28.5%**	**22.4%**	**10.7%**	**3.7%**

Notes:
Damage level represents the highest-probability damage state for each facility
Values shown are accurate for comparison of results in this plan. See Section 0 for discussion of data limitations.

Table 8-15. Estimated Damage to Critical Facilities from 500-Year Earthquake

Type of Critical Facility	Damage Probabilities (%)				
	None	Slight	Moderate	Extensive	Complete
Emergency Response / Public Health & Safety	33.65%	41.57%	18.60%	3.58%	2.58%
Infrastructure Lifeline	41.97%	16.59%	11.75%	15.12%	14.54%
Military Facilities	0.86%	33.45%	31.05%	22.42%	12.19%
Recovery Facilities	0.73%	7.16%	18.27%	31.65%	42.17%
Socioeconomic Facilities	14.58%	25.17%	31.46%	17.14%	11.63%
Hazardous Materials	0.92%	1.51%	13.03%	35.48%	49.04%
Overall	**15.5%**	**20.9%**	**20.7%**	**20.9%**	**22.0%**

Notes:
Damage level represents the highest-probability damage state for each facility
Values shown are accurate for comparison of results in this plan. See Section 0 for discussion of data limitations.

Table 8-16. Estimated Damage to Critical Facilities from Hayward Fault

Type of Critical Facility	Damage Probabilities (%)				
	None	Slight	Moderate	Extensive	Complete
Emergency Response / Public Health & Safety	71.42%	24.54%	3.20%	0.72%	0.09%
Infrastructure Lifeline	84.93%	7.97%	3.49%	2.53%	1.06%
Military Facilities	7.07%	62.40%	20.98%	7.64%	1.89%
Recovery Facilities	9.45%	30.59%	39.02%	19.16%	1.76%
Socioeconomic Facilities	45.68%	37.92%	14.57%	1.69%	0.13%
Hazardous Materials	34.33%	21.99%	32.50%	9.98%	1.18%
Overall	**42.1%**	**30.9%**	**19.0%**	**7.0%**	**1.0%**

Notes:
Damage level represents the highest-probability damage state for each facility
Values shown are accurate for comparison of results in this plan. See Section 0 for discussion of data limitations.

Table 8-17. Estimated Damage to Critical Facilities from San Andreas Fault

Type of Critical Facility	Damage Probabilities (%)				
	None	Slight	Moderate	Extensive	Complete
Emergency Response / Public Health & Safety	84.28%	13.09%	2.36%	0.24%	0.01%
Infrastructure Lifeline	88.39%	7.01%	2.63%	1.48%	0.47%
Military Facilities	7.07%	62.40%	20.98%	7.64%	1.89%
Recovery Facilities	35.99%	35.29%	22.64%	5.49%	0.57%
Socioeconomic Facilities	59.68%	29.35%	10.32%	0.61%	0.02%
Hazardous Materials	14.67%	20.40%	49.77%	14.09%	1.05%
Overall	48.3%	27.9%	18.1%	4.9%	0.7%

Notes:
Damage level represents the highest-probability damage state for each facility
Values shown are accurate for comparison of results in this plan. See Section 0 for discussion of data limitations.

Table 8-18. Estimated Damage to Critical Facilities from Calaveras

Type of Critical Facility	Damage Probabilities (%)				
	None	Slight	Moderate	Extensive	Complete
Emergency Response / Public Health & Safety	90.24%	8.66%	0.99%	0.09%	0.00%
Infrastructure Lifeline	93.78%	4.14%	1.22%	0.65%	0.19%
Military Facilities	16.11%	67.77%	12.42%	3.15%	0.53%
Recovery Facilities	33.15%	39.76%	23.25%	3.34%	0.49%
Socioeconomic Facilities	78.26%	19.10%	2.57%	0.06%	0.00%
Hazardous Materials	62.94%	20.18%	15.79%	1.04%	0.03%
Overall	**62.4%**	**26.6%**	**9.4%**	**1.4%**	**0.2%**

Notes:
Damage level represents the highest-probability damage state for each facility
Values shown are accurate for comparison of results in this plan. See Section 0 for discussion of data limitations.

Time to Return to Functionality

Hazus 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 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. The analysis was performed for the 100-year and 500-year events and for all three fault scenarios. Results are summarized in Table 8-19 through Table 8-23.

Table 8-19. Functionality of Critical Facilities for 100-Year Event

Type of Critical Facility	# of Critical Facilities	Probability of Being Fully Functional (%)					
		at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Emergency Response / Public Health & Safety	288	59.0	59.7	88.6	89.3	98.0	99.3
Infrastructure Lifeline	1500	87.6	91.0	93.2	93.4	94.8	97.2
Military Facilities	1	74.7	85.9	89.8	90.3	91.4	96.0
Recovery Facilities	4	24.9	29.1	42.5	42.7	70.3	91.8
Socioeconomic Facilities	1382	36.7	37.9	69.5	70.0	94.1	98.4
Hazardous Materials	374	17.6	18.3	31.8	31.8	70.4	91.4
Total/Average	**3,549**	**50.1**	**53.6**	**69.2**	**69.6**	**86.5**	**95.7**

Table 8-20. Functionality of Critical Facilities for 500-Year Event

Type of Critical Facility	# of Critical Facilities	Probability of Being Fully Functional (%)					
		at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Emergency Response / Public Health & Safety	288	33.6	34.5	74.2	75.2	93.8	96.3
Infrastructure Lifeline	1500	58.3	65.6	70.0	70.8	72.8	81.7
Military Facilities	1	50.7	65.6	71.1	72.2	75.0	86.7
Recovery Facilities	4	10.2	13.7	17.0	17.4	29.4	58.0
Socioeconomic Facilities	1382	14.5	15.2	39.2	39.7	71.2	87.3
Hazardous Materials	374	0.9	0.9	2.4	2.4	15.4	50.9
Total/Average	**3,549**	**28.0**	**32.6**	**45.6**	**46.3**	**59.6**	**76.8**

Table 8-21. Functionality of Critical Facilities for Hayward Fault

Type of Critical Facility	# of Critical Facilities	Probability of Being Fully Functional (%)					
		at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Emergency Response / Public Health & Safety	288	71.4	72.0	95.4	95.9	99.1	99.8
Infrastructure Lifeline	1500	91.1	93.5	95.4	95.6	96.7	98.2
Military Facilities	1	78.6	88.6	92.1	92.4	93.3	97.0
Recovery Facilities	4	27.3	30.5	45.6	45.8	79.7	97.9
Socioeconomic Facilities	1382	45.6	47.0	83.1	83.5	98.1	99.8
Hazardous Materials	374	34.3	35.3	56.2	56.3	88.8	98.7
Total/Average	**3,549**	**58.0**	**61.1**	**78.0**	**78.2**	**92.6**	**98.6**

Table 8-22. Functionality of Critical Facilities for San Andreas Fault

Type of Critical Facility	# of Critical Facilities	Probability of Being Fully Functional (%)					
		at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Emergency Response / Public Health & Safety	288	84.3	84.6	97.1	97.3	99.7	99.9
Infrastructure Lifeline	1500	93.4	95.3	97.1	97.2	98.2	99.1
Military Facilities	1	78.6	88.6	92.1	92.4	93.3	97.0
Recovery Facilities	4	53.8	57.3	76.9	77.0	94.6	99.1
Socioeconomic Facilities	1382	59.6	60.8	88.7	89.0	99.3	99.9
Hazardous Materials	374	14.6	15.6	35.0	35.0	84.8	98.9
Total/Average	**3,549**	**64.1**	**67.0**	**81.1**	**81.3**	**95.0**	**99.0**

Table 8-23. Functionality of Critical Facilities for Calaveras Fault

Type of Critical Facility	# of Critical Facilities	Probability of Being Fully Functional (%)					
		at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Emergency Response / Public Health & Safety	288	90.2	90.4	98.7	98.8	99.8	99.9
Infrastructure Lifeline	1500	96.7	97.7	98.8	98.8	99.2	99.6
Military Facilities	1	89.0	94.9	96.9	97.1	97.4	98.9
Recovery Facilities	4	51.0	54.7	78.5	78.6	96.8	99.2
Socioeconomic Facilities	1382	78.2	79.0	97.1	97.3	99.8	99.9
Hazardous Materials	374	62.9	63.8	83.0	83.1	98.9	99.9
Total/Average	**3,549**	**78.0**	**80.1**	**92.2**	**92.3**	**98.7**	**99.6**

Hazardous Materials

An earthquake can cause hazardous material releases from fixed facilities and transportation-related releases.

Transportation

Liquefaction, landslides and fault surface rupture during an earthquake can significantly damage roads. Access to major roads is crucial to life and safety after a disaster event as well as to response and recovery operations. Disruptions in transportation systems are of particular concern in areas with limited access via transportation corridors, as a major event has the potential to isolate these communities from critical assistance and aid.

Bridges

Earthquake shaking, liquefaction and landslides can significantly damage bridges, which often provide the only access to some neighborhoods. Since soft soil regions generally follow floodplain boundaries, those bridges that cross water courses are considered vulnerable. Key factors in the degree of vulnerability are the facility's age and type of construction and soil classification at the bridge support structure, 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. Distribution systems with older brittle pipes are vulnerable to shaking and liquefaction in particular. Water and sewer restoration generally takes longer than other critical infrastructure.

8.5.4 Environment

The environmental vulnerability from earthquakes would be an expansion of what was discussed under environmental exposure in Section 8.4.4. 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.

8.5.5 Economic Impact

Earthquake events can severely disrupt the economy of the affected area. Economic impact will be largely associated with the disruption of power, gas, telecommunication, water, and wastewater 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.

The total economic impact of a major earthquake is likely to spread well beyond the impacted area, especially in a population center like the Santa Clara County OA. This is often referred to the "ripple effect" (National Academies of Science, Engineering and Medicine, 2017). The United States has a highly developed, specialized, interdependent, money economy. While those features make the economy productive and resilient, they also mean that a large magnitude earthquake will not be just a regional event. It has the potential to impact the national economy. An earthquake can result in three kinds of national economic damage:

- Disruptions to supply lines
- Shocks to financial markets
- Drain on the insurance system.

Various sectors of an economy would be impacted differently. For example; tourism would likely be impacted over a long term while the impacted area recovers. The retail sector would likely recover quickly to support recovery, and the construction sector would eventually experience growth.

8.6 FUTURE TRENDS IN DEVELOPMENT

Unincorporated Santa Clara 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 OA welcomes thousands of new residents and hundreds of new businesses to each year.

Land use planning is 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 the Santa Clara County Operational Area is located within an earthquake hazard zone, all future development will, to some extent, be exposed to the earthquake hazard.

8.7 SCENARIO

With the abundance of fault exposure in the Bay Area, the potential scenarios for earthquake activity are many. According to the USGS, there is a 72-percent probability by 2043 of one or more earthquakes in the San Francisco Bay region with a magnitude of 6.7 or greater. An earthquake does not have to occur within the OA to have a significant impact on the people, property and economy of the OA.

Any seismic activity of 6.0 or greater on faults within the OA would have significant impacts throughout the OA. Potential warning systems could give up to approximately 40 seconds notice that strong earthquake shaking is about to occur. This 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. River valley 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.

8.8 ISSUES

Important issues associated with an earthquake include the following:

- More quantitative information is needed on the exposure and performance of soft-story construction within the OA.
- Approximately 29 percent of the OA's building stock was built prior to 1975, when seismic provisions became uniformly applied through building code applications.
- Based on the modeling of critical facility performance performed for this plan, a portion of facilities in the OA is expected to have complete or extensive damage from scenario events. These facilities are prime targets for structural retrofits.
- Critical facility owners 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 high risk dams within the OA. 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.
- Earthquakes could trigger other natural hazard events such as liquefaction, dam failures and landslides, and fire which could severely impact the OA.
- A worst-case scenario would be the occurrence of a large seismic event during a flood or high-water event. Levee failures would happen 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, the Santa Clara County Operational Area is likely to experience disruptions in the flow of goods and services resulting from the destruction of major transportation infrastructure across the broader region.
- The Santa Clara County OA is home to multiple tech centers that provide goods and services to the nation and world. A major earthquake in the region would disrupt these service providers and severely impact the economic and functional stability of the region and potentially the country.

9. FLOOD

9.1 GENERAL BACKGROUND

A floodplain is the area adjacent to a river, creek or lake that becomes inundated 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, the water drawn from them being filtered compared to the water in the stream. Fertile, flat reclaimed floodplain lands are commonly used for agriculture, commerce and residential development.

Connections between a river 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 with levees and other flood control facilities, natural, built-in benefits can be lost, altered, or significantly reduced.

DEFINITIONS

Flood—The inundation of normally dry land resulting from the rising and overflowing of a body of water.

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

1-Percent-Annual-Chance (100-Year) Floodplain—The area flooded by the flood that has a 1-percent chance of being equaled or exceeded in a given year. The 1-percent-annual-chance flood is the standard used by most federal and state agencies.

0.2-Percent-Annual-Chance (500-Year) Floodplain—The area flooded by the flood that has a 0.2-percent chance of being equaled or exceeded in a given year.

Regulatory Floodway—Channel of a river or other water course 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.

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

Riparian Zone—The area along the banks of a natural watercourse.

9.1.1 Measuring Floods and Floodplains

The frequency and severity of flooding are measured using a discharge probability, which is the probability that a certain river discharge (flow) level will be equaled or exceeded in a given year. Flood studies use historical records to determine the probability of occurrence for the different discharge levels. The 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. These measurements reflect statistical averages only; it is possible for two or more floods with a 100-year or higher recurrence interval to occur in a short time period. The same flood can have different recurrence intervals at different points on a river.

The 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 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, which is one of the most important factors used in estimating flood damage.

9.1.2 Floodplain Ecosystems

Floodplains can support ecosystems that are 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 the 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. The production of nutrients peaks and falls away quickly, but the surge of new growth endures for some time. This makes floodplains valuable for agriculture. Species growing in floodplains are markedly different 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.

9.1.3 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. But human activity in floodplains frequently interferes with the natural function of floodplains. It can affect the distribution and timing of drainage, thereby increasing flood problems. Human development can create local flooding problems by altering or confining drainage channels. This increases flood potential in two ways: it reduces the stream's capacity to contain flows, and it increases flow rates or velocities downstream during all stages of a flood event.

9.1.4 Federal Flood Programs

National Flood Insurance Program

The NFIP makes federally backed flood insurance available to homeowners, renters, and business owners in participating communities. For most participating communities, FEMA has prepared a detailed Flood Insurance Study. The study presents water surface elevations for floods of various magnitudes, including the 1-percent annual chance (100-year) flood and the 0.2-percent annual chance (500-year) flood. Base flood elevations and the boundaries of the 100- and 500-year floodplains are shown on Flood Insurance Rate Maps (FIRMs), which are the principle tool for identifying the extent and location of the 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 governments and stakeholders.

Participants in the NFIP must, at a minimum, regulate development in 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:

- New buildings and those undergoing substantial improvements must, at a minimum, be elevated to protect against damage by the 100-year 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 threatened salmonid species.

Table 9-1 lists each participating municipal jurisdiction's date of entrance into the NFIP and the effective date for its current FIRM. Structures permitted or built in the OA before these dates are called "pre-FIRM" structures, and structures built afterwards are called "post-FIRM." The insurance rate is different for the two types of structures. Details about participation in the NFIP are further described the individual annexes in Volume 2 of this plan.

Table 9-1. NFIP Status in the Operational Area

Community	NFIP Community #	NFIP Entry Date	Current Effective FIRM
City of Campbell	060338	06/30/1976	02/19/2014
City of Cupertino	060339	05/01/1980	05/18/2009
City of Gilroy	060340	08/01/1980	05/18/2009
City of Los Altos	060341	07/16/1980	05/18/09
Los Altos Hills	060342	01/02/1980	05/18/09
Los Gatos	060343	01/17/1979	02/19/2014
City of Milpitas	060344	07/16/1980	02/19/2014
City of Monte Sereno	060345	05/18/2009	02/19/2014
City of Morgan Hill	060346	06/18/1980	05/18/2009
City of Mountain View	060347	08/15/1980	05/18/2009
City of Palo Alto	060348	09/19/1984	10/16/2012
City of San José	060349	08/02/1982	02/19/2014
City of Santa Clara	060350	07/16/1980	02/19/2014
City of Saratoga	060351	01/17/1979	02/19/2014
City of Sunnyvale	060352	05/15/1978	05/18/2009
Unincorporated County	060337	08/02/1982	02/19/2014

All participating planning partners are currently in good standing with the provisions of the NFIP. Compliance is monitored by FEMA regional staff and by the California Department of Water Resources under a contract with FEMA. Maintaining compliance under the NFIP is an important component of flood risk reduction. All planning partners that participate in the NFIP have identified actions to maintain compliance and good standing.

FEMA Regulatory Flood Zones

FEMA defines flood hazard areas 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.

Bay-adjacent SFHAs are of concern to the Santa Clara County Operational Area, particularly where land is at or slightly above sea level.

In California, the DWR is the coordinating agency for floodplain management. The 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 the DWR.

The Community Rating System

The CRS is a voluntary program within the NFIP that encourages floodplain management activities that exceed the minimum NFIP requirements. Flood insurance premiums are discounted to reflect the 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 discount partially depends on location of the property. Properties outside the SFHA receive smaller discounts: a 10-percent discount if the community is at Class 1 to 6 and a 5-percent discount if the community is at Class 7 to 9.

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 9-1 shows the nationwide number of CRS communities by class as of October 2016, when there were 1,391 communities receiving flood insurance premium discounts under the CRS program.

Source: FEMA, 2016

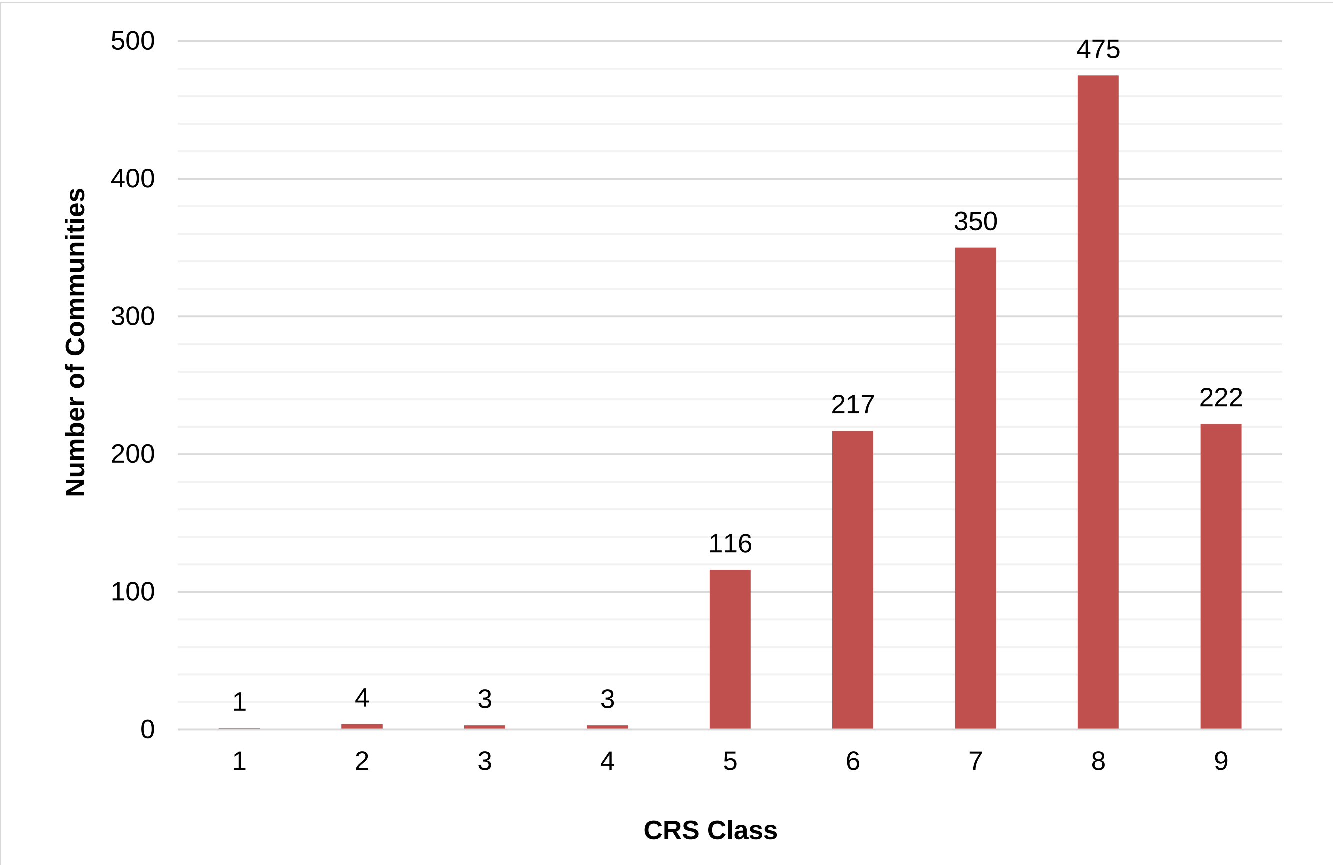


Figure 9-1. CRS Communities by Class Nationwide as of October 2016

CRS activities can help to 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 located in 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.

Current CRS ratings are detailed in each jurisdiction's annex and in Table 9-2. Many of the mitigation actions identified in planning partners' individual annexes for this plan are creditable activities under the CRS program. Therefore, successful implementation of this plan offers the potential to enhance the CRS classification.

Table 9-2. CRS Community Status in the OA

Community	NFIP Community #	CRS Entry Date	Current CRS Classification	% Premium Discount, SFHA/non-SFHA	Total Premium Savings (2014)
Cupertino	060339	10/01/2005	7	15/5	$6,537
Gilroy	060340	05/01/2007	8	10/5	$23,722
Los Altos	060341	10/01/1991	8	10/5	$10,465
Milpitas	060344	10/01/1991	7	15/5	$329,749
Morgan Hill	060346	05/01/2003	7	15/5	$51,026
Mountain View	060347	05/01/2002	8	10/5	$53,181
Palo Alto	060348	10/01/1991	7	15/5	$713,103
San José	060349	10/01/1991	7	15/5	$1,234,021
Santa Clara (city)	060350	05/01/2002	8	10/5	$94,810
Sunnyvale	060352	10/01/1998	7	15/5	$170,009
Total					**$2,686,623**

Source: FEMA, 2016

9.2 HAZARD PROFILE

The following information is extracted from the Santa Clara County Flood Insurance Study (FEMA, 2014):

- The mountains and foothills in northern Santa Clara County are the sources of the watercourses that flow through the north portion of the OA. Near San José, the major waterways include Los Gatos, Guadalupe, and Alamitos Creeks flowing out of the Santa Cruz Mountains; Coyote Creek and a host of tributaries, including Upper Penitencia and Silver Creeks, flowing out of the Diablo Range; and Fisher Creek with headwaters on the western side of the Coyote Creek Valley. The 75-mile-long Coyote Creek is the primary natural drainage facility for the eastern side of the Santa Clara Valley.
- Permanente and Stevens Creeks, which flow north through the OA near Mountain View, are the primary runoff drainage channels in that area. In addition to providing flood control, these creek beds provide gravel lenses that penetrate the impervious underground clay layers. These lenses allow rain runoff to percolate down to replenish the underground water supply.
- The principal watercourses in the south portion of the OA are Llagas, Uvas, and Coyote Creeks. Edmundson (Little Llagas), Church, Center, Tennant, Maple, and Foothill Creeks also flow through the area. The area is unusual in that creeks originate in both the Diablo Range, to the east, and the Santa Cruz Mountains, to the west. Waters originating in the area are conveyed to Monterey Bay via the Pajaro River.
- Drainage-ways in the OA are a combination of natural channels (creek beds) and channels altered by human activity.
- Drainage patterns in the OA have been altered by urbanization, and the runoff, which has increased, is a greater flood threat than in previous years. The construction of water-conservation flood retention facilities has also altered the drainage pattern.
- A variety of conditions cause flooding in the Santa Clara County OA. In smaller drainage basins, flooding is usually the result of intense storms. In larger basins, flooding results from storms of long duration. Shallow overland flooding often occurs due to the small capacity of the creeks.

9.2.1 Types of Flood-Related Hazards

Flooding in the Santa Clara County OA typically occurs during the rainy winter season. Four types of flooding primarily affect the County: stormwater runoff, riverine, flash floods, and tidal 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 the Santa Clara County OA 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.

Flash Floods

The National Weather Service defines a flash flood as 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. Such floods generally begin within 6 hours of the rain event that causes them. Ongoing flooding can intensify to flash flooding in cases where intense rainfall results in a rapid surge of rising flood waters (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.

Tidal Floods

Tidal floods are characterized by inundation of normally dry lands by bay waters, often caused by extreme high tide events that result in shallow flooding of low-lying coastal areas. Colloquially known as “King Tides,” extreme high level tide events are the highest predicted high tide events of the year at a coastal location. These tides exceed the highest water level reached at high tide on an average day and normally occur once or twice per year. King Tide events are the leading cause of flooding by bay waters.

Tidal flooding is becoming increasingly exacerbated by sea level rise as a result of climate change or tectonic activity (NOAA, no date). Average daily water levels are rising along with the oceans. As a result, high tides are reaching higher and extending further inland than in the past. Additional information regarding the impacts and exposure of the OA to sea level rise is presented in Chapter 14.

9.2.2 Principal Flooding Sources

FEMA’s Flood Insurance Study for Santa Clara County assessed over 50 creeks, channels, and water bodies, including the following principal flooding sources (FEMA, 2014):

- Adobe Creek
- Alamitos Creek
- Alviso Slough
- Arastradero Creek
- Arroyo Calero
- Barron Creek
- Berryessa Creek
- Calabazas Creek
- Canoas Creek
- Concepcion Drain
- Coyote Creek
- Daves Creek
- East Little Llagas Creek
- East Penitencia Creek
- Evergreen Creek
- Fisher Creek
- Fisher Creek Overbank
- Flint Creek
- Fowler Creek
- Guadalupe River
- Guadalupe Slough
- Hale Creek
- Lions Creek
- Llagas Creek
- Llagas Overbank
- Los Gatos Creek
- Lower Penitencia Creek
- Matadero Creek
- Miguelita Creek
- Miller Slough
- North Morey Creek
- Permanente Creek
- Permanente Diversion
- Purissima Creek
- Quimby Creek
- Ronan Channel
- Ross Creek
- Ruby Creek
- San Francisco Bay
- San Francisquito Creek
- San Joaquin River
- Santa Teresa Creek
- San Tomas Aquino Creek
- San Tomas Aquino Creek Reach 2
- Saratoga Creek
- Silver Creek
- Smith Creek
- South Babb Creek
- South Morey Creek
- Stevens Creek
- Sunnyvale East Channel
- Sunnyvale West Channel
- Thompson Creek
- Upper Penitencia Creek
- Upper Penitencia Creek Reach 2
- Upper Penitencia Creek Reach 2 Overflow
- Uvas Creek
- West Branch Llagas Creek
- West Little Llagas Creek
- Wildcat Creek

Investigation of Santa Clara County's vulnerability to flooding can also include assessments of watersheds. Every watershed has unique qualities that affect its response to rainfall. The Santa Clara County OA contains five watersheds (SCVWD, 2017):

- Coyote Watershed is the OA's largest watershed, with 322 square miles. It contains Coyote Creek, which is the longest creek in the county.
- Guadalupe Watershed drains the Guadalupe River and its tributaries through downtown San José.
- Lower Peninsula Watershed is a small-creek watershed that feeds tidal wetlands along the San Francisco Bay's southwest shoreline.
- Uvas-Llagas Watershed is mainly agricultural land and natural areas. This is the only watershed in the county where waterways flow southward.
- West Valley Watershed is the smallest watershed in the county, covering 85 square miles of numerous small creeks.

9.2.3 Past Events

Based on NOAA's National Centers for Environmental Information and the ABAG 2010 Plan, 23 flood events in the OA were recorded between 1950 and 2016, as summarized in Table 9-3. These events include flash floods, winter storm flooding, urban and small stream flooding, and flooding from heavy multi-day rain events. Since 1954, 13 presidential-declared flood events in the OA have caused in excess of $4.468 billion in property damage throughout the region.

According to the USDA's Risk Management Agency, Santa Clara County received $8,200,676 in payments for insured crop losses on 2,710 affected acres as a result of excessive moisture and flood events between 2003 and 2016. Table 9-4 summarizes these payments. The highest damaging year was 2016.

9.2.4 Location

Flooding that has occurred in portions of the OA has been extensively documented by gage records, high water marks, damage surveys and personal accounts. This documentation was the basis for the 2014 FIRMs generated by FEMA for the Santa Clara County OA. The 2014 current effective Flood Insurance Study is the sole source of data used in this risk assessment to map the extent and location of the flood hazard, as shown in Figure 9-2.

9.2.5 Frequency

Recurrence intervals and average annual numbers of events in the Santa Clara County OA were calculated based on data from 1996 to 2016 in NOAA's Storm Events Database. Santa Clara County has experienced nine significant events since 1996 classified as "flood" in the database. Smaller floods may occur more frequently and be categorized as a different event type, typically "flash flood" or "winter storm." Based on these data, floods have a 52 percent chance of occurring in any given year, flash floods have a 38 percent chance, and winter storms have a 10 percent chance. Total estimated percent chance of occurrence for any type of flood in a given year is 100 percent, meaning that flooding will likely continue to be an annual hazard.

Additionally, 45 flood-related federally declared disasters or emergencies have occurred in California since 1954 (all 45 events were non-tsunami or hurricane-related flood events). This equates to a major, non-tsunami or hurricane-related flood event impacting the state every 1.37 years on average.

Table 9-3. History of Flood Events

Date	Declaration #	Type of event	Estimated Damage
2/5/1954	15	Flood & Erosion	Not available
12/23/1955	47	Flood	Coyote Creek, Stevens Creek, Matadero Creek, San Francisquito Creek, and Guadalupe River flooded
4/4/1958	82	Heavy Rainstorms and Flood	Penitencia Creek, Guadalupe River, San Tomas Aquinas Creek, Stevens Creek, Permanente Creek, Matadero Creek, and San Francisquito Creek flooded. $20 million, plus $4 million agricultural damage
3/6/1962	122	Floods	Not available
10/24/1962	138	Severe Storms and Flooding	$4 million in regional flooding
2/25/1963	145	Severe Storms, Heavy Rains and Flooding	Not available
1/16/1973	N/A	Severe Storms and Flooding	$86,207 in damage
1/7/1982	651	Severe Storms, Flood, Mudslides and High Tide	$273 million, 256 homes and 41 businesses destroyed; 6,259 homes and 1,276 businesses damaged.
2/9/1983	677	Coastal Storms, Floods, Slides and Tornadoes	$523 million
2/21/1986	758	Severe Storms and Flooding	$407 million; 1,382 homes and 185 businesses destroyed; 12,447 homes and 967 businesses damaged.
2/11-14/1992	N/A	Severe Storms and Flooding	$20,000 in damage
1/13/1993	N/A	Severe Storms and Flooding	$112,000 in damage
1/10/1995	1044	Severe Winter Storms, Flooding, Landslides, Mud Flows	$741 million total; 11 deaths
3/12/1995	1046	Severe Winter Storms, Flooding Landslides, Mud Flow	Approx. $1.1 billion total; damage to homes: major 1,322; minor 2,299; destroyed 267.
1/4/1997	1155	Severe Storms, Flooding, Mud and Landslides	$1.8 billion total; 23,000 homes; 2,000 businesses damaged or destroyed.
2/9/1998	1203	Severe Winter Storms and Flooding	$550 million; 17 deaths
2/13/2000	N/A	Flash Flood	Mainly on Coyote Creek
10/13/2009	N/A	Heavy Rain and Flooding	$400,000
1/18-20/2010	N/A	Heavy Rain and Flooding	Localized flooding, roads closed, damage estimate not available.
12/23/2012	N/A	Heavy Rain and Tornado	Localized flooding, levee overtopped in East Palo Alto.
2/28/2014	N/A	Heavy Rain and Flooding	Flooding of urban areas, small streams and creeks, and a few localized mud and rockslides.
12/11/2014	N/A	Heavy Rain and Flooding	Flooding and mudslides
2/06/2015	N/A	Heavy Rain and Flooding	Multiple off ramps from I-280 flooded.
2/14/2017	4301	Severe Winter Storms, Flooding, and Mudslides	34 of 57 CA Counties declared for flooding events that occurred from January 3 to January 12, 2017

N/A = Not Applicable

Sources: NOAA, 2017 and ABAG, 2010

Table 9-4. Crop Insurance Claims Paid from Excessive Moisture and Flood, 2003-2016

Crop Year	Commodity	Acres Affected	Indemnity Amount
2003	None	None	None
2004	None	None	None
2005	All Other Crops	79	$13,144
2006	All Other Crops	83	$6,937
2007	None	None	None
2008	None	None	None
2009	None	None	None
2010	None	None	None
2011	Walnuts, Cherries, Processing Apricots	910	2,706,413
2012	Cherries	239	$113,052
2013	None	None	None
2014	Cherries	18	$29,015
2015	Cherries, Processing Apricots, All Other Crops	322	$1,053,095
2016	Cherries, Processing Apricots	1,059	$4,279,020
Total		2,710	$8,200,676

Source: USDA, 2016

Figure Placeholder

Figure 9-2. Mapped Flood Hazard Areas in the Operational Area

9.2.6 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. This is especially true when a channel migrates over a broad floodplain, redirecting high velocity flows and transporting debris and sediment.

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.

Flood severity is often evaluated by examining peak discharges; Table 9-5 lists peak flows used by FEMA to map the floodplains of the OA.

Table 9-5. Summary of Peak Discharges Within the OA

Flooding Source and Location	Discharge (cubic feet/second)			
	10-year	50-Year	100-Year	500-Year
ADOBE CREEK				
Above Railroad (At El Camino Real)	1,350	2,500	2,700[a]	2,700[a]
At East Charleston Road	1,400[a]	1,400[a]	1,400[a]	1,400[a]
At East Meadow Drive	1,350	1,350	1,350	1,350
At Edith Road	1,000	1,830	2,140	2,700
At El Monte Avenue	690	1,340	1,700	2,370
At corporate limits	890	1,650	1,920	2,400
At Foothill Expressway	1,070	2,120	2,320	2,690
At Middlefield Road	1,020[a]	1,020[a]	1,020[a]	1,020[a]
At Moody Road	590	1,150	1,430	1,930
At Old Altos Road	960	1,760	2,050	2,490
At Pine Lane	1,110	2,150	2,360	2,730
At Railroad	1,350	1,450[a]	1,450[a]	1,450[a]
At U.S. Highway 101	1,660	1,780	1,780	1,780
At Van Buren Road	1,060	1,890	2,220	2,810
Below Alma Street	1,450	1,700	1,700	1,750
Below Purissima Creek	1,040	1,980	2,200	2,510
ALAMITOS CREEK				
Downstream of confluence with Arroyo Calero	2,150	5,180	6,750	11,000
Downstream of confluence with Golf Creek	3,530	7,020	8,680	12,700
Downstream of confluence with Greystone Creek	2,940	6,200	7,800	11,800
Downstream of confluence with Randol Creek	2,660	5,800	7,380	11,400
Upstream of confluence with Arroyo Calero	1,430	3,580	4,750	7,900
Upstream of confluence with Guadalupe River	3,630	7,180	8,860	12,900
ALAMITOS CREEK BY-PASS CHANNEL	*b*	*b*	3,250	*b*
ALAMITOS CREEK OVERFLOW AREA	*b*	*b*	140	*b*
ARROYO CALERO				
Downstream of confluence with Santa Teresa Creek	1,020	1,820	2,180	3,010
Upstream of confluence with Alamitos Creek	1,180	1,980	2,330	3,110
Upstream of confluence with Santa Teresa Creek	660	1,120	1,320	1,770
ARASTRADERO CREEK				
At Page Mill Road	140	300	360	460

Flooding Source and Location	Discharge (cubic feet/second)			
	10-year	50-Year	100-Year	500-Year
ARROYO DE LOS COCHES				
At confluence with Berryessa Creek	*b*	*b*	1,420	*b*
BARRON CREEK				
At El Camino Real	270	270	270	270
At Foothill Expressway	176	364	453	640
At Foothill Expressway	320	630	760	1,100
At Laguna Avenue	180[b]	180[b]	180[b]	180[b]
At Lower Fremont Road	96	208	268	390
At mouth	320	430	430	430
At Ramona Street	320	430[a]	430[a]	430[a]
At Railroad	320	675	675	675
At Upper Fremont Road	32	77	98	143
Downstream of El Camino Real	270	270	270	270
Upstream of Barron Creek Diversion	*b*	*b*	740	*b*
Upstream of Fabian Way	*b*	*b*	250	*b*
Upstream of Laguna Avenue	*b*	*b*	1,603	*b*
Upstream of Railroad	320	820	920	1,080
BERRYESSA CREEK				
At confluence with Calera Creek	*b*	*b*	3,600[a]	*b*
At confluence with Sierra Creek	1,230	2,250	2,580	1,230
At confluence with Tularcitos Creek	*b*	*b*	2,500[a]	*b*
At confluence with Wrigley Ditch	*b*	*b*	2,000[a]	*b*
At Morrill Avenue	1,230	1,7001	1,750[a]	1,230
At Piedmont Road	*b*	*b*	1,600	*b*
Downstream of confluence with Arroyo De Los Coches	*b*	*b*	2,000[a]	*b*
Downstream of Montague Expressway	800[a]	800[a]	800[a]	800[a]
CALABAZAS CREEK				
Above Prospect Road	*b*	*b*	1,800	*b*
Above Railroad and Prospect Creek	*b*	*b*	1,140	*b*
At Coffin Road	3,000	4,100	4,600	5,800
At El Camino Real	2,090[d]	2,290[d]	2,340[d]	2,360[d]
At Grant Road	1,200	1,600	1,800	2,300
At Interstate Highway 280	1,950	2,490	2,700	3,360
At Junipero Serro	2,000	2,700	3,100	3,900
At Kifer Road	2,600	3,600	4,000	5,200
At Lawrence Expressway	2,100	3,000	3,300	4,200
At Rainbow Drive Below La Mar Court	750	1,070	1,310	1,370
Below Miller Avenue	1,670	2,050	2,210	2,670
Below Tantau Avenue/Upstream of Pruneridge Avenue	1,700[a]	1,900[a]	1,950[a]	2,000[a]
Downstream of confluence with Rodeo Creek	1,170	1,700	1,950	2,610
Downstream of Prospect Road	7501	1,000[e]	1,180[e]	1,220[e]
Downstream of U.S. Highway 101	2,760[d]	3,200[f]	4,780[f]	5,510[f]
Through box culvert at Miller Avenue	1,400[a]	1,550[a]	1,600[a]	1,600[a]
Upstream of Benton Street	2,100[d]	2,170[a]	2,170[a]	2,200[a]
Upstream of Kifer Road	2,550[d]	2,820[d]	3,000[d]	3,340[d]
Upstream of Lawrence Expressway	2,050[d]	2,310[d]	2,370[d]	2,540[d]
Upstream of Pomeroy Avenue	2,190[d]	2,200[d]	2,200[d]	2,200[d]

Flooding Source and Location	Discharge (cubic feet/second)			
	10-year	50-Year	100-Year	500-Year
Upstream of U.S. Highway 101	2,760[d]	3,020[d]	3,200[d]	3,550[d]
Upstream of State Highway 237	3,010[d]	3,420[d]	5,000[d]	5,100[d]
CALERA CREEK				
At confluence with Berryessa Creek	*b*	*b*	920	*b*
Upstream of Interstate Highway 680	*b*	*b*	850	*b*
CANOAS CREEK				
At Blossom Hill Road	1,320	1,390	1,400	1,420
At Capitol Expressway	1,850	1,910	1,960	2,000
At confluence with Guadalupe River	1,900[a]	1,950[a]	1,970[a]	2,000[a]
At Cottle Road	480	500	510	530
At Santa Teresa Boulevard	780	810	830	850
Upstream of Nightingale Drive	1,990	2,250	2,350	2,500
CONCEPCION DRAINAGE				
At Alto Verde Lane	22	51	68	102
COYOTE CREEK				
At Interstate Highway 280	3,880	10,180	12,630	14,700
At U.S. Geological Survey gage near Edenvale	4,050	10,940	13,670	14,700[a]
At U.S. geological Survey gage near Madrone	4,500	12,000	15,000	24,000
Downstream of Anderson Reservoir	4,500	11,000	15,000	23,500
Downstream of confluence with Berryessa Creek	7,300	10,500	12,800	15,000
Downstream of confluence with Silver Creek	6,200	10,300	12,500	15,000
Downstream of Silver Creek Diversion	4,000	10,680	13,330	14,700
Upstream of confluence with Fisher Creek	4,410	12,010	14,830	16,400[a]
Upstream of confluence with Silver Creek	3,790	9,920	11,400[a]	11,400[a]
Upstream of Silver Creek Diversion	4,000	10,680	13,330	14,700
DAVES CREEK				
At Los Gatos Creek	130	230	270	370
EAST LITTLE LLAGAS CREEK				
Approx. 1,500 ft. upstream of Sycamore Ave.	*b*	*b*	2,211	*b*
At confluence of Church Creek	*b*	*b*	5,355	*b*
At confluence of San Martin Creek	*b*	*b*	3,712	*b*
At U.S. Highway 101	700	1,200	1,300	1,700
At Tenant Creek confluence	*b*	*b*	2,881	*b*
Upstream of Seymour Ave	330	430	460	490
EAST PENITENCIA CREEK				
Downtown of Trimble Road	280	340[a]	340[a]	340[a]
Upstream of confluence with Lower Penitencia Creek	480	970[h]	1,080[h]	1,280[h]
Upstream of Trimble Road	280	400	450	540
FISHER CREEK				
At confluence with Coyote Creek	700[a]	700[a]	700[a]	700[a]
At Kalana Avenue	470	960	1,130	1,500
At Miramonte Avenue	300	600	710	930
At Richmond Avenue	450	700	700	700
At Willow Springs Road	270	460	560	810
Downstream of Bailey Avenue	1,000	1,810	2,160	2,950
Upstream of Bailey Avenue	620	900	900	900
Upstream of Railroad	1,260	2,310	2,560	3,530

Flooding Source and Location	Discharge (cubic feet/second)			
	10-year	50-Year	100-Year	500-Year
FISHER CREEK OVERBANK				
500 feet downstream of Richmond Avenue	250	630	900	1,540
At Bailey Avenue	220[b]	680	970	1,670
GUADALUPE RIVER				
At Blossom Hill Road	3,500	8,500	11,500	19,000
At Coleman Avenue	7,000	13,500[a]	15,500[a]	15,500[a]
At Hedding Street	7,500	9,800[a]	9,800[a]	9,800[a]
At Hobson Avenue	7,000	11,400[a]	11,400[a]	11,400[a]
At Interstate Highway 280	6,000	7,000[a]	7,000[a]	7,000[a]
At Malone Road	5,600	11,500	11,900[a]	11,900[a]
At Railroad	5,800	10,900[a]	10,900[a]	10,900[a]
Downstream of confluence with Canoas Creek	5,500	11,000	12,800	12,800
Downstream of confluence with Los Gatos Creek	7,000[a]	10,000[a]	10,000[a]	10,000[a]
Downstream of confluence with Ross Creek	4,500	9,000	12,500	20,000
Downstream of State Highway 17	7,500	12,000[a]	13,000[a]	17,000[a]
Upstream of confluence with Canoas Creek	4,500	9,500	12,000[a]	12,000[a]
HALE CREEK				
At Berry Avenue	510	1,020	1,120	1,580
At confluence with Permanente Creek	710	880	900	960
At Cuesta Drive/North Springer Road	595	750	760	810
At Foothill Expressway	460	970	1,060	1,490
At Interstate Highway 280	101	218	284	440
At Rosita Avenue	595	700[a]	700[a]	700[a]
At Summer Hill Avenue	177	370	472	735
LIONS CREEK				
Upstream of West Branch Llagas Creek	*b*	*b*	1,840	*b*
LLAGAS CREEK				
At Rucker Avenue	4,900[i]	9,700[i]	10,200[i]	12,700[i]
At Railroad	2,200	3,900	5,300	8,500
Downstream of Buena Vista Creek	5,200	10,400	11,000	11,500[a]
Downstream of Chesbro Reservoir	900	3,100	3,900	6,000
Downstream of East Little Llagas Creek	5,000	9,800	10,400	12,900
Downstream of Hayes Creek	1,800	3,800	4,800	7,500
Downstream of Leavesley Road	5,200[d]	5,200[d]	5,200[d]	5,200[d]
Downstream of Live Oak Creek	5,500	9,700	9,800	10,300
Downstream of Machado Creek	1,400	3,600	4,500	7,000
Downstream of Panther Creek	5,300	9,700[a]	9,800[a]	10,100[a]
Downstream of Princevalle Drain	*b*	*b*	18,800	*b*
Downstream of West Branch Llagas Creek	*b*	*b*	17,800	*b*
Upstream of East Little Llagas Creek	2,500	4,300	5,400	8,600
Upstream of Jones Creek	*b*	*b*	18,800	*b*
Upstream of Panther Creek	5,200	9,400[a]	9,400[a]	9,400[a]
LOS GATOS CREEK				
At Leigh Avenue	1,680	6,510	7,440	11,340
At Meridian Avenue	1,770	6,620	7,570	11,500
At Park Road	1,580	6,140	6,990	10,630
At State Highway 17	1,540[k]	6,370	7,300	11,200

Flooding Source and Location	Discharge (cubic feet/second)			
	10-year	50-Year	100-Year	500-Year
Below Lexington Dam	1,610	5,850	6,650	9,630
Below Vasona Dam	1,550	6,100	6,950	10,600
Upstream of confluence with Guadalupe River	2,130	7,000	7,980	11,900
LOWER PENITENCIA CREEK				
At Capitol Avenue	740	1,200	1,210	1,220
At confluence with Berryessa Creek	2,550	3,700	3,700	3,700
At Nimitz Freeway	1,750[a]	3,500[a]	3,500[a]	3,500[a]
At Redwood Avenue	850	1,150[j]	1,150[j]	1,150[j]
At South Main Street	7003	1,120[j]	1,120[j]	1,120[j]
Downstream of confluence with Berryessa Creek	2,550	2,600[a]	2,600[a]	2,600[a]
Downstream of confluence with East Penitencia Creek	800	1,670	2,150	2,840
Downstream of Trimble Road	320	1,060[h]	1,510[h]	1,620[h]
MADRONE CHANNEL				
At East Dunne Avenue	*b*	*b*	600	*b*
Upstream of East Little Llagas Creek	*b*	*b*	1,200	*b*
MATADERO CREEK				
Above confluence with Arastradero Creek	194	392	506	690
Approximately 270 feet upstream of U.S. Highway 101	*b*	*b*	2,800	*b*
At Alma Street	1,380	2,000[a]	2,000[a]	2,000[a]
At corporate limits	402	795	970	1,300
At El Camino Real	1,100	2,100	2,280	2,690
At Louis Road	1,380	1,500[b]	1,500[b]	1,500[b]
At Middlefield Road	1,380	1,900[b]	1,500[b]	1,900[b]
At Railroad	*b*	*b*	2,435	*b*
At U.S. Highway 101	1,660	1,775	1,775	1,775
Below confluence with Arastradero Creek	325	660	790	1,030
Downstream of Foothill Expressway	*b*	*b*	1,900	*b*
Downstream of Park Boulevard	*b*	*b*	2,700	*b*
Downstream of U.S. Highway 101	*b*	*b*	3,100	*b*
Upstream of Railroad	1,220	2,170	2,520	2,810
MILLER SLOUGH				
At U.S. Highway 101	*b*	*b*	760	*b*
MIDDLE ROAD OVERFLOW AREA				
At convergence with Llagas Creek	*b*	*b*	39	*b*
At divergence from West Little Llagas Creek	*b*	*b*	658	*b*
NORTH MOREY CREEK				
Upstream of Lions Creek	*b*	*b*	485	*b*
PAJARO RIVER				
At U.S. Highway 101	*b*	*b*	30,500	*b*
PERMANENTE CREEK				
At confluence with Hale Creek	780[l]	1,650[l]	1,780[l]	1,980[l]
At El Camino Real	1,150	1,310	1,310	1,310
At Railroad	1,270	1,470	1,600	1,600
Downstream of confluence with Hale Creek	1,000[a]	1,000[a]	1,000[a]	1,000[a]
Downstream of East Charleston Road	1,390[n]	1,400[a]	1,400[a]	1,400[a]
Downstream of Miramonte Avenue	370	760	890	1,030
Downstream of Permanente Road	760	1,260	1,480	1,960
Downstream of Portland Avenue	1,340	2,050	2,050	2,050

Flooding Source and Location	Discharge (cubic feet/second)			
	10-year	50-Year	100-Year	500-Year
Downstream of U.S. Highway 101	1,350	1,400[a]	1,400[a]	1,400[a]
Upstream of confluence with Hale Creek	440[l]	840[l]	980[l]	1,110[l]
Upstream of Interstate Highway 280	1,250	2,160	2,570	3,480
Upstream of Portland Avenue	1,340	2,220	2,700	3,440
Upstream of Tributary, 700 feet upstream of Highway 280	860	1,460	1,720	2,310
Upstream of U.S. Highway 101	1,350	2,250[f]	4,000[f]	7,100[f]
PERMANENTE DIVERSION				
At confluence with Stevens Creek	1,230	1,280	1,390	1,550
At Grant Road	1,200	1,240[a]	1,340[a]	1,490[a]
Downstream of Carmel Terrace	1,075[a]	1,075[a]	1,075[a]	1,075[a]
Downstream of Diversion Structure	1,190	1,610	1,610	1,610
PROSPECT CREEK				
Upstream of confluence with Calabazas Creek	*b*	*b*	635	*b*
PURISSIMA CREEK				
At corporate limits	147	320	402	588
At Interstate Highway 280	37	82	104	153
At Viscaino Road	88	182	227	320
SAN FRANCISQUITO CREEK				
At Alma Street	4,350	7,050	8,280	9,850[a]
At U.S. Geological Survey gage	4,050	6,700	7,860	10,500
Downstream of Chaucer Road	4,350	6,000[a]	6,000[a]	6,200[a]
Downstream of Middlefield Road	4,350	6,350[a]	6,690[a]	7,410[a]
Near Pasteur Drive	4,200	6,850	8,070	10,400
Upstream of Middlefield Road	4,350	7,100	8,330	9,850[a]
SAN FRANCISQUITO CREEK - OVERFLOW				
At Chaucer Street	*b*	*b*	563	*b*
At Middlefield Road	*b*	*b*	752	*b*
Combined Middlefield/Chaucer Overflows	*b*	*b*	1,080	*b*
SAN THOMAS AQUINO CREEK				
At Cabrillo Avenue	2,560[f]	2,920[f]	2,920[f]	2,920[f]
At confluence with Saratoga Creek	5,900	8,300	9,100	11,000
At El Camino Real	3,570	3,610	3,610	3,610
At Homestead Road	3,450[f]	3,450[f]	3,450[f]	3,450[f]
At Pruneridge Avenue	3,460	3,820[f]	3,820[f]	3,820[f]
At Saratoga and Los Gatos Roads	620	990	1,140	1,480
At Stevens Creek Boulevard	3,300	3,820[f]	3,820[f]	3,820[f]
At U.S. Highway 101	5,900	8,300	9,100	11,000
At U.S. Highway 237	5,900	8,300	9,100	11,000
Downstream of Railroad	5,900	8,300	9,100	11,000
Upstream of Westmont Avenue	2,000	2,900	3,200	4,077[o]
Near Bicknell and Quito Roads	670	1,050	1,230	1,580
Near Old Adobe and Quito Roads	730	1,150	1,350	1,720
SARATOGA CREEK				
At confluence with San Tomas Aquino Creek	2,700	3,750	4,100	4,800
At El Camino Road	2,700	3,750	4,100	4,800
At Herriman Avenue	1,550	3,020	3,750	4,630
At Homestead Road	2,700	3,750	4,100	4,800
At Kiely Boulevard	2,700	3,750	4,100	4,800

Flooding Source and Location	Discharge (cubic feet/second)			
	10-year	50-Year	100-Year	500-Year
At Stevens Creek Boulevard	2,500	3,500	3,900	4,600
At U.S. Geological Survey gage at Springer	1,350	2,750	3,490	4,450
At Railroad	1,760	3,230	3,950	4,800
Downstream of Benton Street	2,700	3,750	4,100	4,800
Downstream of Kiely Boulevard	2,700	3,750	4,100	4,800
Downstream of Warburton Avenue	2,700	3,750	4,100	4,800
SILVER CREEK				
At confluence with Coyote Creek	2,550	2,650	2,670	2,750
At intersection of King and McKee Roads	2,000[a]	2,000[a]	2,000[a]	2,000[a]
At Interstate Highway 680	2,210	2,400	2,400	2,400
At Ocala Avenue	1,530	2,000[p]	2,000[p]	2,000[p]
Downstream of confluence with Thompson Creek	2,080	3,200	3,600	4,300
Downstream of Cunningham Avenue	1,420[p]	2,150[p]	2,580[p]	2,600[p]
Downstream of confluence with Miguelita Creek	2,300	2,300	2,300	2,300
Downstream of confluence with North Babb Creek	1,500[a]	1,500[a]	1,500[a]	1,500[a]
Downstream of confluence with South Babb Creek	1,940	2,600	2,700	2,700
SMITH CREEK				
At Railroad	200	370	440	610
At Wedgewood Avenue	160	300	350	480
Below Smith Creek Drive	125	230	280	390
SOUTH BABB CREEK				
At Clayton Road	390	760	890	1,150
At confluence with Silver Creek	200[a]	200[a]	200[a]	200[a]
Downstream of White Road	390[a]	390[a]	390[a]	390[a]
Upstream of Clayton Road	*b*	*b*	890	*b*
Upstream of Lochner Drive	400	550[a]	550[a]	550[a]
Upstream of White Road	400	570[a]	570[a]	570[a]
SOUTH MOREY CREEK				
Upstream of Lions Creek	*b*	*b*	420	*b*
STEVENS CREEK				
At Crittenden Lane	2,350[g]	2,350[g]	2,350[g]	2,350[g]
At Homestead Road	1,110[m]	4,530	5,570	7,470
At Interstate Highway 280	1,110[m]	4,460	5,460	7,310
At Stevens Creek Boulevard	1,110[m]	4,430[m]	5,430	7,240
At U.S. Geological Survey gaging station No. 262	1,200	2,800	5,400	7,000
At U.S. Highway 101	3,030	5,550	5,750	5,950
Downstream of Interstate Highway 280	1,110	4,460	5,460	7,310
Downstream of Junipero Serra	1,550	3,200	5,580	7,650
Downstream of Stevens Creek Dam	1,140	4,440	5,280	6,940
Downstream of Railroad	2,750	5,350[g]	5,350[g]	5,350[g]
Upstream of Junipero Serra	1,500	3,150	5,500	7,500
Upstream of Permanente Diversion	1,750	3,600	6,000	8,200
Upstream of Railroad	2,750	6,110	7,360	9,610
SUNNYVALE EAST CHANNEL				
Downstream of Caribbean Drive	*b*	*b*	1,100	*b*
SUNNYVALE WEST CHANNEL				
Downstream of Highway 237	*b*	*b*	360	*b*

Flooding Source and Location	Discharge (cubic feet/second)			
	10-year	50-Year	100-Year	500-Year
TENNANT CREEK				
Approximately 1,250 feet upstream of Hill Avenue	*b*	*b*	420	*b*
Downstream of Maple Avenue	*b*	*b*	650	*b*
Upstream of confluence with East Little Llagas Creek	*b*	*b*	2,015	*b*
THOMPSON CREEK				
2,000 feet downstream of Aborn Road	1,440	2,550	3,000	3,700
At Aborn Road	1,440	2,350	2,700	3,250
At Quimby Road	1,480	1,900[a]	1,900[a]	1,900[a]
Downstream of Yerba Buena Creek	1,060	1,750	1,950	2,400
UPPER PENITENCIA CREEK				
At Capitol Avenue	1,350[a]	1,350[a]	1,350[a]	1,350[a]
At confluence with Coyote Creek	1,110	1,110	1,110	1,110
At Gridley Street	1,460	3,050	3,600	4,950
Upstream of North Jackson Avenue	1,350[a]	1,350[a]	1,350[a]	1,350[a]
At King Road	960[a]	960[a]	960[a]	960[b]
At Mabury Avenue	1,050[a]	1,050[a]	1,050[a]	1,050[a]
At Upper Penitencia Road	1,460	2,810[a]	2,950[a]	2,950[a]
At U.S. Geological survey gage at Dorel Road	1,400	2,940	3,600	5,170
UVAS CREEK				
At confluence with Bodfish Creek	*b*	*b*	10,910	*b*
At confluence with Little Arthur Creek	*b*	*b*	8,500	*b*
At downstream face of Watsonville Road Bridge	*b*	*b*	10,360	*b*
At Thomas Road	*b*	*b*	14,000	*b*
At Railroad	*b*	*b*	5,2003	*b*
At U.S. Highway 101	*b*	*b*	8,0003	*b*
At Uvas Road	*b*	*b*	7,800	*b*
Downstream of Hecker Pass Road	*b*	*b*	13,550	*b*
Downstream of Santa Teresa Boulevard	*b*	*b*	14,000	*b*
UVAS CREEK – EAST OVERBANK ABOVE HIGHWAY 101				
Approximately 1,200 feet above U.S. Highway 101	*q*	*b*	2,200	*b*
At U.S. Highway 101	*q*	*b*	1,100	*b*
UVAS CREEK – EAST OVERBANK ABOVE RAILROAD				
At downstream limit of flooding	*q*	*b*	3,200	*b*
At upstream limit of flooding	*q*	*b*	2,100	*b*
WATSON ROAD OVERFLOW AREA				
At convergence with Llagas Creek	*b*	*b*	447	*b*
At divergence from West Little Llagas Creek	*b*	*b*	97	*b*
WEST BRANCH LLAGAS CREEK				
Downstream of divergence from West Branch Llagas Creek – East Split	*b*	*b*	160	*b*
Upstream of divergence from West Branch Llagas Creek – East Split	*b*	*b*	1,400	*b*
WEST BRANCH LLAGAS CREEK – LOWER SPLIT				
At Day Road Interceptor (NRCS PL566)	*q*	*b*	1,200	*b*
WEST BRANCH LLAGAS CREEK – MIDDLE SPLIT				
Downstream of Highland Avenue	*q*	*q*	80	*q*
WEST BRANCH LLAGAS CREEK – UPPER SPLIT				
Upstream of Highland Avenue	*q*	*q*	200	*q*

Flooding Source and Location	Discharge (cubic feet/second)			
	10-year	50-Year	100-Year	500-Year
WEST LITTLE LLAGAS CREEK				
1,000 feet upstream of Wright Avenue	*a*	*a*	1882	*a*
At Fourth Street	*a*	*a*	9002	*a*
At U.S. Highway 101	*a*	*a*	1,080*b*	*a*
Downstream of Edmundson Avenue	*a*	*a*	1,269	*a*
Downstream of Monterey Highway	*a*	*a*	8132	*a*
Downstream of Railroad	*a*	*a*	4602	*a*
Upstream of Llagas Avenue	*a*	*a*	1,702*b*	*a*
Upstream of Monterey Highway	*a*	*a*	1,936	*a*
Upstream of Seymour Avenue	*a*	*a*	1,770*b*	*a*
WILDCAT CREEK				
Above Portos Drive	480	810	960	1,230
At Saratoga and Los Gatos Roads	310	500	570	740
Below Douglas Lane	430	710	840	1,070
MAYFIELD SLOUGH				
At Embarcadero Road	10.00	*a*	10.5	10.8
SAN FRANCISCO BAY				
At confluence of Guadalupe Slough and Coyote Creek	*b*	*b*	10.8	*b*
At crossing of Railroad and Alviso Slough	*b*	*b*	11.3	*b*
At Milpitas	*b*	*b*	11.4	*b*
At Mountain View	10.2	*b*	10.7	11.0
At Palo Alto	9.9	*b*	10.5	10.8
At Sunnyvale	3.7	*b*	10.7	*b*

a. Decrease in flow rate based on capacity restrictions
b. Data not available/computed
c. Discharge decrease due to Barron Creek Diversion
d. Flow rate accounts for upstream channel spills
e. Slow rate reflects upstream capacity restriction
f. Flow influenced by spill from adjoining watercourse
g. Flow reduction due to bridge or channel capacity restriction
h. Increase in flow rate due to spills from neighboring subbasins
i. Flow rate reduction due to attenuation in the floodplain
j. Reduction in flood rate due to storage behind railroad
k. Flow rate reduction due to attenuation in reservoirs
l. High flows affected by Permanente Diversion
m. Decrease in flow rate due to storage along channel
n. High flows diverted to Stevens Creek
o. Logarithm extrapolation
p. Flow rate reduction due to storage in Lake Cunningham
q. Flooding due to spill – drainage area not applicable

9.2.7 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 (NWS, 2011):

- 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.

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 Santa Clara County, based on available stream gage information. Current stream flows are gathered from the following USGS stream gauges in the county (USGS, 2017b).

- USGS 11153000 Pacheco Creek, Dunneville, CA.
- USGS 11153650 Llagas Creek, Gilroy, CA.
- USGS 11164500 San Francisquito Creek, Stanford University.
- USGS 11166000 Matadero Creek, Palo Alto, CA.
- USGS 11169025 Guadalupe River along Highway 101, San José, CA.
- USGS 11169500 Saratoga Creek, Saratoga, CA.
- USGS 11169800 Coyote Creek, Gilroy, CA.
- USGS 11172715 Coyote Creek along Highway 237 at Milpitas, CA.
- USGS 11173200 Arroyo Hondo, San José CA.

9.3 SECONDARY HAZARDS

The most problematic secondary hazard for flooding is bank erosion, which in some cases can be 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 the 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.

9.4 EXPOSURE

The Level 2 Hazus protocol was used to assess flood risk in the OA. The model used census data at the block level and FEMA floodplain data, which has a level of accuracy acceptable for planning purposes. Where possible, the Hazus default data was enhanced using local GIS data from local, state and federal sources.

9.4.1 Population

Population counts of those living in the floodplain within the OA 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 OA. This approach yielded an estimated population in the OA of 112,894 living within the 100-year floodplain (5.9 percent of the total OA population). Table 9-6 lists population estimates by jurisdiction living in the 10-percent, 1-percent and 0.2-percent annual chance flood hazard areas.

Table 9-6. Population Within the 10-Percent, 1-Percent and 0.2-Percent Annual Chance Flood Hazard Areas

Jurisdiction	10-Percent Annual Chance Flood Hazard Area		1-Percent Annual Chance Flood Hazard Area		0.2-Percent Annual Chance Flood Hazard Area	
	Population Exposed[a]	% of Total Population	Population Exposed[a]	% of Total Population	Population Exposed[a]	% of Total Population
Campbell	0	0.0%	34	0.1%	50	0.1%
Cupertino	292	0.5%	310	0.5%	33,871	58.2%
Gilroy	4	0.0%	447	0.8%	40,630	73.6%
Los Altos	69	0.2%	228	0.7%	29,417	93.8%
Los Altos Hills	68	0.8%	106	1.2%	7,960	91.9%
Los Gatos	29	0.1%	35	0.1%	28,230	90.0%
Milpitas	4,758	6.3%	17,998	23.8%	45,594	60.4%
Monte Sereno	6	0.2%	6	0.2%	31	0.9%
Morgan Hill	1,794	4.1%	2,021	4.6%	40,149	92.0%
Mountain View	49	0.1%	2,122	2.7%	5,602	7.2%
Palo Alto	9,499	13.9%	17,186	25.2%	68,135	99.9%
San José	7,674	0.7%	56,606	5.4%	98,858	9.5%
Santa Clara (city)	0	0.0%	6,897	5.6%	100,893	81.5%
Saratoga	57	0.2%	66	0.2%	29,931	99.0%
Sunnyvale	4,151	2.8%	6,312	4.3%	111,924	75.4%
Unincorporated County	1,257	1.4%	2,519	2.9%	2,811	3.2%
Total	**29,707**	**1.5%**	**112,894**	**5.9%**	**644,088**	**33.4%**

a. Represents percent of residential buildings exposed multiplied by estimated 2016 population.

9.4.2 Property

Structures in the Floodplain

Table 9-7, Table 9-8, and Table 9-9 summarize the total area of the 10-, 1-, and 0.2-percent-annual-chance flood hazard areas and the number of structures in each. The Hazus model determined that there are 8,033 structures within the 10-percent-annual-chance flood hazard area, 28,236 structures within the 1-percent-annual-chance flood hazard area, and 167,415 structures within the 0.2-percent-annual-chance flood hazard area. In the 1-percent-annual-chance flood hazard area, about 92 percent are residential, and 8 percent are commercial, industrial or agricultural.

Exposed Value

Table 9-10, Table 9-11 and Table 9-12 and summarize the estimated value of exposed buildings in the OA. This methodology estimated $16.8 billion worth of building-and-contents exposure to the 10-percent-annual-chance flood, representing 3.5 percent of the total replacement value of the OA, $40.1 billion worth of building-and-contents exposure to the 1-percent-annual-chance flood, representing 8.4 percent of the total replacement value of the OA, and $200.4 billion worth of building-and-contents exposure to the 0.2-percent-annual-chance flood, representing 42 percent of the total.

Table 9-7. Area and Structures in the 10-Percent Annual Chance Flood Hazard Area

Jurisdiction	Area in Floodplain (acres)	Number of Structures in the Flood Hazard Area							
		Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Campbell	1	0	0	0	0	0	0	0	**0**
Cupertino	148	80	2	0	0	0	0	0	**82**
Gilroy	887	1	23	67	2	0	0	0	**93**
Los Altos	34	23	0	0	0	0	0	0	**23**
Los Altos Hills	80	23	0	0	0	0	0	0	**23**
Los Gatos	152	9	0	0	0	0	0	0	**9**
Milpitas	317	1,096	28	0	0	1	0	0	**1,125**
Monte Sereno	3	2	0	0	0	0	0	0	**2**
Morgan Hill	498	466	102	5	3	3	1	0	**580**
Mountain View	677	11	25	27	0	0	0	0	**63**
Palo Alto	2,188	2,637	113	67	0	4	0	8	**2,829**
San José	12,160	1,668	111	29	0	9	0	3	**1,820**
Santa Clara (city)	103	0	2	0	0	0	0	0	**2**
Saratoga	68	20	1	0	0	0	0	0	**21**
Sunnyvale	3,131	851	53	114	1	1	0	0	**1,020**
Unincorporated County	6,170	271	17	3	41	5	4	0	**341**
Total	**26,616**	**7,158**	**477**	**312**	**47**	**23**	**5**	**11**	**8,033**

Table 9-8. Area and Structures in the 1-Percent Annual Chance Flood Hazard Area

Jurisdiction	Area in Floodplain (acres)	Number of Structures in Flood Hazard Area							
		Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Campbell	93	9	5	0	0	0	0	0	**14**
Cupertino	179	85	2	0	0	0	0	0	**87**
Gilroy	1,794	100	61	78	2	0	0	0	**241**
Los Altos	91	76	1	0	0	0	0	0	**77**
Los Altos Hills	104	36	0	0	0	0	0	0	**36**
Los Gatos	177	11	0	0	0	0	0	0	**11**
Milpitas	1,531	4,146	90	135	0	2	0	0	**4,373**
Monte Sereno	3	2	0	0	0	0	0	0	**2**
Morgan Hill	587	525	106	5	3	3	1	0	**643**
Mountain View	1,154	480	87	39	0	1	0	0	**607**
Palo Alto	3,112	4,771	137	69	0	8	0	9	**4,994**
San José	19,330	12,304	551	354	1	33	2	17	**13,262**
Santa Clara (city)	953	1,502	70	77	0	3	0	0	**1,652**
Saratoga	84	23	1	0	0	0	0	0	**24**
Sunnyvale	3,405	1,294	62	115	1	2	0	1	**1,475**
Unincorporated County	24,131	543	33	5	147	5	4	1	**738**
Total	**56,727**	**25,907**	**1,206**	**877**	**154**	**57**	**7**	**28**	**28,236**

Table 9-9. Area and Structures in the 0.2-Percent Annual Chance Flood Hazard Area

Jurisdiction	Area in Floodplain (acres)	Number of Structures in Flood Hazard Area							
		Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Campbell	104	13	5	0	0	0	0	0	**18**
Cupertino	4,993	9,275	366	10	0	19	4	3	**9,677**
Gilroy	6,214	9,096	518	147	7	24	7	8	**9,807**
Los Altos	3,845	9,803	503	1	0	19	1	5	**10,332**
Los Altos Hills	5,271	2,704	11	0	8	4	0	1	**2,728**
Los Gatos	5,485	8,794	542	10	2	19	3	30	**9,400**
Milpitas	5,225	10,503	433	287	0	13	4	1	**11,241**
Monte Sereno	19	11	0	0	0	0	0	0	**11**
Morgan Hill	7,053	10,427	376	182	49	13	7	4	**11,058**
Mountain View	2,092	1,267	126	43	0	3	0	0	**1,439**
Palo Alto	15,023	18,915	1026	158	5	52	6	22	**20,184**
San José	24,708	21,488	1141	618	3	38	10	20	**23,318**
Santa Clara (city)	7,836	21,972	670	299	1	33	2	26	**23,003**
Saratoga	7,540	10,492	196	0	8	17	1	3	**10,717**
Sunnyvale	9,637	22,945	530	152	2	26	4	7	**23,666**
Unincorporated County	26,221	606	38	5	156	5	4	2	**816**
Total	**131,266**	**158,311**	**6,481**	**1,912**	**241**	**285**	**53**	**132**	**167,415**

Table 9-10. Value of Structures in the 10-Percent Annual Chance Flood Hazard Area

Jurisdiction	Estimated Value within the Floodplain			% of Total Replacement Value
	Structure	Contents	**Total**	
Campbell	$0	$0	$0	0.0%
Cupertino	$27,647,546	$14,420,410	$42,067,956	0.3%
Gilroy	$566,223,042	$716,782,132	$1,283,005,174	9.6%
Los Altos	$9,351,180	$4,675,590	$14,026,770	0.2%
Los Altos Hills	$16,383,887	$8,191,944	$24,575,831	0.8%
Los Gatos	$3,704,359	$1,852,180	$5,556,539	0.1%
Milpitas	$281,341,173	$173,296,707	$454,637,880	2.4%
Monte Sereno	$846,663	$423,331	$1,269,994	0.1%
Morgan Hill	$328,112,270	$259,388,932	$587,501,203	5.3%
Mountain View	$516,073,912	$592,978,692	$1,109,052,604	4.4%
Palo Alto	$1,737,322,004	$1,460,635,068	$3,197,957,072	12.4%
San José	$2,162,328,492	$1,907,957,229	$4,070,285,722	1.9%
Santa Clara (city)	$33,273,884	$33,273,884	$66,547,769	0.2%
Saratoga	$10,479,575	$5,871,764	$16,351,339	0.2%
Sunnyvale	$2,603,248,582	$2,809,224,975	$5,412,473,557	12.6%
Unincorporated County	$317,538,668	$260,462,301	$578,000,969	2.3%
Total	**$8,613,875,238**	**$8,249,435,141**	**$16,863,310,378**	**3.5%**

Table 9-11. Value of Structures in the 1-Percent Annual Chance Flood Hazard Area

Jurisdiction	Estimated Value within the Floodplain			% of Total Replacement Value
	Structure	Contents	Total	
Campbell	$60,706,038	$53,432,344	$114,138,382	1.0%
Cupertino	$29,853,614	$15,523,445	$45,377,059	0.3%
Gilroy	$857,099,327	$978,830,296	$1,835,929,624	13.7%
Los Altos	$47,522,858	$32,368,309	$79,891,167	0.9%
Los Altos Hills	$23,030,568	$11,515,284	$34,545,851	1.1%
Los Gatos	$4,750,797	$2,375,399	$7,126,196	0.1%
Milpitas	$1,914,405,204	$1,412,176,099	$3,326,581,303	17.4%
Monte Sereno	$846,663	$423,331	$1,269,994	0.1%
Morgan Hill	$351,696,852	$272,045,135	$623,741,987	5.6%
Mountain View	$863,391,510	$891,948,249	$1,755,339,759	7.0%
Palo Alto	$2,634,825,080	$1,974,405,542	$4,609,230,622	17.9%
San José	$9,823,110,379	$8,298,299,926	$18,121,410,305	8.5%
Santa Clara (city)	$1,278,101,561	$1,148,481,943	$2,426,583,504	5.6%
Saratoga	$11,266,355	$6,265,154	$17,531,509	0.2%
Sunnyvale	$2,831,823,587	$2,960,259,832	$5,792,083,419	13.5%
Unincorporated County	$713,062,623	$608,794,293	$1,321,856,917	5.2%
Total	**$21,445,493,017**	**$18,667,144,581**	**$40,112,637,598**	**8.4%**

Table 9-12. Value of Structures in the 0.2-Percent Annual Chance Flood Hazard Area

Jurisdiction	Estimated Value within the Floodplain			% of Total Replacement Value
	Structure	Contents	Total	
Campbell	$61,554,595	$53,856,622	$115,411,217	1.0%
Cupertino	$6,121,581,843	$4,318,062,400	$10,439,644,243	75.2%
Gilroy	$5,817,785,372	$4,568,044,111	$10,385,829,483	77.5%
Los Altos	$5,131,184,367	$3,222,243,127	$8,353,427,494	94.7%
Los Altos Hills	$1,872,115,137	$1,055,557,499	$2,927,672,637	90.3%
Los Gatos	$5,821,620,292	$4,274,397,260	$10,096,017,551	92.7%
Milpitas	$8,419,488,654	$7,360,099,766	$15,779,588,420	82.4%
Monte Sereno	$4,075,984	$2,037,992	$6,113,976	0.7%
Morgan Hill	$6,037,072,687	$4,442,854,817	$10,479,927,505	93.9%
Mountain View	$1,729,570,951	$1,584,953,565	$3,314,524,516	13.2%
Palo Alto	$14,329,115,228	$11,343,355,359	$25,672,470,587	99.6%
San José	$23,401,556,637	$19,811,495,639	$43,213,052,276	20.3%
Santa Clara (city)	$14,681,795,650	$12,183,150,968	$26,864,946,619	61.9%
Saratoga	$5,016,383,748	$2,897,535,178	$7,913,918,926	97.2%
Sunnyvale	$13,736,062,646	$9,589,591,988	$23,325,654,634	54.4%
Unincorporated County	$790,512,159	$676,480,660	$1,466,992,819	5.8%
Total	**$112,971,475,949**	**$87,383,716,953**	**$200,355,192,902**	**42.0%**

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 9-13 and Table 9-14 show the existing land use for unincorporated Santa Clara County parcels in the 1- and 0.2-percent-annual-chance flood hazard areas, including vacant parcels and those in public/open space uses, broken down for the unincorporated portion of the OA. Only 0.54 percent of the parcels in the 1-percent-annual-chance flood hazard area are zoned for agricultural uses. These are favorable, lower-risk uses for the floodplain. The amount of the floodplain that contains vacant, developable land is not known.

Table 9-13. Unincorporated Santa Clara County Land Use in the 1-Percent Annual Chance Flood Hazard Area

Type of Land Use	Area (acres)	Percentage of Total
Agricultural	13,680.3	54.69
General / Institutional	1,090.3	4.36
Open Space	8,444.8	33.76
Low Density Residential	1,799.1	7.19
High Density Residential	0.0	0.00
Commercial	0.0	0.00
Industrial	0.0	0.00
Total	**25,014.5**	**100.00**

Table 9-14. Unincorporated Santa Clara County Land Use in the 0.2-Percent Annual Chance Flood Hazard Area

Type of Land Use	Area (acres)	Percentage of Total
Agricultural	14,018.5	52.73
General / Institutional	1,122.4	4.22
Open Space	9,608.5	36.14
Low Density Residential	1,836.9	6.91
High Density Residential	0.5	0.00
Commercial	0.0	0.00
Industrial	0.0	0.00
Total	**26,586.9**	**100.00**

9.4.3 Critical Facilities and Infrastructure

Table 9-15, Table 9-16, and Table 9-17 summarize the critical facilities and infrastructure in the 10-, 1-, and 0.2-percent-annual-chance flood hazard areas. Details are provided in the following sections.

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. Sixty-seven facilities within the 1-percent-annual-chance flood zone are TRI reporting facilities.

Table 9-15. Critical Facilities in the 10-Percent Annual Chance Flood Hazard Area

Jurisdiction	Number of Facilities in the Floodplain						
	Emergency Response / Public Health & Safety	Infra-structure Lifeline	Military Facilities	Recovery Facilities	Socio-economic Facilities	Hazardous Materials	**Total**
Campbell	0	0	0	0	0	0	**0**
Cupertino	0	5	0	0	1	0	**6**
Gilroy	1	5	0	0	0	4	**10**
Los Altos	0	6	0	0	0	0	**6**
Los Altos Hills	0	14	0	0	0	0	**14**
Los Gatos	0	8	0	0	0	0	**8**
Milpitas	1	3	0	0	5	0	**9**
Monte Sereno	0	0	0	0	0	0	**0**
Morgan Hill	0	6	0	0	7	0	**13**
Mountain View	0	7	0	0	0	2	**9**
Palo Alto	0	20	0	0	15	5	**40**
San José	2	70	0	0	6	1	**79**
Santa Clara (city)	0	17	0	0	0	0	**17**
Saratoga	0	9	0	0	0	0	**9**
Sunnyvale	1	3	0	0	1	7	**12**
Unincorporated County	1	42	0	0	1	0	**44**
Total	**6**	**215**	**0**	**0**	**36**	**19**	**276**

Table 9-16. Critical Facilities in the 1-Percent Annual Chance Flood Hazard Area

Jurisdiction	Number of Facilities in the Floodplain						
	Emergency Response / Public Health & Safety	Infra-structure Lifeline	Military Facilities	Recovery Facilities	Socio-economic Facilities	Hazardous Materials	Total
Campbell	0	6	0	0	0	0	**6**
Cupertino	0	15	0	0	1	0	**16**
Gilroy	2	15	0	0	0	4	**21**
Los Altos	0	15	0	0	2	0	**17**
Los Altos Hills	0	14	0	0	0	0	**14**
Los Gatos	0	10	0	0	0	0	**10**
Milpitas	2	17	0	0	11	11	**41**
Monte Sereno	0	0	0	0	0	0	**0**
Morgan Hill	1	6	0	0	7	0	**14**
Mountain View	2	34	0	0	0	3	**39**
Palo Alto	1	47	0	0	22	5	**75**
San José	9	265	0	0	44	25	**343**
Santa Clara (city)	1	50	0	0	4	13	**68**
Saratoga	0	13	0	0	0	0	**13**
Sunnyvale	1	20	0	0	5	8	**34**
Unincorporated County	1	102	0	0	3	0	**106**
Total	**20**	**629**	**0**	**0**	**99**	**69**	**817**

Table 9-17. Critical Facilities in the 0.2-Percent Annual Chance Flood Hazard Area

Jurisdiction	Number of Facilities in the Floodplain						
	Emergency Response / Public Health & Safety	Infra-structure Lifeline	Military Facilities	Recovery Facilities	Socio-economic Facilities	Hazardous Materials	Total
Campbell	0	6	0	0	1	0	7
Cupertino	6	30	0	0	34	3	73
Gilroy	15	36	0	1	40	5	97
Los Altos	6	28	0	0	36	0	70
Los Altos Hills	1	48	0	0	6	0	55
Los Gatos	14	39	0	0	22	1	76
Milpitas	9	65	0	0	33	42	149
Monte Sereno	0	0	0	0	0	0	0
Morgan Hill	9	12	0	0	37	7	65
Mountain View	3	41	0	0	6	5	55
Palo Alto	19	70	0	0	95	22	206
San José	16	312	0	0	66	52	446
Santa Clara (city)	13	63	0	0	85	43	204
Saratoga	7	33	0	0	30	0	70
Sunnyvale	11	39	0	0	73	16	139
Unincorporated County	1	106	0	0	3	0	110
Total	**130**	**928**	**0**	**1**	**567**	**196**	**1822**

Utilities and Infrastructure

It is important to determine who may be at risk if infrastructure is damaged by flooding. Roads or railroads that are blocked or damaged can isolate residents and can prevent access throughout the OA, including for emergency service providers needing to get to vulnerable populations or to make repairs. Bridges washed out or blocked by floods or debris also can cause isolation. Water and sewer systems can be flooded or backed up, causing health problems. Underground utilities can be damaged. Dikes can fail or be overtopped, inundating the land that they protect. The following sections describe specific types of critical infrastructure.

Roads

The following major roads in the OA pass through the 1-percent-annual-chance flood zone and thus are exposed to flooding:

- US 101
- Interstate 280
- Interstate 680
- Interstate 880
- State Route 9
- State Route 17
- State Route 82
- State Route 85
- State Route 87
- State Route 152
- State Route 237

Some of these roads are built above the flood level, and others function as levees to prevent flooding. Still, in severe flood events these roads can be blocked or damaged, preventing access to some areas.

Infrastructure Lifelines

Flooding events can significantly impact critical infrastructure lifelines such as highways, bridges, airports, water and wastewater facilities and communication facilities. An analysis showed that there are 629 infrastructure lifelines (241 are bridges) that are in or cross over the 1-percent-annual-chance flood zone and 928 infrastructure lifelines in the 0.2-percent-annual-chance flood zone.

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 causing localized urban flooding. Floodwaters can get into drinking water supplies, causing contamination. Sewer systems can be backed up, causing wastewater to spill into homes, neighborhoods, rivers and streams.

Levees

SCVWD constructed flood protection levees in the north, central, and southern portions of the county, some of which provide 1-percent-annual-chance flood protection. The levees along Uvas Creek, King Creek, Lyons Creek, and Coyote Creek participate in Corps' Levee Program. Levees along the Guadalupe River do not participate. SCVWD does not believe the majority of levees could withstand intensities of a 1-percent annual chance flood. Additionally, coastal flooding from San Francisco Bay circumvents levees near the Bay. Moreover, current flood levels do not account for potential sea level rise, which would exacerbate vulnerability and further reduce the ability of the levees to prevent or reduce flooding.

The presence and effects of levee systems in the Santa Clara County OA are not reflected on the DFIRM, meaning that areas, structures, and populations vulnerable to failures of those levees cannot be determined. 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.

9.4.4 Environment

Flooding is a natural event, and floodplains provide many natural and beneficial functions. Nonetheless, 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, and logjams from timber harvesting can increase stream bank erosion, causing rivers and streams to migrate into non-natural courses.

9.5 VULNERABILITY

Many of the areas exposed to flooding may not experience serious flooding or flood damage. This section describes vulnerabilities in terms of population, property, infrastructure, crops and environment.

9.5.1 Population

Vulnerable Populations

A geographic analysis of demographics using the Hazus model identified populations vulnerable to the flood hazard as follows:

- Economically Disadvantaged Populations—It is estimated that 9.99 percent of the people within the 100-year floodplain are economically disadvantaged, defined as having household incomes of $20,000 or less.

- Population over 65 Years Old—It is estimated that 11.3 percent of the population in the census blocks that intersect the 100-year floodplain are over 65 years old.
- Population under 16 Years Old—It is estimated that 24.0 percent of the population within census blocks located in or near the 100-year floodplain are under 16 years of age.

Additionally, it is estimated that on a normal work day 100,000 Santa Clara County residents commute out of the county and 200,000 non-residents commute in. These commuters are considered vulnerable to the flood hazard. Commuters whose workplaces or major transportation routes are in or near the 1-percent-annual-chance flood zone may be especially vulnerable.

Estimated Impacts on Persons and Households

Impacts on persons and households in the OA were estimated for the 10-, 1-, and 0.2-percent-annual-chance flood events through the Level 2 Hazus analysis. Table 9-18 summarizes the results.

Table 9-18. Estimated Flood Impact on Persons and Households

Jurisdiction	Number of Displaced Households			Number of Persons Requiring Short-Term Shelter		
	10% Annual Chance Flood	1% Annual Chance Flood	0.2% Annual Chance Flood	10% Annual Chance Flood	1% Annual Chance Flood	0.2% Annual Chance Flood
Campbell	0	3	4	0	2	2
Cupertino	41	34	26,940	37	28	26,552
Gilroy	0	96	37,365	0	80	36,429
Los Altos	5	21	27,996	1	11	27,548
Los Altos Hills	2	3	7,384	0	0	6,980
Los Gatos	3	3	25,104	2	2	24,167
Milpitas	1,466	7,895	38,643	1,407	7,563	38,147
Monte Sereno	0	0	1	0	0	0
Morgan Hill	547	572	37,516	490	510	36,590
Mountain View	7	315	1,554	2	251	1,390
Palo Alto	7,704	8,879	68,050	7,516	8,421	66,730
San José	2,081	1,925	44,795	1,913	1,796	42,637
Santa Clara (city)	0	2,127	93,108	0	1,966	91,881
Saratoga	3	3	29,602	1	1	28,997
Sunnyvale	2,809	2,982	11,430	2,693	2,845	11,325
Unincorporated County	231	503	563	130	315	361
Total	**14,899**	**25,361**	**450,055**	**14,192**	**23,791**	**439,736**

Public Health and Safety

Floods and their aftermath present numerous threats to public health and safety:

- Unsafe food—Floodwaters contain disease-causing bacteria, dirt, oil, human and animal waste, and farm and industrial chemicals. Their contact with food items, including food crops in agricultural lands, can make that food unsafe to eat. Refrigerated and frozen foods are affected during power outages caused by flooding. Foods in cardboard, plastic bags, jars, bottles, and paper packaging may be unhygienic with mold contamination.
- Contaminated drinking and washing water and poor sanitation—Flooding impairs clean water sources with pollutants. The pollutants also saturate into the groundwater. Flooded wastewater treatment plants

can be overloaded, resulting in backflows of raw sewage. Private wells can be contaminated by floodwaters. Private sewage disposal systems can become a cause of infection if they or overflow.

- Mosquitoes and animals—Floods provide new breeding grounds for mosquitoes in wet areas and stagnant pools. The public should dispose of dead animals that can carry viruses and diseases only 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—In the event of power outages following floods, some people use alternative fuels for heating or cooking in enclosed or partly enclosed spaces, such as small gasoline engines, stoves, generators, lanterns, gas ranges, 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 them. Electrical power systems can become hazardous. Gas leaks can trigger fire and explosion. Flood debris—such as broken bottles, wood, stones and walls—may cause injuries to those cleaning damaged buildings. Containers of hazardous chemicals may be buried under flood debris. Hazardous dust and mold can circulate through a building and be inhaled by those engaged in cleanup and restoration.
- Mental stress and fatigue—People who live through a devastating flood can experience long-term psychological impact. The expense and effort required to repair flood-damaged homes places severe financial and psychological burdens on the people affected. Post-flood recovery can cause, anxiety, anger, depression, lethargy, hyperactivity, and sleeplessness. There is also a long-term concern among the affected that their homes can be flooded again in the future.

Current loss estimation models such as Hazus 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.

9.5.2 Property

Structures and Contents

Hazus calculates losses to structures from flooding by looking at depth of flooding and type of structure. Using historical flood insurance claim data, Hazus estimates the percentage of damage to structures and their contents by applying established damage functions to an inventory. For this analysis, local data on facilities was used instead of the default inventory data provided with Hazus. The analysis is summarized in Table 9-19, Table 9-20 and Table 9-21 for the 10-, 1-, and 0.2-percent-annual-chance flood events, respectively.

Table 9-19. Loss Estimates for 10-Percent-Annual-Chance Flood

Jurisdiction	Structures Impacted[a]	Estimated Loss Associated with Flood			% of Total Replacement Value
		Structure	Contents	**Total**	
Campbell	0	$0	$0	$0	0.0%
Cupertino	3	$11,144	$7,429	$18,573	0.0%
Gilroy	3	$1,317,398	$3,768,744	$5,086,142	0.0%
Los Altos	2	$105,619	$53,714	$159,333	0.0%
Los Altos Hills	2	$68,121	$42,876	$110,998	0.0%
Los Gatos	0	$0	$0	$0	0.0%
Milpitas	986	$43,135,138	$37,117,050	$80,252,189	0.4%
Monte Sereno	1	$47,268	$29,165	$76,433	0.0%
Morgan Hill	189	$5,527,952	$11,327,545	$16,855,497	0.2%
Mountain View	25	$4,868,005	$8,260,107	$13,128,112	0.1%
Palo Alto	2,025	$199,314,582	$245,524,051	$444,838,633	1.7%
San José	966	$136,449,482	$236,308,663	$372,758,145	0.2%
Santa Clara (city)	1	$1,338,585	$2,185,626	$3,524,211	0.0%
Saratoga	1	$39,746	$14,453	$54,199	0.0%
Sunnyvale	408	$136,886,599	$305,316,148	$442,202,747	1.0%
Unincorporated County	91	$4,367,410	$6,513,733	$10,881,143	0.0%
Total	**4,703**	**$533,477,050**	**$856,469,306**	**$1,389,946,356**	**0.3%**

a. Impacted structures are those with finished floor elevations below the flood event water surface elevation. These structures are the most likely to receive significant damage in a flood event.

Note: Values shown are accurate for comparison of results in this plan. See Section 0 for discussion of data limitations.

Table 9-20. Loss Estimates for 1-Percent-Annual-Chance Flood

Jurisdiction	Structures Impacted[a]	Estimated Loss Associated with Flood			% of Total Replacement Value
		Structure	Contents	**Total**	
Campbell	3	$16,926,865	$29,428,799	$46,355,665	0.4%
Cupertino	24	$1,052,781	$588,706	$1,641,487	0.0%
Gilroy	30	$6,689,735	$15,161,388	$21,851,123	0.2%
Los Altos	41	$9,402,307	$10,673,460	$20,075,767	0.2%
Los Altos Hills	3	$121,654	$73,603	$195,257	0.0%
Los Gatos	0	$0	$0	$0	0.0%
Milpitas	1,803	$51,494,330	$46,269,246	$97,763,576	0.5%
Monte Sereno	1	$97,424	$55,018	$152,442	0.0%
Morgan Hill	207	$7,087,165	$13,899,757	$20,986,921	0.2%
Mountain View	244	$9,745,617	$14,874,352	$24,619,969	0.1%
Palo Alto	3,023	$224,950,926	$288,040,109	$512,991,035	2.0%
San José	7,258	$321,601,980	$525,105,450	$846,707,430	0.4%
Santa Clara (city)	844	$13,146,658	$17,557,461	$30,704,119	0.1%
Saratoga	3	$92,280	$57,599	$149,879	0.0%
Sunnyvale	794	$150,768,106	$320,868,331	$471,636,438	1.1%
Unincorporated County	346	$75,915,605	$100,008,535	$175,924,140	0.7%
Total	**14,624**	**$889,093,433**	**$1,382,661,816**	**$2,271,755,249**	**0.5%**

a. Impacted structures are those with finished floor elevations below the flood event water surface elevation. These structures are the most likely to receive significant damage in a flood event.

Note: Values shown are accurate for comparison of results in this plan. See Section 0 for discussion of data limitations.

Table 9-21. Loss Estimates for 0.2-Percent-Annual-Chance Flood

Jurisdiction	Structures Impacted[a]	Estimated Loss Associated with Flood			% of Total Replacement Value
		Structure	Contents	**Total**	
Campbell	8	$17,093,500	$29,500,064	$46,593,564	0.4%
Cupertino	5,398	$1,022,251,503	$952,596,401	$1,974,847,904	14.2%
Gilroy	5,498	$772,578,473	$965,570,283	$1,738,148,756	13.0%
Los Altos	4,047	$467,470,569	$405,893,093	$873,363,662	9.9%
Los Altos Hills	889	$365,547,411	$225,030,872	$590,578,283	18.2%
Los Gatos	5,626	$1,809,407,428	$1,694,708,840	$3,504,116,269	32.2%
Milpitas	5,881	$335,288,895	$426,087,597	$761,376,492	4.0%
Monte Sereno	5	$174,826	$102,546	$277,371	0.0%
Morgan Hill	6,339	$1,082,158,998	$955,615,585	$2,037,774,583	18.3%
Mountain View	751	$40,575,174	$47,979,623	$88,554,797	0.4%
Palo Alto	15,514	$2,297,621,503	$2,682,440,183	$4,980,061,686	19.3%
San José	12,992	$824,133,410	$1,140,183,083	$1,964,316,492	0.9%
Santa Clara (city)	11,358	$708,522,448	$740,423,216	$1,448,945,665	3.3%
Saratoga	3,235	$846,879,388	$555,760,836	$1,402,640,224	17.2%
Sunnyvale	8,468	$707,246,874	$869,214,144	$1,576,461,018	3.7%
Unincorporated County	607	$101,251,522	$127,422,897	$228,674,420	0.9%
Total	**86,616**	**$11,398,201,921**	**$11,818,529,265**	**$23,216,731,186**	**4.9%**

a. Impacted structures are those with finished floor elevations below the flood event water surface elevation. These structures are the most likely to receive significant damage in a flood event.

Note: Values shown are accurate for comparison of results in this plan. See Section 0 for discussion of data limitations.

Key results are as follows:

- There would be up to $1.39 billion of flood loss from a 10-percent-annual-chance flood event in the OA. This represents 3.5 percent of the total exposure to that level of flood and 0.3 percent of the total replacement value for the OA.
- There would be up to $2.27 billion of flood loss from a 1-percent-annual-chance flood event in the OA. This represents 8.4 percent of the total exposure to that level of flood and 0.5 percent of the total replacement value for the OA.
- There would be $23.22 billion of flood loss from a 0.2-percent-annual-chance flood event in the OA. This represents 42 percent of the total exposure to a that level of flood and 4.9 percent of the total replacement value.

Flood-Caused Debris

The Hazus analysis estimated the amount of flood-caused debris within the OA generated by flooding, as summarized in Table 9-22.

Estimate of Crop Losses

According to the USDA's Risk Management Agency, the amount of claims paid for crop damage as a result of flood in Santa Clara County over a 14-year period was $8,200,676. According to the 2016 California Insurance Profile from the USDA's Risk Management Agency, 54 percent of the insurable crops in California are insured with USDA Crop Insurance. To provide an adjusted estimate of losses accounting for insurable crops that are not insured, the 54 percent crop insurance coverage was factored in. According to this calculation, estimated annualized losses are almost $1 million (see Table 9-23). Considering the value of crops from the 2012 Census of Agriculture as baseline crop exposure, the estimated annual loss from flood was determined to be low compared to the value of the insurable crops.

Table 9-22. Estimated Flood-Caused Debris

Jurisdiction	10% Annual-Chance Flood		1% Annual-Chance Flood		0.2% 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]	Debris to Be Removed (tons)[a]	Estimated Number of Truckloads[b]
Campbell	0	0	2,958	118	3,051	122
Cupertino	201	8	1,258	50	186,456	7,458
Gilroy	246	10	1,317	53	46,923	1,877
Los Altos	118	5	998	40	82,064	3,283
Los Altos Hills	52	2	93	4	81,669	3,267
Los Gatos	130	5	1,934	77	553,516	22,141
Milpitas	4,977	199	9,638	386	17,375	695
Monte Sereno	11	0	14	1	100	4
Morgan Hill	1,072	43	1,480	59	143,514	5,741
Mountain View	129	5	1,867	75	3,190	128
Palo Alto	15,047	602	20,323	813	199,656	7,986
San José	23,022	921	79,315	3,173	96,082	3,843
Santa Clara (city)	216	9	10,367	415	63,338	2,534
Saratoga	420	17	678	27	217,199	8,688
Sunnyvale	1,223	49	3,386	135	42,176	1,687
Unincorporated County	1,113	45	8,721	349	13,384	535
Total	**47,979**	**1,919**	**144,344**	**5,774**	**1,749,694**	**69,988**

a. Debris generation estimates were based on updated general building stock dataset at a Census Block analysis level.
b. Hazus assumes 25 tons/trucks.
Note: Values shown are accurate for comparison of results in this plan. See Section 0 for discussion of data limitations.

Table 9-23. Estimated Insurable Annual Crop Loss Resulting From Flood

14-Year Flood Insurance Paid[a]	Adjusted 14-year Flood Losses (considering 54% insured)	Estimated Annualized Losses	2012 Value of Crops[b]
$8,200,676	$13,524,077	$966,005	$233,397,000

a. Crop insurance paid from USDA's Risk Management Agency for 2003-2016.
b. 2012 Census of Agriculture, Santa Clara County

Flood Insurance Statistics

Table 9-24 lists flood insurance statistics that help identify vulnerability in the OA. All 16 municipal planning partners participate in the NFIP, with 17,129 flood insurance policies providing $4.5 billion in insurance coverage. According to FEMA statistics, 784 flood insurance claims were paid between January 1, 1978 and October 31, 2016, for a total of $14.773 million, an average of $18,843 per claim.

Properties constructed after a FIRM has been adopted are eligible for reduced flood insurance rates. Such structures are less vulnerable to flooding since they were constructed after regulations and codes were adopted to decrease vulnerability. Properties built before a FIRM is adopted are more vulnerable to flooding because they do not meet code or are located in hazardous areas. The first FIRMs in the OA were available in 1975.

Table 9-24. Flood Insurance Statistics

Jurisdiction	Date of Entry Initial FIRM Effective Date	# of Flood Insurance Policies as of 10/31/2016	Insurance In Force	Total Annual Premium	Claims, 11/1978 to 10/31/2016	Value of Claims paid, 11/1978 to 10/31/2016
Campbell	06/30/1976	81	$22,646,000	$44,916	0	$0
Cupertino	04/18/1975	143	$43,735,900	$102,495	10	$812,171
Gilroy	06/04/1976	205	$75,006,900	$243,840	22	$302,117
Los Altos	09/24/1976	83	$25,087,400	$62,551	5	$31,535
Los Altos Hills	11/26/1976	191	$58,726,800	$132,576	5	$37,478
Los Gatos	02/27/1976	149	$44,538,700	$74,818	10	$51,957
Milpitas	03/28/1975	1,592	$403,981,100	$1,663,220	20	$75,336
Monte Sereno	05/18/2009	21	$6,972,000	$7,833	2	$41,974
Morgan Hill	06/18/1980	557	$159,125,300	$506,690	43	$482,726
Mountain View	09/19/1975	601	$174,867,300	$499,833	5	$10,920
Palo Alto	09/06/1989	3,609	$944,663,200	$4,125,112	369	$8,984,658
San José	04/09/1976	7,644	$1,913,467,400	$6,718,976	267	$3,537,348
Santa Clara (city)	02/11/1977	995	$291,146,100	$736,663	14	$309,753
Saratoga	11/28/1975	175	$56,346,900	$87,375	7	$26,681
Sunnyvale	12/05/1975	1,083	$280,813,500	$998,078	5	$68,655
Unincorporated County	06/20/1978	634	$157,454,000	$848,200	84	$1,506,977
Total		**17,129**	**$4,501,124,500**	**$16,004,976**	**784**	**$14,773,309**

The following information from flood insurance statistics is relevant to reducing flood risk:

- The use of flood insurance in the OA is above the national average. Sixty percent of insurable buildings in the OA are covered by flood insurance. According to an NFIP study, about 49 percent of single-family homes in special flood hazard areas are covered by flood insurance nationwide.
- The average claim paid in the OA represents less than 1 percent of the 2016 average replacement value of structures in the floodplain.
- The percentage of policies and claims outside a mapped floodplain suggests that not all of the flood risk in the OA is reflected in current mapping. Based on information from the NFIP, 94 percent of policies in the OA are on structures within an identified SFHA, and 6 percent are for structures outside such areas. Of total claims paid, 11 percent were for properties outside an identified 100-year floodplain.

Repetitive Loss and Severe Repetitive Loss

A repetitive loss property is defined by FEMA as an NFIP-insured property that has experienced any of the following since 1978, regardless of any changes in ownership:

- Four or more paid losses in excess of $1,000.
- Two paid losses in excess of $1,000 within any rolling 10-year period.
- Three or more paid losses that equal or exceed the current value of the insured property.

A severe repetitive loss property is further defined as follows:

- Four or more paid losses in excess of $5,000 each, with the cumulative amount of such claim payments exceeding $20,000.
- At least two separate claim payments made, with the cumulative amount of the building portion of such claims exceeding the market value of the building.

- At least two of the above referenced claims occurred within any rolling 10-year period and must be more than 10 days apart.

Repetitive loss properties make up only 1 to 2 percent of flood insurance policies in force nationally, yet they account for 40 percent of the nation's flood insurance claim payments. The government has instituted programs encouraging communities to identify and mitigate the causes of repetitive losses. A recent report on repetitive losses by the National Wildlife Federation found that 20 percent of these properties are outside any mapped 100-year floodplain. The key identifiers for repetitive loss properties are the existence of flood insurance policies and claims paid by the policies.

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 holding structures that FEMA has identified as meeting the definition of repetitive loss. Identifying repetitive loss areas helps to identify structures that are at risk but are not on FEMA's list of repetitive loss structures because no flood insurance policy was in force at the time of loss. Figure 9-3 shows the repetitive loss areas in the Santa Clara County OA. FEMA's list of repetitive loss properties identifies four such properties in the OA as of November 16, 2016. The breakdown of the properties by jurisdiction is presented in Table 9-25.

Table 9-25. Repetitive Loss Properties

Jurisdiction	Number of Repetitive Loss Properties	Number of Severe Repetitive Loss Properties
Morgan Hill	—	1
Palo Alto	1	—
San José	—	1
Unincorporated County	—	1
Total	**1**	**3**

Based on FEMA Region IX Report of Repetitive Losses, 11/16/2016

A review of the repetitive loss list indicated that none of the properties are outside the OA's special flood hazard area. The average claim paid for these four properties was $19,741, which is approximately 2 percent of the median home value for Santa Clara County ($982,500 according to Zillow.com as of 1/31/2017). This damage level would correlate to shallow flooding of less than 1 foot, which would appear appropriate for flood damage associated with stormwater or urban drainage issues. Although this suggests localized causes of repetitive flooding for the four properties, the fact that all four properties are in an identified special flood hazard area indicates that the flood risk is more than localized. With the potential for flood events annually, all of the mapped floodplain is considered to be susceptible to repetitive flooding.

9.5.3 Critical Facilities and Infrastructure

Hazus was used to estimate the flood loss potential to critical facilities exposed to the flood risk. Using depth/damage function curves to estimate the percent of damage to the building and contents of critical facilities, Hazus 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 helps to gauge how long the OA could have limited usage of facilities deemed critical to flood response and recovery.

Figure Placeholder

Figure 9-3. Repetitive Loss Areas in the Operational Area

The Hazus critical facility results are as follows (see Table 9-26 through Table 9-28):

- 100-year flood event—On average, critical facilities would receive 6.36 percent damage to the structure and 23.35 percent damage to the contents during a 100-year flood event. The estimated time to restore these facilities to 100 percent of their functionality is 501 days.
- 500-year flood event—A 500-year flood event would damage the structures an average of 13.58 percent and the contents an average 28.93 percent. The estimated time to restore these facilities to 100 percent of their functionality after a 500-year event is 571 days.

Table 9-26. Estimated Damage to Critical Facilities and Infrastructure from the 10% Annual Chance Flood

Type of Critical Facility	Number of Facilities Affected	Average % of Total Value Damaged		Days to 100% Functionality
		Building	Contents	
Emergency Response / Public Health & Safety	2	12.36	43.03	555
Infrastructure Lifeline	83	0.63	33.58	N/A
Military Facilities	0	N/A	N/A	N/A
Recovery Facilities	0	N/A	N/A	N/A
Socioeconomic Facilities	28	14.26	38.92	494
Hazardous Materials	15	12.04	25.37	N/A
Total/Average	**128**	**9.82**	**35.22**	**524**

N/A = Not Applicable

Table 9-27. Estimated Damage to Critical Facilities and Infrastructure from the 1% Annual Chance Flood

Type of Critical Facility	Number of Facilities Affected	Average % of Total Value Damaged		Days to 100% Functionality
		Building	Contents	
Emergency Response / Public Health & Safety	4	10.89	30.94	518
Infrastructure Lifeline	248	0.65	27.77	N/A
Military Facilities	0	N/A	N/A	N/A
Recovery Facilities	0	N/A	N/A	N/A
Socioeconomic Facilities	78	8.61	25.46	484
Hazardous Materials	57	5.27	9.24	N/A
Total/Average	**387**	**6.36**	**23.35**	**501**

N/A = Not Applicable

Table 9-28. Estimated Damage to Critical Facilities and Infrastructure from the 0.2% Annual Chance Flood

Type of Critical Facility	Number of Facilities Affected	Average % of Total Value Damaged		Days to 100% Functionality
		Building	Contents	
Emergency Response / Public Health & Safety	52	22.55	42.40	574
Infrastructure Lifeline	359	1.14	21.81	N/A
Military Facilities	0	N/A	N/A	N/A
Recovery Facilities	1	15.52	24.33	N/A
Socioeconomic Facilities	342	19.37	39.98	568
Hazardous Materials	129	9.33	16.11	N/A
Total/Average	**883**	**13.58**	**28.93**	**571**

N/A = Not Applicable

9.5.4 Environment

The environment vulnerable to flood hazard is the same as the environment exposed to the hazard. Loss estimation platforms such as Hazus 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 was not available at the time of this plan. Capturing this data from future events could be beneficial in measuring the 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

9.5.5 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.

9.6 FUTURE TRENDS IN DEVELOPMENT

Santa Clara County has been one of the state’s fastest growing counties over the past 10 years, averaging a 1.21-percent increase in population per year from 2005 through 2015. The Silicon Valley job market continues to grow, and many young tech workers choose to live in an urban environment rather than commute from the suburbs.

The planning partners 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 linking their general plans to this hazard mitigation plan. 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 over 60 percent of communities in the OA 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 maintaining their good standing under the NFIP through actions identified in this plan. Communities participating or considering participation in the CRS program will be able to refine this commitment using CRS programs and templates as a guide.

Any areas of growth could be impacted by the flood hazard if located within the identified hazard areas. The SCVWD intends to discourage development within vulnerable areas and/or to encourage higher regulatory standards on the local level.

9.7 SCENARIO

Historically, floods have regularly affected the Santa Clara County OA. The OA can expect noteworthy flooding about once a year, with a flash flood every 2 to 3 years. Duration and intensity of heavy winter rains and atmospheric river events that cause flooding may increase due to climate change. The floodplains mapped and identified for the Santa Clara County OA will continue to take the brunt of these floods. OA residents prepare themselves for flooding by seeking and receiving information, and by pursuing mitigation. Impacts of flood events should decrease as the OA continues to promote and implement hazard mitigation and preparedness.

The worst-case scenario would be a series of heavy rains or storm events during an atmospheric river event, 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 OA, as the OA 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, Santa Clara County would not be able to make repairs quickly enough to restore critical facilities and assets.

9.8 ISSUES

The Core Planning Group has identified the following flood-related issues relevant to the OA:

- The extent of the flood-protection currently provided by flood control facilities (dams, dikes and levees) is not known due to the lack of an established national policy on flood protection standards.
- The levee system within the OA is not consistently adequate to mitigate effects of a 1-percent annual chance flood.
- The risk associated with the flood hazard overlaps the risk associated with other hazards such as earthquake, landslide, mud slides and fishing losses. This provides an opportunity to seek mitigation alternatives with multiple objectives that can reduce risk for multiple hazards.
- There is no consistency of land-use practices and floodplain management scope within the OA.
- How climate change will affect flood conditions in the OA is uncertain.
- More information is needed on flood risk to support the concept of risk-based analysis of capital projects.
- There needs to be a sustained effort to gather historical damage data, such as high water marks on structures and damage reports, to measure the cost-effectiveness of future mitigation projects.
- Ongoing flood hazard mitigation will require funding from multiple sources.
- There needs to be a coordinated hazard mitigation effort between jurisdictions affected by flood hazards in the OA.
- Floodplain residents need to continue to be educated about flood preparedness and the resources available during and after floods.
- The concept of residual risk should be considered in the design of future capital flood control projects and should be communicated with residents living in the floodplain.

- The promotion of flood insurance as a means of protecting private property owners from the economic impacts of frequent flood events should continue.
- Existing floodplain-compatible uses such as agricultural and open space need to be maintained. There is constant pressure to convert these existing uses to more intense uses within the OA 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.

10. LANDSLIDE/MASS MOVEMENT

DEFINITIONS

Landslide—The movement of masses of loosened rock and soil down a hillside or slope. Slope failures occur when the strength of the soils forming the slope is exceeded by the pressure, such as weight or saturation, acting upon them.

Mass Movement—A collective term for landslides, debris flows, and sinkholes.

Mudslide (or Debris Flow)—A river of rock, earth, organic matter and other materials saturated with water. Mudslides 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 or "slurry."

10.1 GENERAL BACKGROUND

The U.S. Geological Survey defines landslides to include 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.

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, posing 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.

The USGS defines land subsidence as the loss of surface elevation due to the removal of subsurface support. In California, the two principal causes for land subsidence are aquifer compaction due to excessive groundwater pumping and decomposition of wetland soils exposed to air after wetland conversion to farmland.

10.1.1 Landslide Types

Landslides are commonly categorized by the type of initial ground failure. Common types of slides are shown on Figure 10-1 through Figure 10-4 (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.

Mudslides (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.

A debris avalanche (Figure 10-5) 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. The slurry 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 due to the mass of material included in them. They can be among the most destructive events in nature.

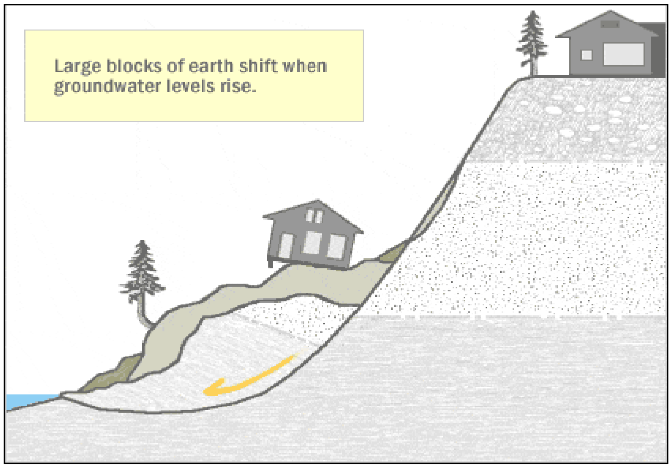


Figure 10-1. Deep Seated Slide

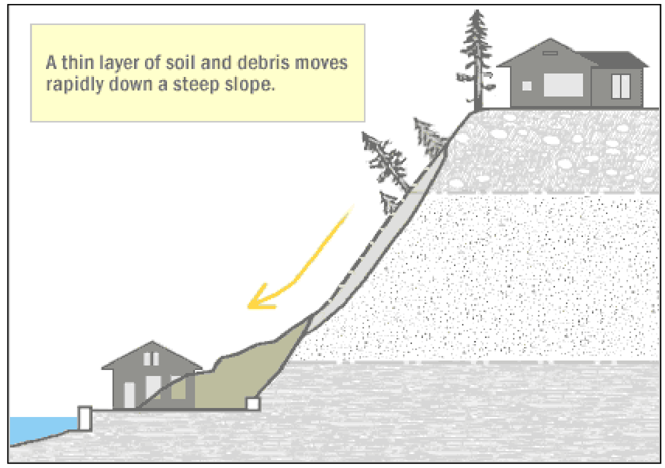


Figure 10-2. Shallow Colluvial Slide

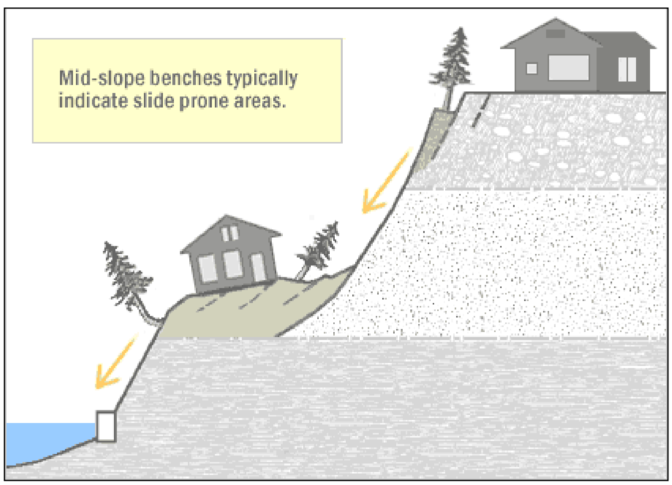


Figure 10-3. Bench Slide

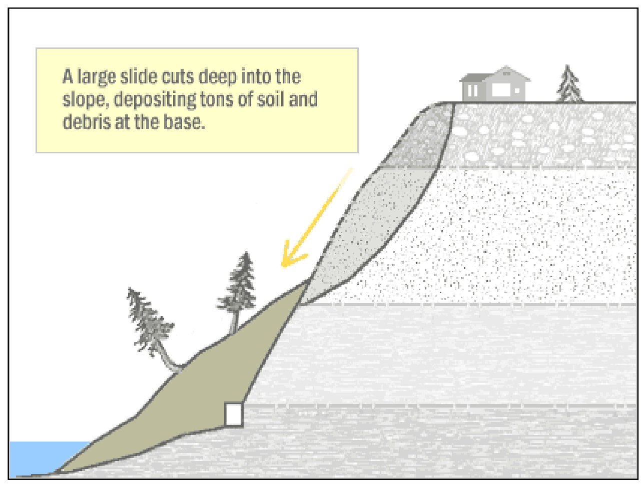


Figure 10-4. Large Slide

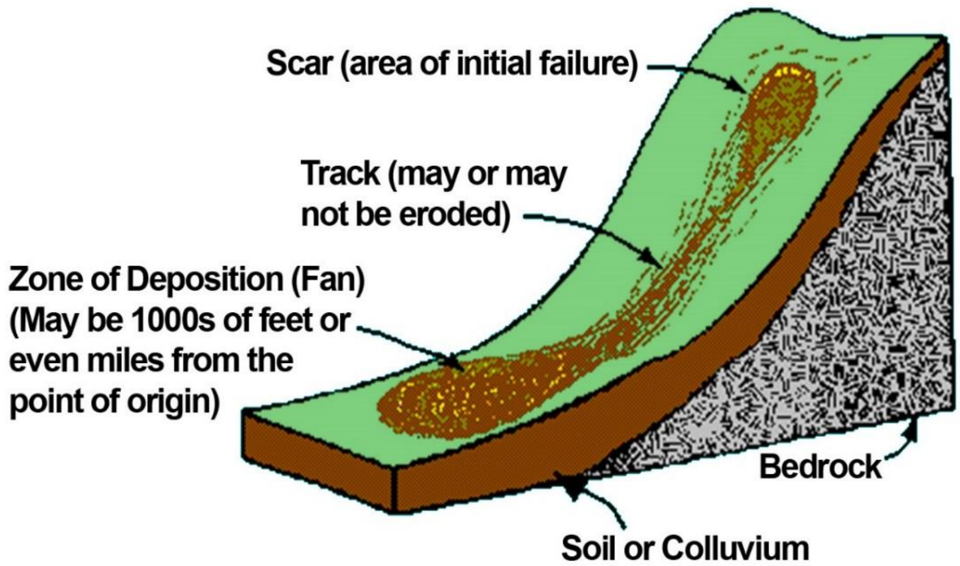


Figure 10-5. Typical Debris Avalanche Scar and Track

Landslides also include the following:

- 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 Slumps—blocks of fine-grained sediment that rotate and move down slope.
- Transitional Slides—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 only noticed through crooked trees and disturbed structures.
- Block Slides—blocks of rock that slide along a slip plane as a unit down a slope.

10.1.2 Landslide Modeling

Two characteristics are essential to conducting an accurate risk assessment of the landslide hazard:

- The type of initial ground failure that occurs, as described above.
- The post-failure movement of the loosened material ("run-out"), including travel distance and velocity.

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. Due to 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 there is additional material incorporated during the event (Savage and Hutter 1991; Rickenmann & Weber, 2000; Iverson, 2004).

10.1.3 Landslide Causes

Mass movements are caused by a combination of geological and climate conditions, as well as encroaching urbanization. Vulnerable natural conditions are affected by 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 slopes that are steeper than the pre-existing natural slopes. 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. 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.

10.1.4 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 Santa Clara County Code and City ordinances.
- Preparation for emergency response to landslides to facilitate rapid, coordinated action among Santa Clara 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.

10.1.5 Land Subsidence Effects

Subsidence is one of the most diverse forms of ground failure, ranging from small or local collapses to broad regional lowering of the earth’s surface. The causes of subsidence, mostly associated with human activities, are as diverse as the forms of failure, and include dewatering (oxidation) of peat or organic soils, dissolution in limestone aquifers, first-time wetting of moisture-deficient low-density soils, natural compaction, liquefaction, crustal deformation, subterranean mining, and withdrawal of fluids (groundwater, petroleum, geothermal).

The compaction of susceptible aquifer systems caused by excessive groundwater pumping is the single largest cause of subsidence in California, and the 5,200 square miles affected by subsidence in the San Joaquin Valley since the latter half of the 20th century has been identified as the single largest human alteration of the Earth’s surface topography. The second largest cause of subsidence in California is the oxidation (decomposition) of organic soils (USGS, 2017c).

Aquifer Compaction

Aquifer compaction due to groundwater pumping affects both manmade infrastructures and natural systems. The greatest effects are on infrastructure that traverses a subsiding area. In the San Joaquin Valley, the main problems reported are related to water conveyance structures. Many water conveyance structures, including long stretches of the California Aqueduct, are gravity driven through the use of very small gradients; even minor changes in these gradients can cause reductions in designed flow capacity. Managers of the canals, such as the California Department of Water Resources, the San Luis Delta-Mendota Authority, the Bureau of Reclamation, and the Central California Irrigation District, have to repeatedly retrofit their canals to keep the water flowing, even at reduced amounts. Subsidence also affects roads, railways, bridges, pipelines, buildings, and wells.

Compaction of an aquifer system may permanently decrease the aquifer’s capacity to store water. Even when water levels rise, sediments can remain compacted; most compaction that occurs as a result of historically low groundwater levels is irreversible.

Additionally, as the topography of the land changes by varying amounts in different places, low areas, such as wetlands, change size and shape, migrate to lower elevations, or even disappear. Rivers may change course or erosion/deposition patterns to reach a new equilibrium.

Decomposition of Wetland Soils

The Sacramento-San Joaquin Delta of California was once a great tidal freshwater marsh. It is blanketed by peat and peaty alluvium deposited where streams that originate in the Sierra Nevada, Coast Ranges, and South Cascade Range enter San Francisco Bay. In the late 1800s, levees were built along the stream channels, and the land thus protected from flooding was drained, cleared, and planted. The leveed tracts and islands help to protect water-export facilities in the southern Delta from saltwater intrusion by displacing water and maintaining favorable freshwater gradients. However, The decomposition of organic carbon in the peat soils causes land subsidence in the Delta and increases stresses on the levees. Ongoing subsidence behind the levees, where the land has been drained, exposed to the atmosphere, and planted, increases stresses on the levee system, making it less stable. This threatens to damage agricultural and developed lands and degrade water quality in the massive water-transfer system.

10.2 HAZARD PROFILE

10.2.1 Past Events

Losses from landslides are typically lower than those from flooding. However, in the El Niño storms of early 1998, the USGS documented $150 million in losses due to approximately 300 landslides in the Bay Area and Santa Clara County. The slides ranged from a 25-cubic-meter failure of engineered material to reactivation of the 13 million-cubic-meter Mission Peak earth flow complex in Alameda County.

Landslides have occurred in conjunction with earthquakes and heavy rains events in Santa Clara County. Table 10-1 lists known landslide events that affected Santa Clara County between 1980 and 2016. Two other landslides outside of Santa Clara County are also recorded in USGS 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 10-1. Landslide Events in Santa Clara County

Dates of Event	Event Type	FEMA Declaration	Location	Losses/Impacts
12/19/1981 to 1/08/1982	Severe storms, flood, mudslides, high tide	651	San Francisco Bay area	Prolonged heavy rains and saturated soils caused numerous slope failures and mud flows on steep and unstable slopes throughout the San Francisco Bay area.
1/21/1983 to 3/30/1983	Coastal storms, floods, slides, tornadoes	677	San Francisco Bay area	A landslide restricted Clayton Road to one lane just east of the community of Alum Rock. Another, on the east side of Milpitas, resulted in vertical and horizontal offset of a roadway.
4/24/1984	Morgan Hill Earthquake		Calaveras fault east of San José.	This 6.2 magnitude earthquake caused minor landslides throughout the region.
10/17/1989	Loma Prieta Earthquake	845	San Andreas fault near Loma Prieta.	Landslides and rockslides in Santa Clara County on steep slopes in the Santa Cruz Mountains blocked roads, damaged structures, and caused at least two deaths.
1/03/1995 to 2/10/1995	Severe winter storms, flooding, landslides, mud flows	1044	San Francisco Bay area	Minor landslide damage in Santa Clara County was attributed to heavy rains and saturated soils.
2/13/1995 to 4/19/1995	Severe winter storms, flooding, landslides, mud flows	1046	San Francisco Bay area	Minor landslide damage in Santa Clara County was attributed to heavy rains and saturated soils.
2/02/1998 to 4/30/1998	Severe Winter Storms and El Nino Rainstorm	1203	San Francisco Bay region	$7.6 million in Santa Clara County landslide damage occurred mostly in the northern county, along the range front of the Santa Clara Valley. $6.1 million in damage was attributed to reactivation of three local landslides. The rest was attributed to small debris flows along road cuts or narrow canyon walls. In Alum Rock, the Penitencia Creek landslide caused extensive damage to water and sewer lines and closed roads. Another landslide closed Clayton Road east of Alum Rock area. The third, near Old Piedmont Road on the east side of Milpitas, had a displacement near the toe of about 20 cm.

Sources: ABAG, 2010; USGS 1984, 1987, 1989 and 1998; NOAA, 2017

According to the Santa Clara Valley Water District (SCVWD), Santa Clara County has experienced as much as 13 feet of subsidence caused by excessive pumping of groundwater in the early 1900s. The SCVWD was created in the early 1930s to protect groundwater resources and minimize land subsidence. To reduce the demand on groundwater and minimize subsidence, the SCVWD uses a combination of imported surface water (from the State Water Project and San Francisco's Hetch-Hetchy system) and groundwater. Figure 10-6 shows the history of land surface elevation, groundwater elevation, and the population of Santa Clara County from 1900 up to 2020. The SCVWD started importing water in the 1960s when the groundwater elevation reached its lowest elevation.

Source: SCVWD, 2016b

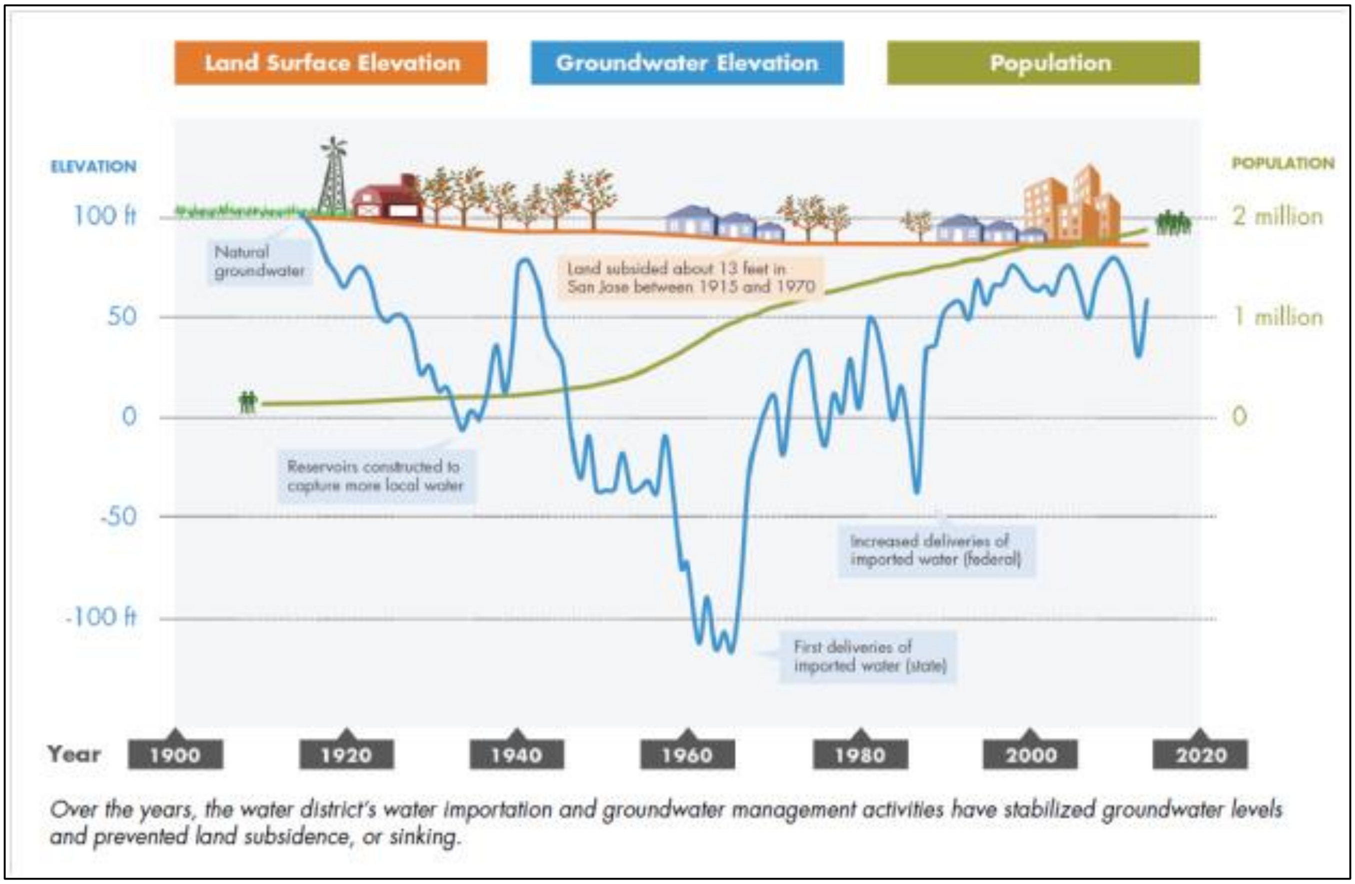


Figure 10-6. SCVWD Timeline of Water Importation and Groundwater Management

10.2.2 Location

In general, landslide hazard areas are where the land has characteristics that contribute to the risk of the downhill movement of material, such as the following:

- A slope greater than 33 percent.
- A history of landslide activity or movement during the last 10,000 years.
- Stream or wave activity, which has caused erosion, undercut a bank or cut into a bank to cause the surrounding land to be unstable.
- The presence of an alluvial fan, indicating vulnerability to the flow of debris or sediments.
- The presence of impermeable soils, such as silt or clay, which are mixed with granular soils such as sand and gravel.

The best available predictor of where movement of slides and earth flows might occur is the location of past movements. Past landslides can be recognized by their distinctive topographic shapes, which can remain in place for thousands of years. Most landslides recognizable in this fashion range from a few acres to several square miles. Most show no evidence of recent movement and are not currently active. A small proportion of them may become active in any given year, with movements concentrated within all or part of the landslide masses or around their edges.

The recognition of ancient dormant mass movement sites is important in the identification of areas susceptible to flows and slides because they can be reactivated by earthquakes or by exceptionally wet weather. Also, because they consist of broken materials and frequently involve disruption of groundwater flow, these dormant sites are vulnerable to construction-triggered sliding.

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 provides access to many of these maps through its California Landslide Inventory, it does not offer them at the County level for Santa Clara County (California Geological Survey, 2016).

The Association of Bay Area Governments 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 Santa Clara overlaid these data on its jurisdictional boundaries to develop Figure 10-7. As shown, the OA includes both high- and low-risk landslide areas.

10.2.3 Frequency

Landslides are often triggered by other natural hazards such as earthquakes, heavy rain, floods or wildfires, so landslide frequency is often related to the frequency of these other hazards. In the OA, landslides typically occur where landslides and earth flows have occurred in the past. These previous locations may not show any evidence of recent movement and may not be currently active, but some portion of them may become active in any given year from natural hazard events. As shown in Table 10-1, damage from the El Niño rainstorm event in 1998 was mainly attributed to reactivation of landslide locations and because of sequential severe storms that saturated steep, vulnerable soils. Landslide events occurred during the severe storms of 1983, 1995, and 1998. Until better data is generated specifically for landslide hazards, this severe storm frequency is appropriate for the purpose of ranking risk associated with the landslide hazard.

10.2.4 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 to society of about $1.5 billion. 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 Placeholder

Figure 10-7. Landslide Hazard Areas in the Operational Area

10.2.5 Warning Time

The speed of mass movements may range from inches per year to many feet per second, depending on slope, material and water content. Some monitoring methods can provide an idea of the type of movement and the amount of time prior to failure. It is also possible to determine what areas are at risk during general time periods. Assessing geology, vegetation and predicted precipitation can help in predictions. However, there is no practical warning system for individual landslides. The current standard operating procedure is to monitor situations case-by-case and respond after the event has occurred. 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 and/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 jambs and 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.

10.3 SECONDARY HAZARDS

Landslides can cause secondary effects such as blocking access to roads, which can isolate residents and businesses and delay transportation. This could result in economic losses for businesses. Other potential problems resulting from landslides are power and communication failures. Vegetation or poles on slopes can be knocked over, resulting in possible losses to power and communication lines. Landslides also have the potential of destabilizing 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.

10.4 EXPOSURE

10.4.1 Population

Population could not be examined by landslide hazard area because the boundaries of census block groups do not coincide with the hazard area boundaries. However, population was estimated using the residential building count in each mapped hazard area and multiplying by the 2016 estimated average population per household. Using this approach, the estimated population living in the “moderate landslides” risk area is 46,397, “high landslide” risk area is 113,137 and “very high landslide” risk area is 5,399.

10.4.2 Property

There are 28,196 structures on parcels in the high landslide risk areas, with an estimated value of $27 billion. Table 10-2, Table 10-3, and Table 10-4 show the number and replacement value of structures exposed to the landslide risk. Over 96 percent of the exposed structures are dwellings. Table 10-5 shows the general land use of parcels exposed to moderate, high and very high landslide hazard in unincorporated portions of the OA. Lands zoned for agricultural uses are most vulnerable.

Table 10-2. Exposure and Value of Structures in Moderate Landslide Risk Areas

Jurisdiction	Estimated Value within the Landslide Risk Area			% of Total Replacement Value
	Structure	Contents	Total	
Campbell	$3,121,464	$1,560,732	$4,682,197	0.04%
Cupertino	$190,106,812	$95,053,406	$285,160,218	2.05%
Gilroy	$101,070,569	$52,408,387	$153,478,956	1.15%
Los Altos	$264,701,185	$179,480,420	$444,181,605	5.03%
Los Altos Hills	$803,549,564	$472,373,076	$1,275,922,640	39.35%
Los Gatos	$933,001,058	$673,980,710	$1,606,981,768	14.75%
Milpitas	$24,758,577	$13,689,330	$38,447,907	0.20%
Monte Sereno	$234,411,610	$117,205,805	$351,617,415	40.28%
Morgan Hill	$191,890,675	$99,229,710	$291,120,385	2.61%
Mountain View	$0	$0	$0	0.00%
Palo Alto	$751,245,482	$956,455,304	$1,707,700,785	6.62%
San José	$2,036,605,070	$1,142,138,929	$3,178,743,999	1.49%
Santa Clara (city)	$0	$0	$0	0.00%
Saratoga	$547,819,024	$323,476,706	$871,295,730	10.70%
Sunnyvale	$0	$0	$0	0.00%
Unincorporated County	$1,157,206,472	$784,286,519	$1,941,492,991	7.66%
Total	**$7,239,487,564**	**$4,911,339,034**	**$12,150,826,598**	**2.55%**

Table 10-3. Exposure and Value of Structures in High Landslide Risk Areas

Jurisdiction	Estimated Value within the Landslide Risk Area			% of Total Replacement Value
	Structure	Contents	Total	
Campbell	$217,596,648	$200,013,738	$417,610,386	3.73%
Cupertino	$574,790,476	$314,896,921	$889,687,397	6.40%
Gilroy	$377,351,372	$206,965,219	$584,316,591	4.36%
Los Altos	$205,378,603	$133,164,941	$338,543,544	3.84%
Los Altos Hills	$645,159,815	$379,839,286	$1,024,999,101	31.61%
Los Gatos	$1,521,396,089	$1,020,105,580	$2,541,501,669	23.33%
Milpitas	$249,861,269	$127,101,096	$376,962,365	1.97%
Monte Sereno	$92,128,893	$46,064,447	$138,193,340	15.83%
Morgan Hill	$553,617,617	$284,963,481	$838,581,098	7.51%
Mountain View	$32,403,360	$16,201,680	$48,605,041	0.19%
Palo Alto	$329,836,716	$348,824,560	$678,661,276	2.63%
San José	$5,821,965,628	$3,605,488,466	$9,427,454,094	4.42%
Santa Clara (city)	$61,122,866	$34,772,456	$95,895,321	0.22%
Saratoga	$1,310,161,174	$838,992,857	$2,149,154,031	26.39%
Sunnyvale	$114,604,443	$91,046,922	$205,651,365	0.48%
Unincorporated County	$4,489,169,151	$3,457,377,079	$7,946,546,230	31.34%
Total	**$16,596,544,120**	**$11,105,818,729**	**$27,702,362,849**	**5.81%**

Table 10-4. Exposure and Value of Structures in Very High Landslide Risk Areas

Jurisdiction	Estimated Value within the Landslide Risk Area			% of Total Replacement Value
	Structure	Contents	Total	
Campbell	$3,818,063	$4,993,432	$8,811,495	0.08%
Cupertino	$27,999,100	$13,999,550	$41,998,650	0.30%
Gilroy	$4,905,422	$2,452,711	$7,358,133	0.05%
Los Altos	$0	$0	$0	0.00%
Los Altos Hills	$8,007,971	$4,003,986	$12,011,957	0.37%
Los Gatos	$71,791,878	$50,946,143	$122,738,022	1.13%
Milpitas	$10,633,625	$7,189,915	$17,823,539	0.09%
Monte Sereno	$1,755,292	$877,646	$2,632,937	0.30%
Morgan Hill	$41,830,817	$20,915,409	$62,746,226	0.56%
Mountain View	$0	$0	$0	0.00%
Palo Alto	$0	$0	$0	0.00%
San José	$78,112,632	$48,583,546	$126,696,178	0.06%
Santa Clara (city)	$0	$0	$0	0.00%
Saratoga	$76,852,694	$46,507,153	$123,359,847	1.51%
Sunnyvale	$0	$0	$0	0.00%
Unincorporated County	$935,016,390	$819,337,451	$1,754,353,841	6.92%
Total	**$1,260,723,884**	**$1,019,806,941**	**$2,280,530,826**	**0.48%**

Table 10-5. Land Use in Landslide Hazard Areas

Type of Land Use	Moderate		High		Very High	
	Area (acres)	% of total	Area (acres)	% of total	Area (acres)	% of total
Agricultural	2,575.4	1.46	1,025.6	0.38	150.2	0.36
General / Institutional	519.6	0.30	200.9	0.07	29.5	0.07
Open Space	169,535.7	96.28	268,021.3	98.91	41,357.9	98.16
Low Density Residential	3,275.8	1.86	1,573.2	0.58	435.0	1.03
High Density Residential	14.3	0.01	2.9	0.00	0.0	0.00
Commercial	161.8	0.09	161.8	0.06	161.8	0.38
Industrial	0.9	0.00	0.1	0.00	0.0	0.00
Total	**176,083.5**	**100%**	**270,985.8**	**100%**	**42,134.5**	**100%**

10.4.3 Critical Facilities and Infrastructure

Table 10-6, Table 10-7, and Table 10-8 summarizes critical facilities exposed to the landslide hazard in moderate, high, and very high risk areas. No loss estimation of these facilities was performed due to the lack of established damage functions for the landslide hazard. A significant amount of infrastructure, under the Infrastructure Lifeline category, can be exposed to mass movements:

- Roads—Access to major roads is crucial after a disaster event. Landslides can block roads, causing neighborhood isolation and transportation delays. This can result in economic losses for businesses.
- Bridges—Landslides can damage road bridges. Mass movements can knock out bridge abutments or significantly weaken the soil supporting them, making them hazardous for use.
- Power Lines—Power lines are generally elevated above steep slopes; but the towers supporting them can be subject to landslides. A landslide could trigger failure of the soil underneath a tower, causing it to collapse and ripping down the lines.

Table 10-6. Critical Facilities and Infrastructure in Moderate Landslide Risk Areas

Jurisdiction	Emergency Response / Public Health & Safety	Infrastructure Lifeline	Military Facilities	Recovery Facilities	Socioeconomic Facilities	Hazardous Materials	Total
Campbell	0	1	0	0	0	0	**1**
Cupertino	1	0	0	0	0	0	**1**
Gilroy	0	0	0	0	2	0	**2**
Los Altos	0	0	0	0	2	0	**2**
Los Altos Hills	0	9	0	0	3	0	**12**
Los Gatos	0	1	0	0	0	0	**1**
Milpitas	0	1	0	0	0	0	**1**
Monte Sereno	0	1	0	0	1	0	**2**
Morgan Hill	0	0	0	0	0	0	**0**
Mountain View	0	0	0	0	0	0	**0**
Palo Alto	0	0	0	0	0	3	**3**
San José	2	8	0	0	5	0	**15**
Santa Clara (city)	0	0	0	0	0	0	**0**
Saratoga	1	0	0	0	0	0	**1**
Sunnyvale	0	0	0	0	0	0	**0**
Unincorporated County	1	21	0	0	2	0	**24**
Total	**5**	**42**	**0**	**0**	**15**	**3**	**65**

Table 10-7. Critical Facilities and Infrastructure in High Landslide Risk Areas

Jurisdiction	Emergency Response / Public Health & Safety	Infrastructure Lifeline	Military Facilities	Recovery Facilities	Socioeconomic Facilities	Hazardous Materials	Total
Campbell	0	9	0	0	0	0	**9**
Cupertino	0	8	0	0	2	1	**11**
Gilroy	0	3	0	0	0	0	**3**
Los Altos	0	14	0	0	1	0	**15**
Los Altos Hills	1	15	0	0	0	0	**16**
Los Gatos	1	12	0	0	5	0	**18**
Milpitas	0	3	0	0	0	0	**3**
Monte Sereno	0	1	0	0	0	0	**1**
Morgan Hill	2	0	0	0	5	0	**7**
Mountain View	0	4	0	0	0	0	**4**
Palo Alto	0	9	0	0	0	0	**9**
San José	4	108	0	0	10	1	**123**
Santa Clara (city)	0	8	0	0	0	0	**8**
Saratoga	1	10	0	0	2	0	**13**
Sunnyvale	0	2	0	0	1	0	**3**
Unincorporated County	5	71	0	0	8	1	**85**
Total	**14**	**277**	**0**	**0**	**34**	**3**	**328**

Table 10-8. Critical Facilities and Infrastructure in Very High Landslide Risk Areas

Jurisdiction	Emergency Response / Public Health & Safety	Infrastructure Lifeline	Military Facilities	Recovery Facilities	Socioeconomic Facilities	Hazardous Materials	Total
Campbell	0	0	0	0	0	0	0
Cupertino	0	0	0	0	0	0	0
Gilroy	0	0	0	0	0	0	0
Los Altos	0	0	0	0	0	0	0
Los Altos Hills	0	0	0	0	0	0	0
Los Gatos	0	0	0	0	0	0	0
Milpitas	0	0	0	0	0	0	0
Monte Sereno	0	0	0	0	0	0	0
Morgan Hill	0	0	0	0	0	0	0
Mountain View	0	0	0	0	0	0	0
Palo Alto	0	0	0	0	0	0	0
San José	0	1	0	0	0	0	1
Santa Clara (city)	0	0	0	0	0	0	0
Saratoga	0	0	0	0	0	0	0
Sunnyvale	0	0	0	0	0	0	0
Unincorporated County	0	4	0	0	0	0	4
Total	**0**	**5**	**0**	**0**	**0**	**0**	**5**

10.4.4 Environment

Environmental problems as a result of mass movements can be numerous. Landslides that fall into streams may significantly impact fish and wildlife habitat, as well as affecting water quality. Hillsides that provide wildlife habitat can be lost for prolong periods of time due to landslides.

10.5 VULNERABILITY

10.5.1 Population

All of the estimated 113,137 persons exposed to high landslide risk areas are considered to be 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.

10.5.2 Property

Although complete historical documentation of the landslide threat in the OA is lacking, the mountainous terrain surrounding the Santa Clara Valley indicates potential for landslides. Loss estimations for the landslide 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 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 10-9 shows the general building stock loss estimates in the aggregate of all landslide risk areas.

Table 10-9. Loss Potential (based on all building Stock in aggregated landslide areas)

Jurisdiction	Exposed Value	Estimated Loss Potential from Landslide		
		10% Damage	30% Damage	50% Damage
Campbell	$431,104,078	43,110,408	129,331,223	215,552,039
Cupertino	$1,216,846,265	121,684,627	365,053,880	608,423,133
Gilroy	$745,153,680	74,515,368	223,546,104	372,576,840
Los Altos	$782,725,150	78,272,515	234,817,545	391,362,575
Los Altos Hills	$2,312,933,698	231,293,370	693,880,110	1,156,466,849
Los Gatos	$4,271,221,458	427,122,146	1,281,366,437	2,135,610,729
Milpitas	$433,233,811	43,323,381	129,970,143	216,616,906
Monte Sereno	$492,443,692	49,244,369	147,733,108	246,221,846
Morgan Hill	$1,192,447,709	119,244,771	357,734,313	596,223,855
Mountain View	$48,605,041	4,860,504	14,581,512	24,302,520
Palo Alto	$2,386,362,061	238,636,206	715,908,618	1,193,181,030
San José	$12,732,894,271	1,273,289,427	3,819,868,281	6,366,447,135
Santa Clara (city)	$95,895,321	9,589,532	28,768,596	47,947,661
Saratoga	$3,143,809,608	314,380,961	943,142,882	1,571,904,804
Sunnyvale	$205,651,365	20,565,137	61,695,410	102,825,683
Unincorporated County	$431,104,078	43,110,408	129,331,223	215,552,039
Total	**$30,491,327,209**	**3,049,132,721**	**9,147,398,163**	**15,245,663,604**

10.5.3 Critical Facilities and Infrastructure

There are 398 critical facilities exposed to the landslide hazard to some degree. A more in-depth analysis of the mitigation measures taken by these facilities to prevent damage from mass movements should be done to determine if they could withstand impacts of a mass movement.

Several types of infrastructure are exposed to mass movements, including transportation, water and sewer and power infrastructure. Highly susceptible areas of the OA include mountain roads and transportation infrastructure. At this time all infrastructure and transportation corridors identified as exposed to the landslide hazard are considered vulnerable until more information becomes available.

10.5.4 Environment

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

10.6 FUTURE TRENDS IN DEVELOPMENT

Santa Clara County has been one of the state's fastest growing counties over the past 10 years, averaging a 1.21-percent increase in population per year from 2005 through 2015. The planning partners are equipped to handle future growth within landslide hazard areas. Landslide risk areas are addressed in the safety elements of local general plans. All planning partners have committed to linking their general plans to this hazard mitigation plan. This will create an opportunity for wise land use decisions as future growth impacts landslide hazard areas.

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.

10.7 SCENARIO

Major landslides in the OA occur as a result of reactivation of previous landslides and soil conditions that have been affected by severe storms, groundwater or human development. The worst-case scenario for landslide hazards in the OA would generally correspond to a severe storm that had heavy rain and caused flooding. Landslides are most likely during 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 accumulates on impermeable silt, it will cause weakness and destabilization in 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 more of a concern as development moves outside of urban centers and into areas less developed in terms of infrastructure. Most mass movements would be isolated events affecting specific areas. It is probable that private and public property, including infrastructure, will be affected. Mass movements could affect bridges that pass over landslide prone ravines and knock out rail service through the OA. 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 communication access to residents.

Continued heavy rains and flooding will 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 occurring all over the OA.

10.8 ISSUES

Important issues associated with landslides in the OA include the following:

- There are existing homes in landslide risk areas throughout the OA. The degree of vulnerability of these structures depends on the codes and standards the structures were constructed to. Information to this level of detail is not currently available.
- Future development could lead to more homes in landslide risk areas.
- Mapping and assessment of landslide hazards are constantly evolving. As new data and science become available, assessments of landslide risk should be reevaluated.
- The impact of climate change on landslides is uncertain. If climate change impacts atmospheric conditions, then exposure to landslide risks is likely to increase.
- Landslides may cause negative environmental consequences, including water quality degradation.
- The risk associated with the landslide hazard overlaps the risk associated with other hazards such as earthquake, flood and wildfire. This provides an opportunity to seek mitigation alternatives with multiple objectives that can reduce risk for multiple hazards.

11. SEVERE WEATHER

11.1 GENERAL BACKGROUND

Severe weather refers to any dangerous meteorological phenomena with the potential to cause damage, serious social disruption, or loss of human life. 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. Severe weather, technically, 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 Santa Clara County OA are heavy rains/atmospheric rivers, extreme temperatures, high wind, and space weather. Extreme cold weather has not been profiled for the Santa Clara County OA has its frequency and severity do not warrant assessment (the California State Hazard Mitigation Plan also omitted extreme cold weather as an identified hazard of concern). These types of severe weather are described in the following sections. Flooding issues associated with severe weather are discussed in Chapter 9.

DEFINITIONS

Atmospheric River—A long, narrow region in the atmosphere that transports most of the water vapor outside of the tropics. These columns of vapor move with the weather, carrying large amounts of water vapor and strong winds. When atmospheric rivers make landfall, they release this vapor in the form of rain or snow, causing flooding and mudslide vents.

Extreme Cold—Temperatures that are below normal that may lead to serious health problems. Extreme cold is a dangerous situation that can bring on health emergencies.

Extreme Heat—Temperatures that hover 10ºF or more above the average high temperature for a region and last for several weeks. Humid or muggy conditions occur when a "dome" of high atmospheric pressure traps hazy, damp air near the ground. Extremely dry and hot conditions can provoke dust storms and low visibility.

Severe Local Storm—Small atmospheric systems, including tornadoes, thunderstorms, windstorms, ice storms and snowstorms. 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.

Space Weather—Variations in the space environment between the sun and earth. It can influence the performance of technology used on Earth.

Windstorm—A storm featuring violent winds. Windstorms are generally short-duration events involving straight-line winds or gusts of over 50 mph, strong enough to cause property damage.

11.1.1 Heavy Rain/Atmospheric River

Most severe storms in the Santa Clara County OA consist of atmospheric rivers, heavy rains or thunderstorms. Heavy rain refers to events where the amount of rain exceeds normal levels. The amount of precipitation needed to qualify as heavy rain varies with 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 indicators of changing precipitation levels. Heavy rain is most frequently measured by tracking the frequency of events, analyzing the mean return period, and measuring the amount of precipitation in a certain period (most typically inches of rain within a 24-hour period) (EPA, 2015).

A relatively common weather pattern that brings southwest winds and heavy rain to California is often referred to as an atmospheric river. Atmospheric rivers are long, narrow regions in the atmosphere that transport most of the water vapor carried away from the tropics. These columns of vapor move with the weather, carrying large amounts of water vapor and strong winds. When the atmospheric rivers make landfall, they often release this water vapor in the form of rain or snow, causing flooding and mudslide vents.

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 tornado.

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 11-1):

- 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.

Source: NOAA, 2015

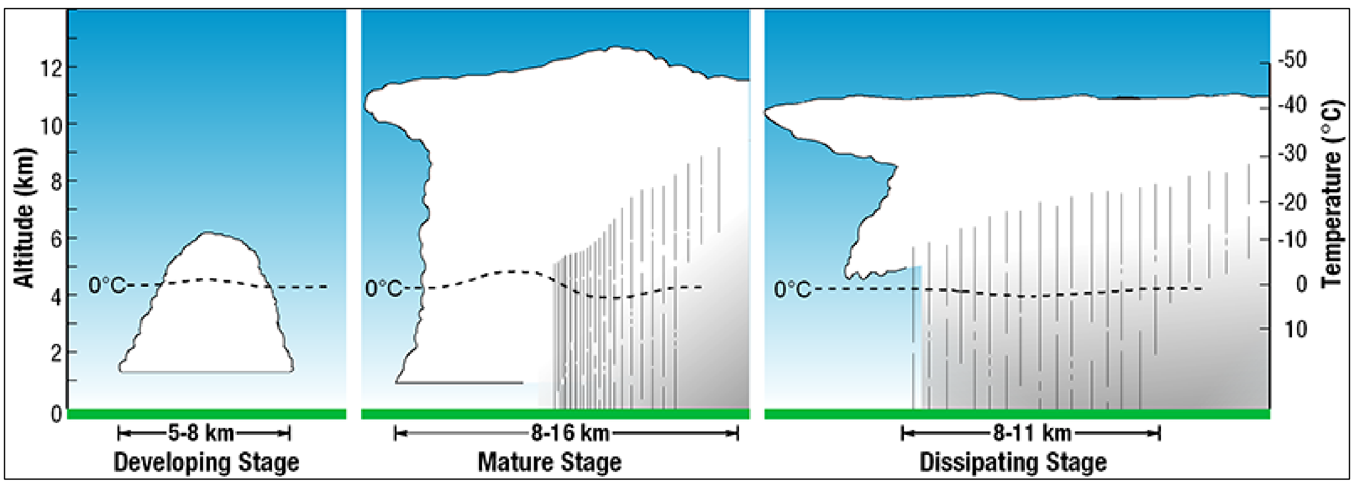


Figure 11-1. The Thunderstorm Life Cycle

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. It consists of a group of cells, moving as one unit, with each cell in a different phase of the thunderstorm life cycle. It is usually more intense than a single cell storm. Mature cells are usually at the center of the cluster and dissipating cells at the downwind edge. These storms can produce moderate-size hail, flash floods and weak tornadoes. Each cell lasts only about 20 minutes, but the cluster may persist for several hours.
- 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. 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.

NOAA classifies a thunderstorm as a storm with lightning and thunder produced by cumulonimbus clouds, usually producing gusty winds, heavy rain, and sometimes hail. Thunderstorms are usually short in duration (seldom more than two hours). Heavy rains associated with thunderstorms can lead to flash flooding during the wet or dry season. According to the American Meteorological Society *Glossary of Meteorology*, thunderstorms are reported as light, medium, or heavy according to the following characteristics:

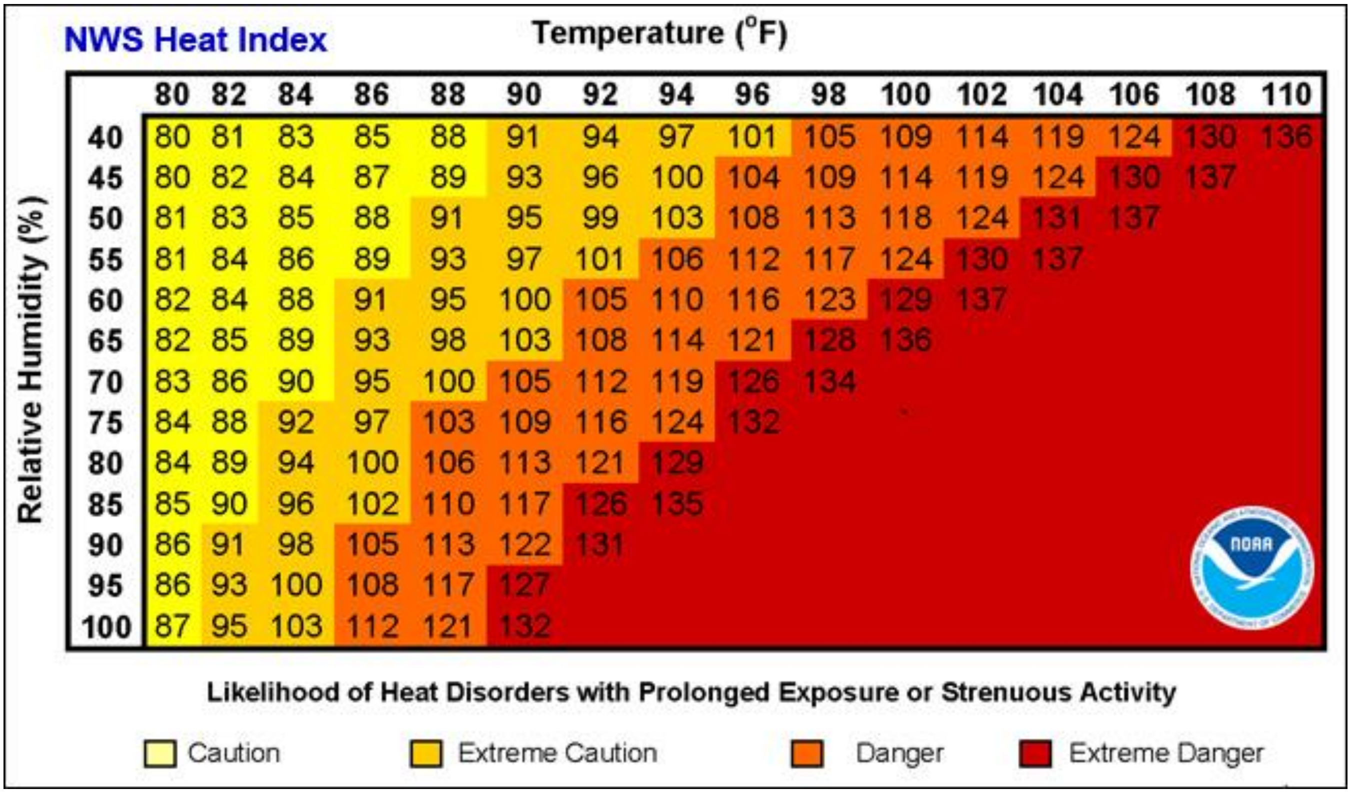
- Nature of the lightning and thunder.
- Type and intensity of the precipitation, if any.
- Speed and gustiness of the wind.
- Appearance of the clouds.
- Effect on surface temperature.

11.1.2 Extreme Temperatures

Extreme temperatures are unexpected, unusual, or unseasonal temperatures—cold or hot—that can create dangerous situations. Extreme cold temperatures are below normal temperatures that may lead to serious health problems. Exposure to the extreme cold can lead to hypothermia and frostbite in people exposed to the weather without adequate clothing protection. It may result in death if it exacerbates preexisting chronic conditions.

Extreme heat is defined as temperatures that hover 10ºF or more above the average high temperatures for the region for several weeks. Ambient air temperature and relative humidity are components of heat conditions, together defining the “apparent temperature,” as shown in Figure 11-2. Extreme heat is the primary weather-related cause of death in the U.S. In a 30-year average of weather fatalities across the nation from 1986-2015, excessive heat claimed more lives each year than floods, lightning, tornadoes, and hurricanes. In 2015, heat claimed 45 lives, though none of them were in California (NWS, 2016b).

Source: NWS, 2016



NWS Heat Index

Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

Caution | Extreme Caution | Danger | Extreme Danger

Figure 11-2. NWS Heat Index

11.1.3 High Winds

High Winds are generally short-duration events involving straight-line winds or gusts of over 50 mph, strong enough to cause property damage. High winds or a windstorm are especially dangerous in areas with significant tree stands and areas with exposed property, poorly constructed buildings, mobile homes (manufactured housing units), major infrastructure, and above-ground utility lines. A windstorm can topple trees and power lines, cause damage to residential, commercial and critical facilities, and leave tons of debris in its wake.

Damaging winds are classified as those exceeding 60 mph. Damage from such winds accounts for half of all severe weather reports in the lower 48 states and is more common than damage from tornadoes. 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.
- Downdrafts—A small-scale column of air that rapidly sinks toward the ground.
- Downbursts—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—A small concentrated downburst that produces 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—A gust front is 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 up air above them, forming a shelf cloud or detached roll cloud.
- Derecho—A derecho is 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 bow echo is 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.

11.1.4 Space Weather

All weather on Earth, from the surface of the planet out into space, is influenced by the small changes the sun undergoes during its solar cycle. These variations are referred to as space weather. Sudden bursts of plasma and magnetic field structures from the sun's atmosphere—called coronal mass ejections—together with sudden bursts of radiation, or solar flares, all cause weather effects here on Earth. Extreme space weather can cause damage to critical infrastructure, especially the electric grid. It can produce electromagnetic fields that induce extreme currents in wires, disrupting power lines, and even causing wide-spread blackouts. In severe cases, it produces solar energetic particles, which can damage satellites used for commercial communications, global positioning, intelligence gathering, and weather forecasting.

NOAA's Space Weather Prediction Center has developed space weather scales. Descriptions of three general NOAA classifications of space weather—geomagnetic storms, solar radiation storms and radio blackouts—are included in Figure 11-3. NOAA studies have determined that different types of space weather may occur separately.

The most important impact the sun has on Earth is related to its brightness or irradiance. The sun produces energy in the form of photons of light. The variability of the sun's output is wavelength dependent:

- Most of the energy from the sun is emitted in the visible wavelengths. The output from the sun in these wavelengths is nearly constant and changes by only 0.1 percent over the course of the 11-year solar cycle.
- At ultraviolet or UV wavelengths, solar irradiance is more variable, with changes up to 15 percent over the course of the 11-year solar cycle. This has a significant impact on the absorption of energy by ozone and in the stratosphere.
- At still shorter wavelengths, like extreme ultraviolet, solar irradiance changes by 30 to 300 percent over a period of minutes. These wavelengths are absorbed in the upper atmosphere, so they have minimal impact on the climate of Earth.
- At the other end of the light spectrum, at infrared wavelengths, solar irradiance is very stable and only changes by a percent or less over the solar cycle.

Other types of space weather can impact the atmosphere. Energetic particles penetrating into the atmosphere can change chemical constituents. These changes in minor species such as nitrous oxide (NO) can have long lasting consequences in the upper and middle atmosphere; however, it has not been determined if these have a major impact on the Earth's climate.

NOAA Space Weather Scales

NOTE: Each type of space weather may occur separately. Descriptions of all three types of space weather warnings are here combined into one table merely to conserve space.

HF means high frequency (radio waves), but other radio frequencies may also be affected by these events. LF means low frequency (radio waves). F: refers to event frequency.

Category Labels	Geomagnetic Storms (effect & frequency)	Solar Radiation Storms (effect & frequency)	Radio Blackouts (effect & frequency)
Minor G1 S1 R1	G1 events can cause weak power grid fluctuations, minor impacts on satellite operations, effects on migratory animals, and widely visible auroras seen in Northern Michigan. F: about 900 days per solar cycle.	S1 events result in minor impacts on HF radio in polar regions. F: about 50 such events per solar cycle, each of which can last more than 1 day.	R1 events cause weak or minor degradation of HF radio communication on the sunlit side of Earth, and occasional loss of radio contact. LF navigation signals used by maritime and general aviation systems may be degraded for brief intervals. F: about 950 days per solar cycle.
Moderate G2 S2 R2	G2 events can cause high-latitude power systems to experience voltage alarms. Long-duration storms may cause transformer damage. Corrections to satellite orientation and orbital drag prediction may be required. HF radio propagation can fade at higher latitudes. Auroras may be visible throughout Michigan. F: about 360 days per solar cycle.	S2 events may expose persons in high-flying aircraft to an elevated radiation risk* in areas of high latitude. Infrequent single-event upsets of satellite operations are possible. Possible effects on HF propagation and navigation through polar regions. F: about 25 events per solar cycle, each of which can last more than 1 day.	R2 events cause a limited blackout of HF radio communications on the sunlit side of Earth, and loss of radio contact for tens of minutes. LF navigation signals may also be degraded for tens of minutes. F: about 300 days per solar cycle.
Strong G3 S3 R3	G3 events may require voltage corrections at power systems and may trigger false alarms on their protection devices. Satellite orientation problems may need correction. Increased atmospheric drag and component surface charging may occur. Intermittent LF radio navigation problems may occur. F: 130 days per solar cycle.	S3 events can expose persons in high-flying aircraft to a radiation risk* in areas of high latitude. Satellite operations may experience single-event upsets, imaging system noise, and slight solar panel inefficiencies. Degraded HF radio propagation in polar regions. Navigation position errors are likely. F: about 10 events per cycle (each can exceed 1 day).	R3 events cause a wide area blackout of HF radio communication and loss of radio contact for about an hour on the sunlit side of Earth. LF navigation signals may be degraded for about an hour. F: about 140 days per solar cycle.
Severe G4 S4 R4	G4 events may cause widespread voltage control problems for power systems, and mistaken exclusion of key assets from a power grid by some protective systems. Satellites may experience surface charging, tracking and orientation problems that may need correction. Pipelines may experience induced currents. HF radio propagation sporadic. LF radio disrupted. Satellite-based navigation may be degraded for hours. F: about 60 days per solar cycle.	S4 events can expose persons in high-flying aircraft to a radiation risk* in areas of high latitude. Satellites may experience memory device problems, imaging systems noise, orientation problems, and degraded solar panel efficiency. A blackout of HF radio communications is likely through the polar regions. Increased navigation errors over several days are likely. F: about 3 events per solar cycle (each can exceed 1 day).	R4 events cause an HF radio communication blackout on most of the sunlit side of Earth for 1 to 2 hours, with HF radio contact lost during this time. LF navigation signals cause increased errors in positioning for 1 to 2 hours. Minor disruptions of satellite navigation are possible on the sunlit side of Earth. F: about 8 days per solar cycle.
Extreme G5 S5 R5	G5 events may cause widespread voltage control and protective system problems in power systems, with some grid systems completely blacking out or collapsing, and possible damage to transformers. Satellites may experience extensive surface charging, orientation, tracking, and linkage problems. Pipelines may receive induced currents reaching hundreds of amps. HF radio may be out for 1 to 2 days in many areas. LF may be out for hours. Satellite-based navigation may be degraded for days. Bright auroral lights visible at night. F: about 4 days per solar cycle.	S5 events can expose persons in high-flying aircraft to a radiation risk* in areas of high latitude. Satellites may be rendered useless, may receive permanent solar panel damage, or may experience memory problems, loss of control, serious imaging data noise, and navigation problems. Complete HF radio communications blackouts are possible throughout the polar regions. Navigation operations will be extremely difficult and error-laden. F: less than 1 event per solar cycle should occur, although an event may exceed 1 day in duration.	R5 events cause a complete HF radio blackout on the entire sunlit side of Earth for a number of hours. No HF radio contact with mariners and aviators in this sector. LF navigation signals experience outages for many hours on the sunlit side of Earth, causing loss in positioning. Satellite navigation errors in positioning increase for several hours on the sunlit side and may spread into the night side of the Earth. F: fewer than 1 event per cycle.

*** Pregnant women are particularly susceptible to radiation risk.**

Figure 11-3. NOAA Space Weather Scales

11.2 HAZARD PROFILE

11.2.1 Past Events

Table 11-1 summarizes severe weather events in the OA since 1970, as recorded by the NOAA National Centers for Environmental Information Storm Events Database and FEMA disaster declarations. Space weather events that affected North America are also included. Santa Clara County has been included in eight FEMA declarations for severe weather events.

Table 11-1. Past Severe Weather Events Impacting OA

Date of Event	Event Type	FEMA Declaration Number	Location	Description
December 19, 1981 – January 8, 1982	Severe storms, flood, mudslides & high tide	DR-651	Bay Area including Santa Clara County	$273 million in damage; 256 homes and 41 businesses destroyed; 6,259 homes and 1,276 businesses damaged.
January 21 – March 30, 1983	Coastal storms, floods, slides and tornadoes	DR-677	Bay Area including Santa Clara County	Heavy rains, high winds, flooding and levee breaks caused $523 million in public, private, and agricultural damage.
February 12-March 10, 1986	Severe storms & flooding	DR-758	Bay Area including Santa Clara County	$407 million; 1,382 homes and 185 businesses destroyed; 12,447 homes and 967 businesses damaged.
March 13, 1989	Space weather storm	N/A	Quebec, Canada	A space weather storm disrupted the hydroelectric power grid in Quebec, Canada. This system-wide outage lasted for nine hours and left six million people without power.
December 19, 1990 – January 3, 1991	Severe freeze	DR-894	Bay Area including Santa Clara County	Very cold air blew through the San Joaquin Valley, east through the Coachella and Imperial valley, and down the coastal valleys of the Santa Paula district. The freeze caused joblessness and hunger among farm workers. Total damage was $856 million from public buildings, utilities, and crop damage, 500 broken pipes affecting 5,400 homes.
January 3 – February 10, 1995	Severe winter storms, flooding, landslides, mud flows	DR-1044	Bay Area including Santa Clara County	Severe winter storms, flooding, landslides and mudflows. Over 100 stations recorded their greatest 1-day rainfall in history. Most of the storms hit Sacramento River Basin, which resulted in small stream flooding due to drainage system failures. $741 million total; 11 deaths
February 13 – April 19, 1995	Severe winter storms, flooding landslides, mud flow	DR-1046	Bay Area including Santa Clara County	Approx. $1.1 billion total; damage to homes: major 1,322; minor 2,299; destroyed 267.
December 28, 1996 – April 1, 1997	Severe storms, flooding, mud and landslides	DR-1155	48 counties including Santa Clara County	300 square miles in California were flooded including the Yosemite Valley. Over 12,000 people were evacuated in northern California. Several levee breaks were reported across the Sacramento and San Joaquin Valleys. Over 23,000 homes and business, agricultural lands, bridges, and roads were damaged. Eight deaths resulted from this event. Overall, the state had $1.8 billion in damage.
February 2 – April 30, 1998	Severe winter storms and flooding	DR-1203	41 counties including Santa Clara County	$550 million; 17 deaths from El Niño causing widespread heavy rains, flooding, and landslides throughout the Bay Area. Record flooding in Santa Clara County.
December 15, 2002	Heavy rain	—	Santa Clara County	Two to four inches of rain fell over the OA.

Date of Event	Event Type	FEMA Declaration Number	Location	Description
October 2003	Space weather	—	Parts of the Europe and the United States	This event was a series of solar flares that impacted satellite-based systems and communications. A one-hour long power outage occurred in Sweden as a result of the solar activity. Aurorae were observed as far south as Texas and the Mediterranean countries of Europe.
December 1, 2005	High winds	—	Bay area	Strong winter storm brought winds gusts up to 74 mph.
February 27, 2006	High winds	—	Bay area	Strong winter storm brought winds gusts up to 77 mph.
July 20-25, 2006	Heat	—	Santa Clara Valley	Very hot weather yielded an extended period of high temperatures over 100 degrees and lows in the 70s. South areas in southern Santa Clara County reached 115 degrees during the day and fell only to around 80 degrees at night. One death was reported in San José.
December 2006	Geomagnetic storms and solar flares	—	United States	This event disabled Global Positioning System (GPS) signal acquisition over the United States.
December 27, 2006	High winds	—	Bay area	A strong storm system swept across the area, knowing out power to thousands of homes and businesses.
January 6, 2007	Frost/freeze	—	Santa Clara Valley	Record cold wave settled upon the area with some morning lows in the 20s. Crop damage in Santa Clara County totaled approximately $50,000.
January 4, 2008	High winds	—	San Francisco and Monterey Bay Areas	A strong cyclone made landfall bringing flooding rains and high winds. The high winds left hundreds of thousands of residences and businesses without power, property damage due to falling trees hitting cars and structures as well as damage to roads due to heavy rains throughout the areas.
December 17, 2008	Frost/freeze	—	Bay area	A cold low pressure system produced winter storm conditions caused several minor traffic accidents with icy conditions.
February 15, 2009	High winds	—	Bay area	An Eastern Pacific storm produced strong wind and heavy rain causing power outages and knocking down numerous trees.
April 14, 2009	High winds	—	Santa Clara Valley	Downed trees crushed cars in San José and clogged major intersections. Power outages also occurred as trees brought power lines to the ground with 4,600 customers losing power in San José.
May 2, 2009	Dense fog	—	Santa Cruz Mountains	Mountain fog caused a chain-reaction automobile collision.
May 17, 2009	Heat	—	Santa Clara Valley	Temperatures rose into the 90s to just over 100ºF in the valleys of Santa Clara County. Cooling centers were open across the area to mitigate heat related illnesses.
October 13, 2009	High winds	—	Santa Clara Valley	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 caused numerous tree, tree limbs, and electrical poles to fall throughout the area.
December 8, 2009	Freeze	—	Santa Clara Valley	A storm moved across northern and central California leaving a cold air mass in its wake. The cold air mass led to overnight temperatures dropping below freezing. Black ice and unsafe speeds led to a fatality car crash, connector highway ramps from Highway 101 to Interstate 280 closed for 90 miles due to severe ice on roadway, and airport delays reported.
January 20, 2010	Strong winds	—	Santa Clara County	Strong wind brought a number of trees and limbs down across San José. On Cherry Lane an 80-foot cedar tree toppled over, taking down a telephone pole and two transformers. The tree fell across the street damaging a vehicle on the other side. In Los Gatos, trees fell on Shady Lane.

Date of Event	Event Type	FEMA Declaration Number	Location	Description
November 30, 2011	Strong winds	—	Bay area	Wind gusted up to 70 mph throughout the area downing trees and power lines.
November 30, 2012	Heavy rains	—	Santa Clara County	A series of significant winter storms impacted the district during late November and early December 2012. Minor urban and small stream flooding was observed across Santa Clara County due to the heavy rainfall.
May 1, 2013	High winds	—	Bay area	Hot weather followed by increasingly strong northeast winds lead to critical fire weather conditions.
October 4, 2013	Strong winds	—	Bay area	Strong winds moved through the area that caused downed trees and powerlines and causing several wildfires to ignite.
February 28, 2014	Strong winds	—	Bay area	A Pacific storm system moved across the area and dropped several inches of rainfall with gusty winds. This resulted in flooding of urban areas, small streams and creeks, and damage to power lines and trees as well as a few localized mud and rockslides.
December 10-11, 2014	Heavy rains and high winds	—	Bay area	Heavy rains and gusty winds impacted the Bay Area for several days. Rainfall rates of 1.5 to 2 inches an hour were reported. A flash flood warning was issued for many municipalities including the Cities of Union City and Newark. Many areas around the Bay Area experienced flooding of streets, highways and creeks. In addition to the heavy rain, strong wind gusts were recorded with some reaching 83 mph. Overall rainfall totals ranged from 5.78 inches to 7.24 inches. This event led to power outages throughout the Bay Area. Rainfall totals in Union City were 3.28 inches.
February 6, 2015	Strong winds	—	Santa Clara Valley	A strong winter 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 to 10 inches or more occurring. Generally 1 to 3.5 inches fell in low elevation areas and urban spots. Tree blown down onto powerlines near Los Gatos.
February 9, 2015	Heavy rain	—	Santa Clara County	A stream gauge in Uvas Canyon County Park measured a 72 hour rainfall total of 8.74 inches.
December 13, 2015	Strong winds	—	Bay area	A cold front swept across the Bay Area with strong winds. Several large trees were blown down, some onto homes and automobiles.

Sources: NOAA, 2017; FEMA, 2017; ABAG, 2010

According to the USDA’s Risk Management Agency, Santa Clara County received $4,958,724 in payments for insured crop losses over 2,243 affected acres as a result of heat, excess wind, frost, and cold wet weather events between 2003 and 2016 (see Table 11-2). The highest damaging year was 2015 for heat events.

11.2.2 Location

Severe weather events have the potential to happen anywhere in the Santa Clara County OA. Communities in low-lying areas next to streams 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.

Table 11-2. Crop Insurance Claims Paid from Heat, Excess Wind, Frost, and Cold Wet Weather, 2003-2016

Crop Year	Commodity	Damage Cause	Acres Affected	Indemnity Amount
2003	All Crops	Heat	127	$73,315
2003	All Crops	Cold Wet Weather	86	$9,896
2004	All Crops	Heat	62	$9,093
2005	None	None	None	None
2006	None	None	None	None
2007	All Crops	Heat	60	$9,633
2008	All Crops	Heat	90	$27,751
2008	All Crops	Frost	72	$15,919
2009	None	None	None	None
2010	None	None	None	None
2011	Cherries, Processing Apricots	Cold Wet Weather, Freeze	64	$278,610
2012	Cherries	Frost	13	$11,000
2013	Cherries	Cold Wet Weather	196	$456,697
2013	All Other Crops	Heat	3	$100
2013	All Other Crops	Excess Wind	22	$2,667
2014	Cherries	Heat	665	$852,523
2015	Cherries, Processing Apricots, All Other Crops	Heat	1,230	$3,354,322
2015	All Other Crops	Frost	50	$2,805
2016	None	None	None	None
Total			**2,243**	**$4,958,724**

Source: USDA, 2016

Atmospheric River, Heavy Rains, and Thunderstorms

The entire Santa Clara County OA is vulnerable to heavy rainfall and atmospheric river events as they make landfall in the Bay Area. These events can drop up to 12 inches of rain over a couple days and cause widespread flooding and disruption to road and air travel.

Thunderstorms affect relatively small localized areas, rather than large regions like winter storms and hurricane events. It is estimated that there are as many as 40,000 thunderstorms each day worldwide. Thunderstorms can strike in all regions of the United States; however, they are most common in the central and southern states. Figure 11-4 shows the annual number of thunderstorms in the United States. According to this figure, the OA can experience around five thunderstorms each year (NWS, 2016).

Extreme Temperatures

Extreme temperatures can occur anywhere in the OA. Extreme heat is a concern to people, animals and pets as well as local nursery crops, cut flowers, and vegetable crops. Extreme cold is usually frost and freeze damage that adversely affects local nursery crops, cut flowers, and vegetable crops.

High Winds

The entire OA is subject to high winds from thunderstorms and other severe weather events. Figure 11-5 indicates how the frequency and strength of windstorms impacts the United States and the general location of the most wind activity. The OA is located in FEMA’s Wind Zone I, where wind speeds can reach up to 130 mph.

Source: NWS, 2016a

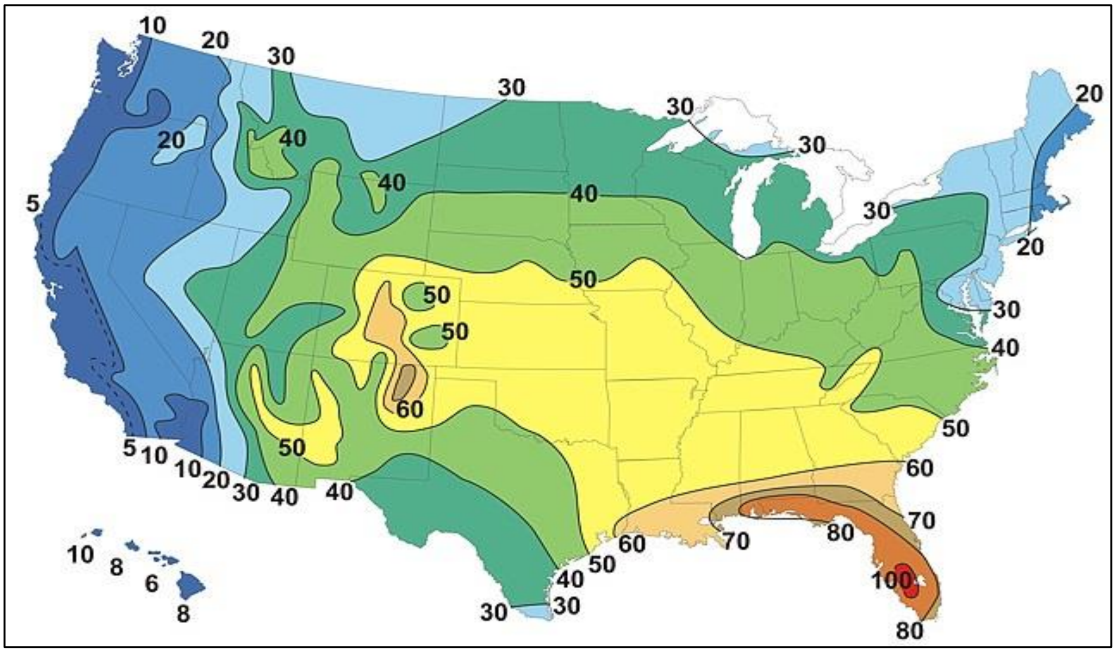
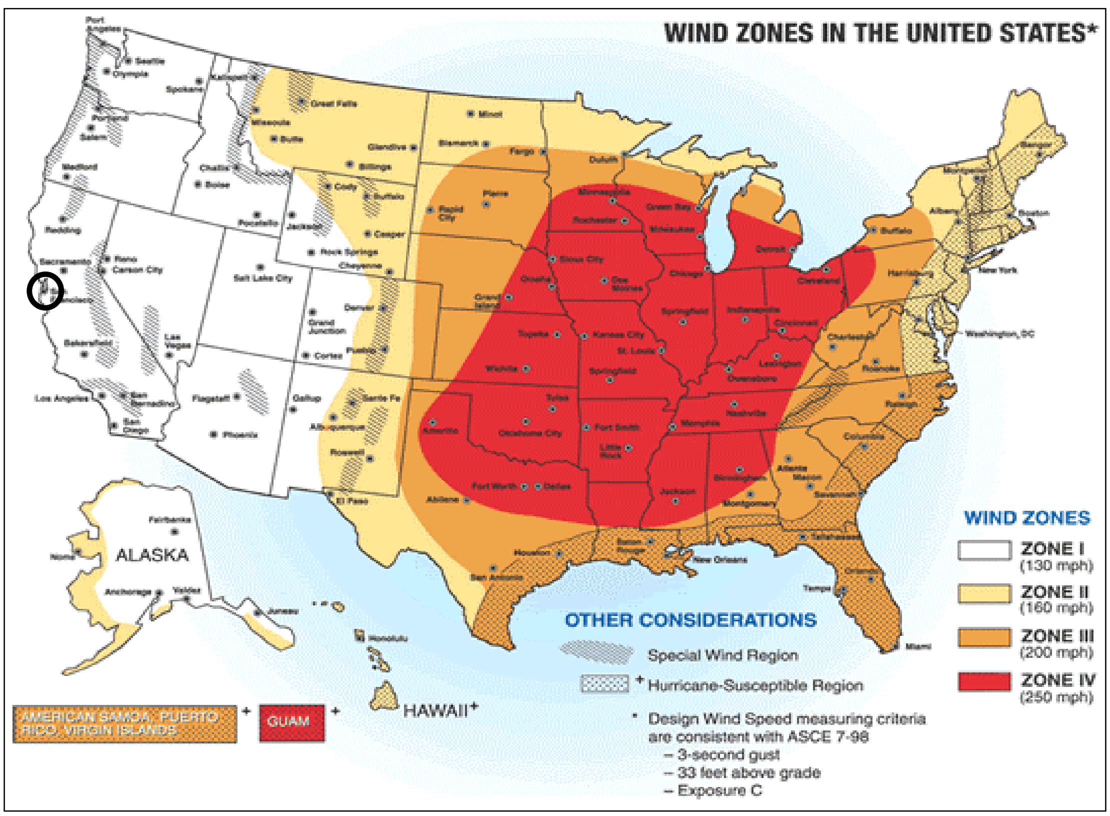


Figure 11-4. Annual Number of Thunderstorms in the United States

Source: FEMA, 2010



Note: The black circle indicates the approximate vicinity of the OA.

Figure 11-5. Wind Zones in the United States

Space Weather

A solar flare occurs when magnetic energy that has built up in the solar atmosphere is suddenly released. The flare ejects clouds of electrons, ions, and atoms through the corona of the sun into space. These clouds typically reach earth a day or two after the event and can disrupt the power grid anywhere in the world (Global Resilience Network, 2016; NASA, 2016b).

11.2.3 Frequency

Predicting the frequency of severe weather events in a constantly changing climate is a difficult task. The OA can expect to experience exposure to and adverse impacts from some type of severe weather event at least annually.

11.2.4 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, ice or snow, 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.

Windstorms can be a frequent problem in the OA and have been known to cause damage to utilities. The predicted wind speed given in wind warnings issued by the National Weather Service is for a one-minute average; gusts may be 25 to 30 percent higher.

Heavy precipitation, which in the OA almost always takes the form of rain, can have significant impacts, including crop damage, flash flooding, and landslides. Stormwater runoff from heavy rains can also impair water quality by washing pollutants into water bodies (EPA, 2015). 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).

Extreme heat is defined as temperatures that generally remain 10 ºF or more above the average high temperatures for the region for several weeks. In 2016, the highest average high temperatures occurred in July and august at 84 ºF. Therefore, extreme temperatures would be considered any temperature over 95 ºF for an extended time. In 2016, temperatures were recorded above 95 ºF for a total of 37 days from April through October.

11.2.5 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.

Space weather prediction services in the United States are provided primarily by NOAA’s Space Weather Prediction Center and the U.S. Air Force’s Weather Agency, which work closely together to address the needs of their civilian and military user communities. The Space Weather Prediction Center draws on a variety of data sources, both space and ground-based, to provide forecasts, watches, warnings, alerts, and summaries as well as operational space weather products to civilian and commercial users.

11.3 SECONDARY HAZARDS

The most significant secondary hazards associated with severe local storms are floods, falling and downed trees, landslides and downed power lines. Rapidly melting snow combined with 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.

With fog, the secondary impacts are car crashes, with injuries and fatalities caused by traveling at high speeds with low visibility on highways and interstates, as well as air travel delays and diversions.

Possibly the most likely secondary impact of space weather on residents, businesses and visitors to OA is disruption to the electric power grid. Space weather can have an impact on advanced technologies, which has a direct impact on daily life.

11.4 EXPOSURE

11.4.1 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 OA is exposed to some extent to severe weather events. Certain areas are more exposed due to geographic location and local 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 in low-lying areas are at risk for possible flooding. Power outages can be life threatening to those dependent on electricity for life support. Isolation of these populations is a significant concern.

11.4.2 Property

According to the County Assessor, there are 464,223 buildings within the census tracts that define the OA. The majority of these buildings are residential. It is estimated that 20 percent of the residential structures were built without the influence of a structure building code with provisions for wind loads. All of these buildings 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. It is unlikely that the impacts of space weather would have a negative impact on the structures themselves.

11.4.3 Critical Facilities and Infrastructure

All critical facilities exposed to flooding (Section 9.4.3) are also likely exposed to severe weather. Additional 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 due to fog or from secondary hazards such as landslides.

11.4.4 Environment

The environment is highly exposed to severe weather events. 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 events caused by severe weather or snowmelt can produce river channel migration or damage riparian habitat. Storm surges can erode beachfront bluffs and redistribute sediment loads.

11.5 VULNERABILITY

11.5.1 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.

11.5.2 Property

All property is vulnerable during severe weather events, but properties in poor condition or in particularly vulnerable locations may 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 vulnerable to falling ice or may be damaged in the event of a collapse.

Loss estimations for the severe weather 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 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 11-3 lists the loss estimates.

Table 11-3. Loss Potential for Severe Weather

Jurisdiction	Exposed Value	Estimated Loss Potential from Severe Weather		
		10% Damage	30% Damage	50% Damage
Campbell	$11,181,660,749	$1,118,166,075	$3,354,498,225	$5,590,830,374
Cupertino	$13,890,786,985	$1,389,078,699	$4,167,236,096	$6,945,393,493
Gilroy	$13,401,505,586	$1,340,150,559	$4,020,451,676	$6,700,752,793
Los Altos	$8,825,187,782	$882,518,778	$2,647,556,335	$4,412,593,891
Los Altos Hills	$3,242,710,721	$324,271,072	$972,813,216	$1,621,355,360
Los Gatos	$10,893,322,460	$1,089,332,246	$3,267,996,738	$5,446,661,230
Milpitas	$19,146,882,365	$1,914,688,237	$5,744,064,710	$9,573,441,183
Monte Sereno	$872,909,228	$87,290,923	$261,872,768	$436,454,614
Morgan Hill	$11,160,393,427	$1,116,039,343	$3,348,118,028	$5,580,196,713
Mountain View	$25,062,452,472	$2,506,245,247	$7,518,735,742	$12,531,226,236
Palo Alto	$25,777,115,586	$2,577,711,559	$7,733,134,676	$12,888,557,793
San José	$213,377,474,752	$21,337,747,475	$64,013,242,426	$106,688,737,376
Santa Clara (city)	$43,398,577,930	$4,339,857,793	$13,019,573,379	$21,699,288,965
Saratoga	$8,143,761,638	$814,376,164	$2,443,128,491	$4,071,880,819
Sunnyvale	$42,852,045,398	$4,285,204,540	$12,855,613,620	$21,426,022,699
Unincorporated County	$25,352,649,992	$2,535,264,999	$7,605,794,998	$12,676,324,996
Total	**$476,579,437,071**	**$47,657,943,707**	**$142,973,831,121**	**$238,289,718,536**

Estimate of Crop Losses

According to the USDA's Risk Management Agency, the amount of claims paid for crop damage as a result of severe weather in Santa Clara County over a 14-year period was $4,958,724. According to the 2016 California

Insurance Profile from the USDA's Risk Management Agency, 54 percent of the insurable crops in California are insured with USDA Crop Insurance. To provide an adjusted estimate of losses accounting for insurable crops that are not insured, the 54 percent crop insurance coverage was factored in. According to this calculation, estimated annualized losses are $655,916 (see Table 11-4). Considering the value of crops from the 2012 Census of Agriculture as baseline crop exposure, the estimated annual losses from flood was determined to be low compared to the value of the insurable crops.

Table 11-4. Estimated Insurable Annual Crop Loss Resulting From Severe Weather

14-Year Flood Insurance Paid[a]	Adjusted 14-year Flood Losses (considering 54% insured)	Estimated Annualized Losses	2012 Value of Crops[b]
$4,958,724	$9,182,822	$655,916	$233,397,000

a. Crop insurance paid from USDA's Risk Management Agency for 2003-2016.
b. 2012 Census of Agriculture, Santa Clara County

11.5.3 Critical Facilities and Infrastructure

Incapacity and loss of roads are the primary transportation failures resulting from severe weather, mostly associated with secondary hazards. Landslides caused by heavy prolonged rains can block roads. High winds can cause significant damage to trees and power lines, blocking roads with debris, incapacitating transportation, isolating population, and disrupting ingress and egress. Of particular concern are roads providing access to isolated areas and to the elderly.

Prolonged obstruction of major routes due to landslides, debris or floodwaters can disrupt the shipment of goods and other commerce. Large, prolonged storms can have negative economic impacts for an entire region.

Severe windstorms, downed trees, and ice can create serious impacts on power and above-ground communication lines. Loss of electricity and phone connection would leave certain populations isolated because residents would be unable to call for assistance.

11.5.4 Environment

The vulnerability of the environment to severe weather is the same as the exposure.

11.6 FUTURE TRENDS IN DEVELOPMENT

All future development will be affected by severe storms, extreme temperatures, fog, high winds, and space weather. The ability to withstand impacts lies in sound land use practices and consistent enforcement of codes and regulations for new construction. The planning partners have adopted the International Building Code in response to California mandates. This code is equipped to deal with the impacts of severe weather events. Land use policies identified in general plans within the OA also address many of the secondary impacts (flood and landslide) of the severe weather hazard. With these tools, the planning partners are well equipped to deal with future growth and the associated impacts of severe weather.

11.7 SCENARIO

Although severe local storms are infrequent, impacts can be significant, particularly when secondary hazards of flood and landslide occur. A worst-case event would involve prolonged high winds during a winter storm accompanied by an atmospheric river event. 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. Flooding and landslides could further obstruct roads and bridges, further isolating residents.

11.8 ISSUES

Important issues associated with a severe weather in the OA include the following:

- Older building stock in the OA is built to low code standards or none at all. These structures could be highly vulnerable to severe weather events such as windstorms.
- Cities may need to open cooling/warming stations during extreme temperature events.
- Redundancy of power supply must be evaluated.
- The capacity for backup power generation is limited.
- Dead or dying trees as a result of drought conditions are more susceptible to falling during severe 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 atmospheric storm events, and will likely lead to increased temperatures and changes in overall precipitation amounts.

12. TSUNAMI

12.1 GENERAL BACKGROUND

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.

Seiche—A standing wave in an enclosed or partially enclosed body of water such as bays and lakes. Seiches are typically caused when strong winds and rapid changes in atmospheric pressure or an earthquake push water from one end of a body of water to the other.

12.1.1 Tsunami

A tsunami consists of a series of high-energy waves that radiate outward like pond ripples from an area where a generating event occurs. Earthquakes may produce displacements of the sea floor that can set the overlying column of water in motion, initiating a tsunami, depending on the magnitude of the earthquake and the type of faulting.

Tsunamis are typically classified as local or distant. Locally generated tsunamis have minimal warning times, leaving few options except to run to high ground. They may be accompanied by damage resulting from the triggering earthquake due to ground shaking, surface faulting, liquefaction or landslides.

Distant tsunamis may travel for hours before striking a coastline, giving a community a chance to implement evacuation plans. In the open ocean, a tsunami may be only a few inches or feet high, but it can travel with speeds approaching 600 miles per hour. Tsunami waves arrive at shorelines over an extended period. Figure 12-1 shows likely travel times across the Pacific Ocean for a tsunami generated along the California coastline near the San Francisco Bay Area.

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 (draw down) caused by the trough preceding the advancing, large inbound wave crest. Rapid draw down can create strong currents in harbor inlets and channels that can severely damage coastal structures due to 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 due to strong currents, collisions with other objects, or impact with the harbor bottom.

Source: NOAA, 2016

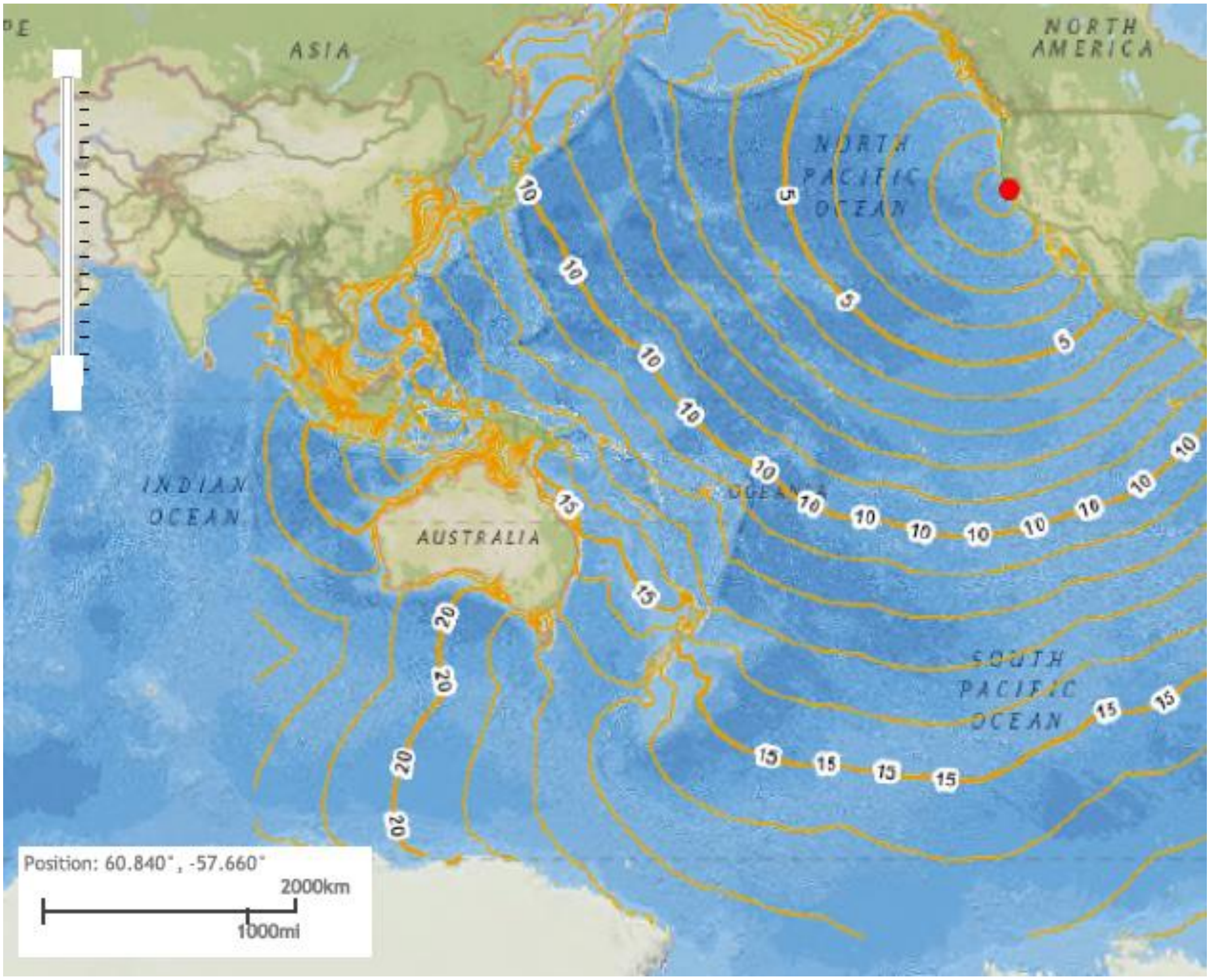


Figure 12-1. Potential Tsunami Travel Times in the Pacific Ocean, in Hours

Conversely, the first indication of a tsunami may be a rise in water level. The advancing tsunami may initially resemble a strong surge increasing the sea level like the rising tide, but the tsunami surge rises faster and does not stop at the shoreline. Even if the wave height 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.

At some locations, the advancing turbulent wave front will be the most destructive part of the wave. 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 with it, 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 withdrawal of the seawater.

12.1.2 Seiche

A seiche is a standing wave in an enclosed or partially enclosed body of water, such as San Francisco Bay. Seiches are typically caused when strong winds and rapid changes in atmospheric pressure or an earthquake push water from one end of a body of water to the other. The largest seiche that was ever measured in the San Francisco Bay, following the 1906 earthquake, was 4 inches high. The Bay Area has not been adversely affected by seiches (U.S. Army Corps of Engineers, 2016).

12.2 HAZARD PROFILE

12.2.1 Past Events

According to the National Centers for Environmental Information, the California coastline has been impacted by tsunami wave events on four dates since 2005: November 15, 2006, February 27, 2010, March 11, 2011, and September 16, 2015. Together these events caused approximately $45 million in property damage. The Santa Clara County OA has never been impacted by a tsunami. The closest tsunami to affect the OA was the tsunami event on March 10, 2011 that occurred in Japan and traveled across the Pacific Ocean to create wave surges that damaged coastal areas in nearby Santa Cruz and Monterey Counties. These counties were included in FEMA-1968-DR-CA declaration.

12.2.2 Location

The most likely site of tsunami impacts in the Santa Clara County OA is along area creeks that would rise with floodwaters from a San Francisco Bay tsunami caused by a local earthquake. Figure 12-2 shows tsunami inundation mapping for areas on the southern portion of the San Francisco Bay and Coyote Creek (the northern portion of the Santa Clara County OA) prepared by the California Department of Conservation.

12.2.3 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.

12.2.4 Severity

Tsunamis are a threat to life and property to anyone living near the ocean. From 1950 to 2007, 478 tsunamis were recorded globally. Fifty-one of these events caused fatalities, to a total of over 308,000 coastal residents. The overwhelming majority of these events occurred in the Pacific basin. Recent tsunamis have struck Nicaragua, Indonesia, and Japan, killing several thousand people. Property damage due to these waves was nearly $1 billion. Historically, tsunamis originating in the northern Pacific and along the west coast of South America have caused more damage on the west coast of the United States than tsunamis originating in Japan and the Southwest Pacific.

It is general consensus that the Santa Clara County OA would not likely see significant impacts from a tsunami originating in the Pacific Ocean, given the area’s inland location. However, the OA would likely see minor tsunami impacts on creeks from a local earthquake event, with any floodwaters flowing up creeks impacting people visiting the creeks. A local earthquake tsunami can occur any time, and the resulting floodwater waves can carry damaging debris.

Figure Placeholder

Figure 12-2. Tsunami Inundation Area

12.2.5 Warning Time

Typical signs of a tsunami hazard are earthquakes and/or 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; with waves 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.

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. The National Weather Service operates two regional information distribution centers. One is located in Ewa Beach, Hawaii, and the other is in Palmer, Alaska. The Ewa Beach center also serves as an administrative hub for the Pacific warning system.

The warning system only begins to function when a Pacific basin earthquake of magnitude 6.5 or greater triggers an earthquake alarm. When this occurs, the following sequence of actions occurs:

- Data is interpolated to determine 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 to be 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.

12.3 SECONDARY HAZARDS

By the time a tsunami wave reaches the Santa Clara County OA, it may carry floating debris that can cause damage to any affected areas.

12.4 EXPOSURE AND VULNERABILITY

12.4.1 Population

The population of the Santa Clara County OA is located outside of a tsunami inundation area, therefore, no population exposure exists for the tsunami hazard.

12.4.2 Property

No buildings are located in the tsunami inundation area in the OA, so no property exposure based on building stock exists for the tsunami hazard.

12.4.3 Critical Facilities and Infrastructure

Critical facilities and infrastructure in the Santa Clara County OA are located outside of the tsunami inundation area, so no such exposure exists for the tsunami hazard.

12.4.4 Environment

Waterways originating from southern portion of San Francisco Bay would be exposed to the effects of a tsunami or seiche; inundation of water and introduction of foreign debris could be hazardous to the environment. All wildlife inhabiting the area is exposed. The vulnerability of aquatic habit and associated ecosystems would be highest in low-lying areas close to the southern portion of San Francisco Bay coastline.

Tsunami waves and seiches can carry destructive debris and pollutants that can have devastating impacts on all facets of the environment. Millions of dollars spent on habitat restoration and conservation in the OA could be wiped out by one significant tsunami. There are currently no tools available to measure these impacts. However, it is conceivable that the potential financial impact of a tsunami or seiche event on the environment could equal or exceed the impact on property. Community planners and emergency managers should take this into account when preparing for the tsunami hazard and considering future development.

12.5 FUTURE TRENDS IN DEVELOPMENT

Tsunami inundation areas in the OA are within flood hazard areas that are already regulated under floodplain management regulations.

12.6 SCENARIO

The worst-case scenario for the OA is a local tsunami or seiche event originating in the San Francisco Bay triggered by a seismic event. This can occur anytime and the series of floodwater waves can carry damaging debris and cause environmental impacts.

12.7 ISSUES

The Core Planning Group has identified the following issues related to the tsunami hazard for the OA:

- As tsunami warning technologies evolve, the tsunami warning capability within the OA will need to be enhanced to provide the highest degree of warning.
- With the possibility of climate change, the issue of sea level rise may become an important consideration as probable tsunami inundation areas are identified through future studies.
- Special attention will need to be focused on the vulnerable communities in the tsunami zone and on hazard mitigation through public education and outreach.

13. WILDFIRE

DEFINITIONS

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.

13.1 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. Short-term loss caused by a wildfire can include the 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 due to the destruction of watersheds. The potential for significant damage to life and property exists in areas designated as “wildland urban interface areas,” where development is adjacent to densely vegetated areas.

13.2 HAZARD PROFILE

13.2.1 Past Events

According to the *State of California Multi-Hazard Mitigation Plan* and the California Department of Forestry and Fire Protection, the Santa Clara County OA experiences wildfires every two to three years. There have been two federal disaster declarations for wildfires since 1950. The following are wildfires of over 10 acres that have been recorded in or near the OA (CAL FIRE, 2016):

- June 26 – July 19, 1985; “Lexington Fire” (FEMA-739-DR-CA)—This federal wildfire disaster included six counties. In Santa Clara County, the worst of the fires affected the Santa Cruz Mountains south of San José, threatening at least 2,000 homes and forcing the evacuation of more than 4,500 people (L.A. Times, 2016).
- October 25 – 26, 2006, Felter Fire—Burned 200 acres.
- August 30 – September 2, 2007, Stevens Fire—Burned 151 acres near Stevens Canyon Reservoir.
- September 3 – 11, 2007, Lick Fire—Burned 47,760 acres at Henry Coe State Park, with four residences and 20 outbuildings destroyed.
- May 22 – 30, 2008, Summit Fire (FEMA-2766-FM-CA)—Burned 4,270 acres along with 35 residences, 64 outbuildings at Summit Road and Maymen Flats, south of the Town of Loma Prieta.
- June 21 – 26, 2008, Whitehurst/Hummingbird Fires—Burned 794 acres at Hummingbird and 200 acres at Whitehurst.
- August 29 – 30, 2009, Pacheco Fire—Burned 1,650 acres.
- September 23 – October 5, 2002, “Croy Fire” (FM-2465)—13,128 acres burned.
- July 21, 2011, McDonald Fire—Burned 27 acres east of Morgan Hill below Anderson Lake.
- July 12, 2013, Uvas Fire—Burned 50 acres along Uvas Road and Casa Loma Road, near Calero County Park and west of Morgan Hill.

- June 30 – July 1, 2014, Curie Fire—Burned 125 acres off Curie Drive south of San José.
- August 28 – 31, 2014, Casa Fire—Burned 80 acres along Highway 152 at Casa De Fruta.
- June 30 – 3, 2015, Highway Fire—Burned 42 acres off Highway 101 near Monterey Frontage Road, south of the City of Gilroy.
- September 9 – 10, 2015, Pacheco Fire—Burned 215 acres off Highway 152 at Dinosaur Point, 3 miles west of San Luis Reservoir.
- July 30 – 31, 2016, Sierra Fire—Burned 114 acres off Sierra Road and Calaveras Road.
- August 17 – 18, 2016, Bailey Fire—Burned 100 acres off Highway 101 and Bailey Road.
- September 1 – 2, 2016, Oak Fire—Burned 25 acres off Oak Glen Avenue, 2 miles west of Morgan Hill.
- September 26 – October 12, 2016, Loma Fire—Burned 4,474 acres and destroyed 12 residences and 16 outbuildings off Loma Prieta Road and Loma Chiquita Road, 10 miles northwest of Morgan Hill.

13.2.2 Location

CAL FIRE's Fire and Resource Assessment Program has modeled and mapped wildfire hazard zones using a science-based and field-tested computer model that assigns a fire hazard severity zone (FHSZ) of moderate, high or very high. The FHSZ model is built from existing CAL FIRE data and hazard information 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).
- Probability of Future Occurrence—The likelihood of an area burning over a 30- to 50-year time period, based on history and other factors.

The model also is based on frequency of fire weather, ignition patterns, and expected rate-of spread. It accounts for flying ember production, which is the principal driver of the wildfire 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 model refines the zones to characterize fire exposure mechanisms that cause ignitions to structures. Significant land-use changes need to be accounted for through periodic model updates.

Figure 13-1 shows the FHSZ mapping for the Santa Clara County OA. Table 13-1 lists the total area mapped in each zone. Most of the mapped zones are in the unincorporated county.

Figure Placeholder

Figure 13-1. Wildfire Severity Zones and Historical Perimeters

Table 13-1. Record of Fire Affecting OA

Fire Hazard Severity Zone (FHSZ)	Total Area in Wildfire Severity Zone (acres)	Area Burned, 1878 – 2015	
		Acres	Percent of Total
Moderate FHSZ	33,593	693	2.1
High FHSZ	372,359	35,026	9.4
Very High FHSZ	161,211	76,521	47.5
Total	**567,163**	**112,240**	**19.8**

13.2.3 Frequency

Wildfire frequency can be assessed through review of the portion of an area burned in previous wildfire events. Table 13-1 includes a summary of CAL FIRE records of fires over the 137 years from 1878 to 2015. About 20 percent of the mapped wildfire risk zones in the Santa Clara County OA have burned in that period.

13.2.4 Severity

Potential losses from wildfire include human life, structures and other improvements, and natural resources. There are no recorded incidents of loss of life from wildfires in the OA. There have been multiple destructive wildfires in the OA destroying residents, thousands of acres, and evacuating people. 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 also threatens those fighting the fires. First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke.

13.2.5 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 fire likelihood. 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 prior to a significant electrical storm.

If a fire does break 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 phone and two-way radio communications in recent years has further contributed to a significant improvement in warning time.

13.3 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 cause the contamination of reservoirs, destroy transmission lines and contribute to flooding. They strip slopes of vegetation, exposing them to greater amounts of runoff. This in turn can weaken soils and cause 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. This increases the runoff generated by storm events, thus increasing the chance of flooding.

13.4 EXPOSURE

13.4.1 Population

Population could not be examined by FHSZ because the boundaries of census block groups do not coincide with the zone boundaries. However, population was estimated using the residential building count in each mapped FHSZ and multiplying by the 2016 estimated average population per household. Table 13-2 presents the results.

Table 13-2. Population Within Wildfire Hazard Areas

Jurisdiction	Moderate FHSZ			High FHSZ			Very High FHSZ		
		Population						Population	
	Buildings	Number	% of Total	Buildings	Number	% of Total	Buildings	Number	% of total
Campbell	0	0	0.0%	0	0	0.0%	0	0	0.0%
Cupertino	0	0	0.0%	1	4	0.0%	8	29	0.1%
Gilroy	0	0	0.0%	3	4	0.0%	0	0	0.0%
Los Altos	0	0	0.0%	0	0	0.0%	0	0	0.0%
Los Altos Hills	34	100	1.2%	2	6	0.1%	0	0	0.0%
Los Gatos	0	0	0.0%	21	55	0.2%	2,456	7,582	24.2%
Milpitas	0	0	0.0%	0	0	0.0%	0	0	0.0%
Monte Sereno	0	0	0.0%	0	0	0.0%	410	1,171	33.7%
Morgan Hill	0	0	0.0%	0	0	0.0%	1,752	6,630	15.2%
Mountain View	0	0	0.0%	0	0	0.0%	0	0	0.0%
Palo Alto	0	0	0.0%	0	0	0.0%	1	4	0.0%
San José	2	9	0.0%	123	552	0.1%	109	492	0.0%
Santa Clara (city)	0	0	0.0%	0	0	0.0%	0	0	0.0%
Saratoga	0	0	0.0%	4	11	0.0%	2,071	5,657	18.7%
Sunnyvale	0	0	0.0%	0	0	0.0%	0	0	0.0%
Unincorporated County	959	3,604	4.1%	2,445	8,990	10.3%	2,740	11,601	13.3%
Total	**995**	**3,714**	**0.2%**	**2,599**	**9,622**	**0.5%**	**9,547**	**33,167**	**1.7%**

13.4.2 Property

Property damage from wildfires can significantly alter entire communities. The number of structures in each FHSZ within the OA and their values are summarized in Table 13-3 through Table 13-5. Table 13-6 shows the general land use of parcels exposed to the wildfire hazard in unincorporated areas of the OA.

13.4.3 Critical Facilities and Infrastructure

Table 13-7 identifies critical facilities exposed to the wildfire hazard in the OA. 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 lines 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 13-3. Exposure and Value of Structures in Very High Wildfire Hazard Areas

Jurisdiction	Buildings Exposed	Value Exposed			% of Total Replacement Value
		Structure	Contents	Total	
Campbell	0	$0	$0	$0	0.0%
Cupertino	8	$4,430,735	$2,215,367	$6,646,102	0.0%
Gilroy	0	$0	$0	$0	0.0%
Los Altos	0	$0	$0	$0	0.0%
Los Altos Hills	0	$0	$0	$0	0.0%
Los Gatos	2,456	$2,020,032,294	$1,481,843,045	$3,501,875,339	32.1%
Milpitas	0	$0	$0	$0	0.0%
Monte Sereno	410	$214,752,042	$107,376,021	$322,128,063	36.9%
Morgan Hill	1,752	$718,520,327	$374,497,669	$1,093,017,996	9.8%
Mountain View	0	$0	$0	$0	0.0%
Palo Alto	1	$103,393	$51,697	$155,090	0.0%
San José	109	$48,455,379	$32,806,811	$81,262,190	0.0%
Santa Clara (city)	0	$0	$0	$0	0.0%
Saratoga	2,071	$1,352,630,982	$863,254,769	$2,215,885,752	27.2%
Sunnyvale	0	$0	$0	$0	0.0%
Unincorporated County	2,740	$3,050,159,884	$2,320,634,488	$5,370,794,371	21.2%
Total	**9,547**	**$7,409,085,035**	**$5,182,679,866**	**$12,591,764,902**	**2.6%**

Table 13-4. Exposure and Value of Structures in High Wildfire Hazard Areas

Jurisdiction	Buildings Exposed	Value Exposed			% of Total Replacement Value
		Structure	Contents	Total	
Campbell	0	$0	$0	$0	0.0%
Cupertino	1	$299,414	$149,707	$449,120	0.0%
Gilroy	3	$5,388,313	$5,211,943	$10,600,256	0.1%
Los Altos	0	$0	$0	$0	0.0%
Los Altos Hills	2	$1,712,545	$856,272	$2,568,817	0.1%
Los Gatos	21	$17,090,786	$11,984,620	$29,075,407	0.3%
Milpitas	0	$0	$0	$0	0.0%
Monte Sereno	0	$0	$0	$0	0.0%
Morgan Hill	0	$0	$0	$0	0.0%
Mountain View	0	$0	$0	$0	0.0%
Palo Alto	0	$0	$0	$0	0.0%
San José	123	$101,534,540	$75,587,110	$177,121,649	0.1%
Santa Clara (city)	0	$0	$0	$0	0.0%
Saratoga	4	$1,395,833	$697,916	$2,093,749	0.0%
Sunnyvale	0	$0	$0	$0	0.0%
Unincorporated County	2,445	$2,762,305,929	$2,293,960,965	$5,056,266,893	19.9%
Total	**2,599**	**$2,889,727,358**	**$2,388,448,533**	**$5,278,175,892**	**1.1%**

Table 13-5. Exposure and Value of Structures in Moderate Wildfire Hazard Areas

Jurisdiction	Buildings Exposed	Value Exposed			% of Total Replacement Value
		Structure	Contents	Total	
Campbell	0	$0	$0	$0	0.0%
Cupertino	0	$0	$0	$0	0.0%
Gilroy	0	$0	$0	$0	0.0%
Los Altos	0	$0	$0	$0	0.0%
Los Altos Hills	34	$20,249,594	$10,124,797	$30,374,391	0.9%
Los Gatos	0	$0	$0	$0	0.0%
Milpitas	0	$0	$0	$0	0.0%
Monte Sereno	0	$0	$0	$0	0.0%
Morgan Hill	0	$0	$0	$0	0.0%
Mountain View	0	$0	$0	$0	0.0%
Palo Alto	0	$0	$0	$0	0.0%
San José	2	$607,153	$303,576	$910,729	0.0%
Santa Clara (city)	0	$0	$0	$0	0.0%
Saratoga	0	$0	$0	$0	0.0%
Sunnyvale	0	$0	$0	$0	0.0%
Unincorporated County	959	$610,543,345	$433,143,162	$1,043,686,507	4.1%
Total	**995**	**$631,400,091**	**$443,571,535**	**$1,074,971,627**	**0.2%**

Table 13-6. Land Use Within the Wildfire Hazard Areas

Type of Land Use	Moderate Severity Zone		High Severity Zone		Very High Severity Zone	
	Area (acres)	% of total	Area (acres)	% of total	Area (acres)	% of total
Agricultural	32,38.4	9.73	2,144.1	0.58	576.3	0.39
General / Institutional	0.0	0.00	202.1	0.05	19.9	0.01
Open Space	28,491.3	85.58	365,560.4	98.73	145,633.9	98.17
Low Density Residential	1,561.4	4.69	2,366.4	0.64	2,122.6	1.43
High Density Residential	0.0	0.00	0.0	0.00	0.0	0.00
Commercial	0.0	0.00	0.0	0.00	0.0	0.00
Industrial	0.0	0.00	0.0	0.00	0.0	0.00
Total	**33,291.2**	**100%**	**370,273.1**	**100%**	**148,352.6**	**100%**

Table 13-7. Critical Facilities and Infrastructure in Wildfire Hazard Areas

Type of Critical Facility	Number of Critical Facilities in Hazard Zone		
	Moderate	High	Very High
Emergency Response / Public Health & Safety	2	6	6
Infrastructure Lifeline	31	74	55
Military Facilities	0	0	0
Recovery Facilities	0	0	0
Socioeconomic Facilities	1	5	11
Hazardous Materials	0	2	0
Total	**34**	**87**	**72**

There are registered hazardous material containment sites in wildfire risk zones in the OA. During a wildfire, containers for these materials could rupture due to 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.

13.4.4 Environment

Fire is a natural and critical ecosystem process in most terrestrial ecosystems, dictating in part the types, structure, and spatial extent of native vegetation. However, 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.

Many ecosystems are adapted to historical patterns of fire occurrence. These patterns, called “fire regimes,” include temporal attributes (e.g., frequency and seasonality), spatial attributes (e.g., size and spatial complexity), and magnitude attributes (e.g., 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.

13.5 VULNERABILITY

Structures, above-ground infrastructure, critical facilities and natural environments are all vulnerable to the wildfire hazard. There is currently no validated damage function 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.

13.5.1 Population

There are no recorded incidents of loss of life from wildfires within the OA. 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, nitrogen oxides), and toxics (formaldehyde, 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.

13.5.2 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 replacement value of exposed structures. This 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 to be substantial by most building codes and typically requires total reconstruction of the structure. Table 13-8 lists the loss estimates for the general building stock for jurisdictions that have an exposure to a fire hazard severity zone (the aggregate of the 3 zones assessed).

Table 13-8. Loss Estimates for Wildfire (Aggregate of all Fire Severity zones assessed)

Jurisdiction	Exposed Value	Estimated Loss Potential from Wildfire		
		10% Damage	30% Damage	50% Damage
Campbell	$0	$0	$0	$0
Cupertino	$7,095,222	$709,522	$2,128,567	$3,547,611
Gilroy	$10,600,256	$1,060,026	$3,180,077	$5,300,128
Los Altos	$0	$0	$0	$0
Los Altos Hills	$32,943,208	$3,294,321	$9,882,962	$16,471,604
Los Gatos	$3,530,950,746	$353,095,075	$1,059,285,224	$1,765,475,373
Milpitas	$0	$0	$0	$0
Monte Sereno	$322,128,063	$32,212,806	$96,638,419	$161,064,031
Morgan Hill	$1,093,017,996	$109,301,800	$327,905,399	$546,508,998
Mountain View	$0	$0	$0	$0
Palo Alto	$155,090	$15,509	$46,527	$77,545
San José	$259,294,568	$25,929,457	$77,788,370	$129,647,284
Santa Clara (city)	$0	$0	$0	$0
Saratoga	$2,217,979,501	$221,797,950	$665,393,850	$1,108,989,750
Sunnyvale	$0	$0	$0	$0
Unincorporated County	$11,470,747,772	$1,147,074,777	$3,441,224,331	$5,735,373,886
Total	**$18,944,912,420**	**$1,894,491,242**	**$5,683,473,726**	**$9,472,456,210**

13.5.3 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 in which bridges are obstructed. 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.

13.6 FUTURE TRENDS IN DEVELOPMENT

Santa Clara County has been one of the state's fastest growing counties over the past 10 years, averaging a 1.21-percent increase in population per year from 2005 through 2015. The highly urbanized portions of the OA have little or no wildfire risk exposure. However, ongoing development can create the potential for the expansion of urbanized areas into wildland areas. The expansion of the wildland urban interface can be managed with strong land use and building codes. The OA is well equipped with these tools and this planning process has assessed capabilities with regards to the tools. As the OA 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.

13.7 SCENARIO

A major wildfire in the OA might begin with a water shortage causing tinder-like wildlands and "Red Flag" conditions occurring, indicating a combination of higher than normal temperatures, low humidity and winds blowing from the east across California to the ocean. Lightning strikes or human carelessness with combustible materials could trigger a multitude of small isolated fires.

The embers from these smaller fires could be carried miles by hot, dry winds. 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 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 include an active fire season throughout the American west, spreading resources thin. Firefighting teams would be exhausted or unavailable. Many federal assets would be responding to other fires that started earlier in the season.

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 vegetation 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.

13.8 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 activities such as defensible space, and advance identification of evacuation routes and safe zones.
- The OA has been under multi-year drought conditions and mandatory water rations.
- 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 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.
- Fire department water supply in high risk wildfire areas.
- 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.

14. CLIMATE CHANGE

14.1 GENERAL BACKGROUND

14.1.1 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 1.78ºF since 1880 (NASA, 2017). Although this change 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 before the industrial era began in the late 1700s and reached 401 parts per million in 2015 (EPA, 2016) (see Figure 14-1). In addition, the concentration of methane has almost doubled and nitrous oxide is being measured at a record high of 328 parts per billion (EPA, 2016a). In the United States, electricity generation is the largest source of these emission, followed by transportation (EPA, 2016b).

Scientists are able to place this rise in carbon dioxide in a longer historical context through the measurement of 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, most of this trend is very likely human-induced and it is proceeding at an unprecedented rate (NASA, 2016). There is broad scientific consensus (97 percent of scientists) that climate-warming trends are very likely due to human activities (NASA, 2016). Unless emissions of greenhouse gases are substantially reduced, this warming trend is expected to continue.

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

14.1.2 How Climate Change Affects Hazard Mitigation

An essential aspect of hazard mitigation is predicting the likelihood of hazard events. 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.

Source: EPA, 2016

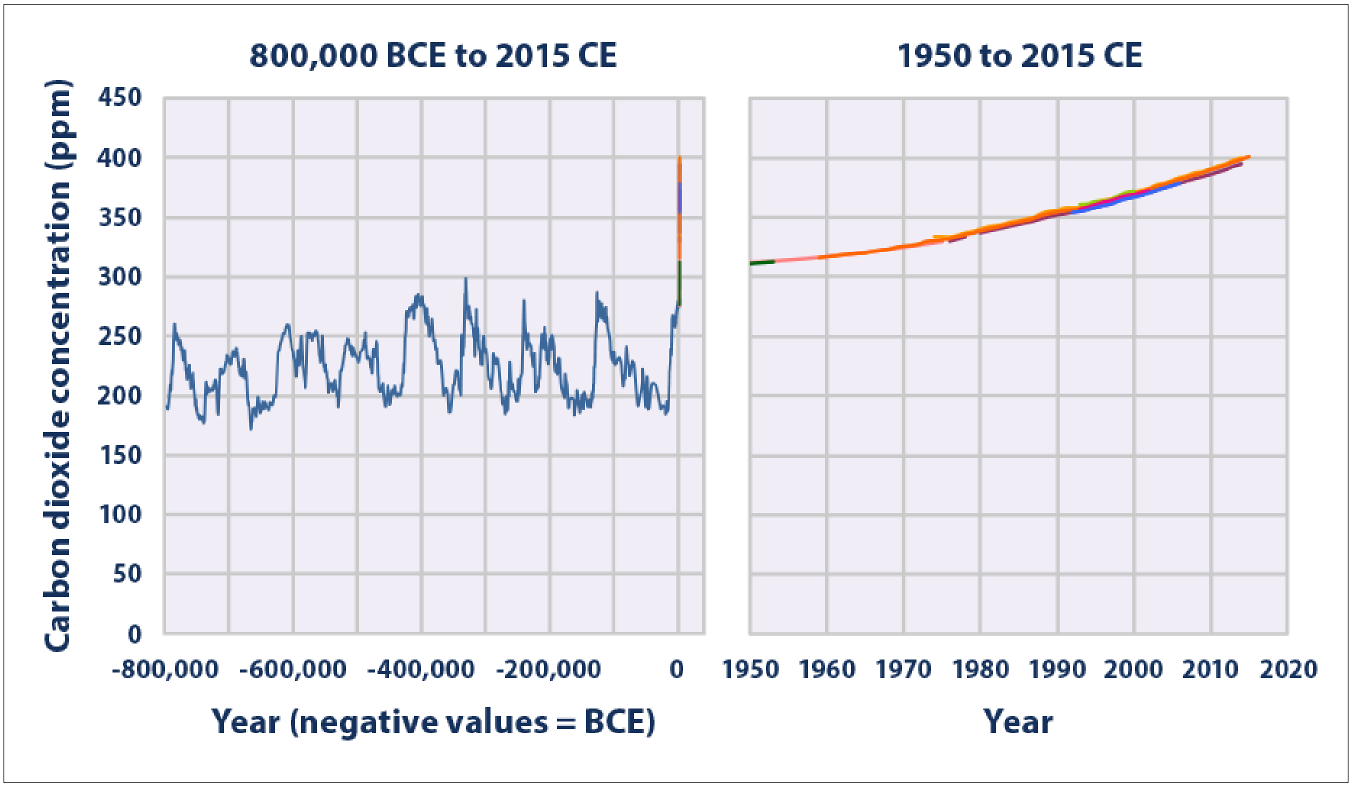


Figure 14-1. Global Carbon Dioxide Concentrations Over Time

For hazards that are affected by climate conditions, the assumption that future behavior will be equivalent to past behavior is not valid if climate conditions are changing. As flooding is generally associated with precipitation frequency and quantity, 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 in order to provide a context for the recommendation and implementation of hazard mitigation measures.

14.1.3 Current Indicators of Climate Change

The major scientific agencies of the United States and the world—including NASA, 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. The IPCC has stated that the warming of the climate system is unequivocal (IPCC, 2014). Sixteen of the 17 warmest years on record occurred since 2001, and 2015 was the warmest year on record (NASA, 2017).

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 has already put some coastal homes, beaches, roads, bridges, and wildlife at risk (USGCRP, 2009). At the time of the development of this plan, NASA reports the following trends (NASA, 2016):

- Carbon Dioxide—Increasing trend, currently at 405.6 parts per million.
- Global Temperature—Increasing trend, increase of 1.7ºF since 1880.
- Arctic Ice Minimum—Decreasing trend, 13.3 percent per decade.
- Land Ice—Decreasing trend, 281.0 gigatonnes per year.
- Sea Level—Increasing trend, 3.4 millimeters (0.04 inches) per year.

14.1.4 Projected Future Impacts

The *Third National Climate Assessment Report for the United States* indicates that impacts resulting from climate change will continue through the 21st century and beyond. Although 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, 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 1-4 feet by 2100.
- The Arctic may become ice free.

The *California Climate Adaptation Planning Guide* outlines the following climate change impact concerns for the Bay Area Region 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.

Some of these changes are direct or primary climatic changes, such as increased temperature, while others are indirect climatic changes or secondary impacts resulting from these direct changes, such as heat and air pollution. Some direct changes may interact with one another to create unique secondary impacts. These primary and secondary impacts may then result in impacts on human and natural systems. The primary and secondary impacts likely to effect the OA are summarized in Table 14-1.

Climate change projections contain inherent uncertainty, largely derived from the fact that they depend on future greenhouse gas emission scenarios. Generally, the uncertainty in greenhouse gas emissions is addressed by the presentation of differing scenarios: low-emissions or high-emissions scenarios. In low-emissions 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.

Table 14-1. Summary of Primary and Secondary Impacts Likely to Affect the OA

Primary Impact	Secondary Impact	Example Human and Natural System Impacts
Increased temperature	Heat wave	• Increased frequency of illness and death • Increased stress on mechanical systems, such as HVAC systems
Increased temperature and changes in precipitation	Changed seasonal patterns	• Reduced agricultural productivity • Reduced tourism
Increased temperature and/or reduced precipitation	Drought	• Reduced agricultural productivity • Decreased water supply
	Reduced Snowpack	• Decreased water supply • Reduced tourism
Sea level rise	Permanent inundation of previously dry land	• Loss of assets and tax base • Loss of coastal habitat
	Larger area impacted by extreme high tide	• More people and structures impacted by storms
	Increased coastal erosion	• Loss of assets and tax base
	Saltwater intrusion into freshwater systems	• Decreased water supply • Ecosystem disruption
Changes in wind patterns	Increased extreme events, including severe storms and fires	• More frequent disruption to systems resulting from severe storms
Ocean acidification		• Decreased biodiversity in marine ecosystems

Adapted and expanded from California Adaptation Planning Guide: Planning for Adaptive Communities

Despite this uncertainty, climate change projections present valuable information to help guide decision-making for possible future conditions. The following sections summarize information developed for the Santa Clara County OA by Cal-Adapt, a resource for public information on how climate change might impact local communities, based on the most current data available.

Temperature

The historical (1961-1990) average temperature in Santa Clara County is 60.2ºF. By 2090, the average temperature is expected to increase above this baseline by 3.4ºF and 5.8ºF in the low- and high-emissions scenarios, respectively (see Figure 14-2).

Extreme Heat

The extreme heat day temperature threshold for the OA is 91°F. The historical average number of extreme heat days is four. The number of extreme heat days, the number of warm nights (62°F threshold), the number of heat waves and the duration of heat waves are all expected to increase over the next century (see Figure 14-3).

Precipitation

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. Changes in precipitation patterns, coupled with warmer temperatures, may lead to significant changes in hydrology. In high-emissions scenarios, more precipitation may fall as rain rather than snow and this snow may melt earlier in the season, thus impacting the timing of changes in stream flow and flooding (Cal-Adapt, 2016).

Snow Pack

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

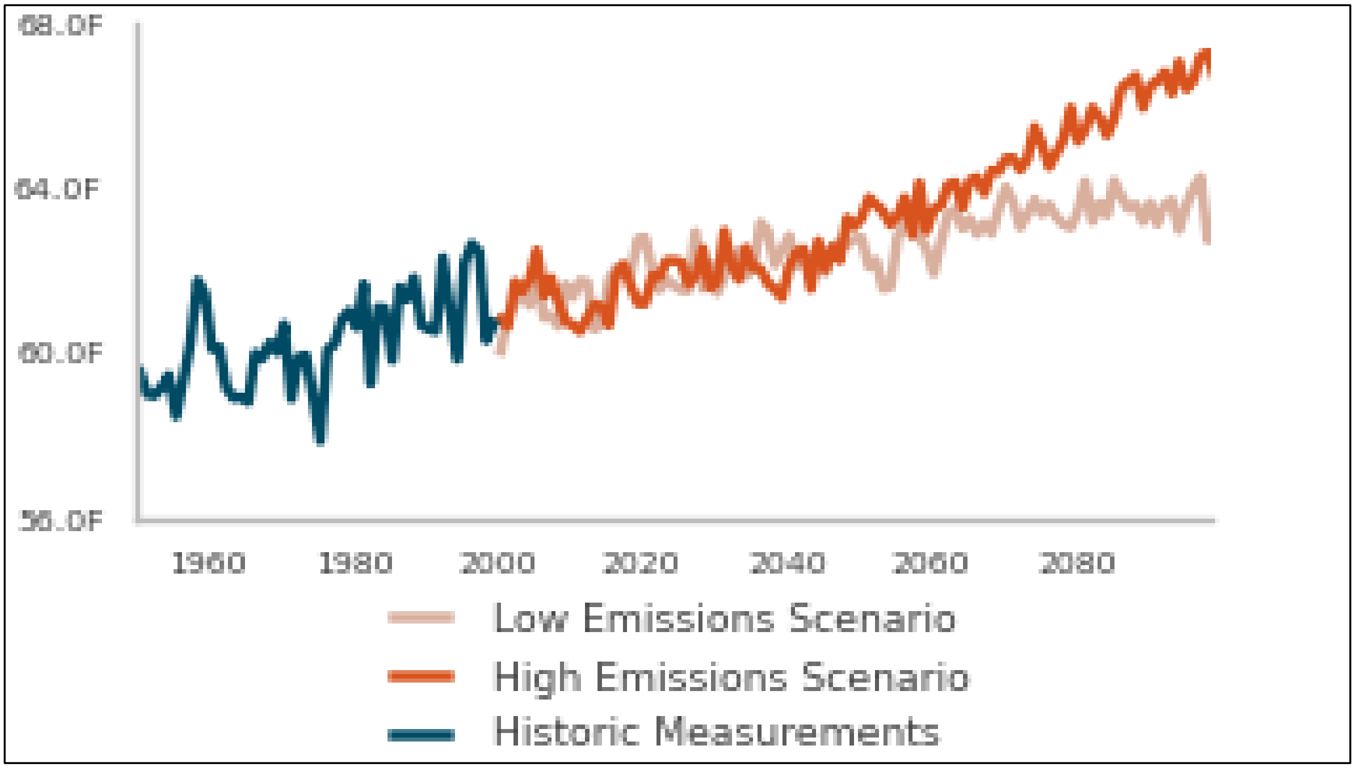


Figure 14-2. Observed and Projected Average Temperatures in Santa Clara County

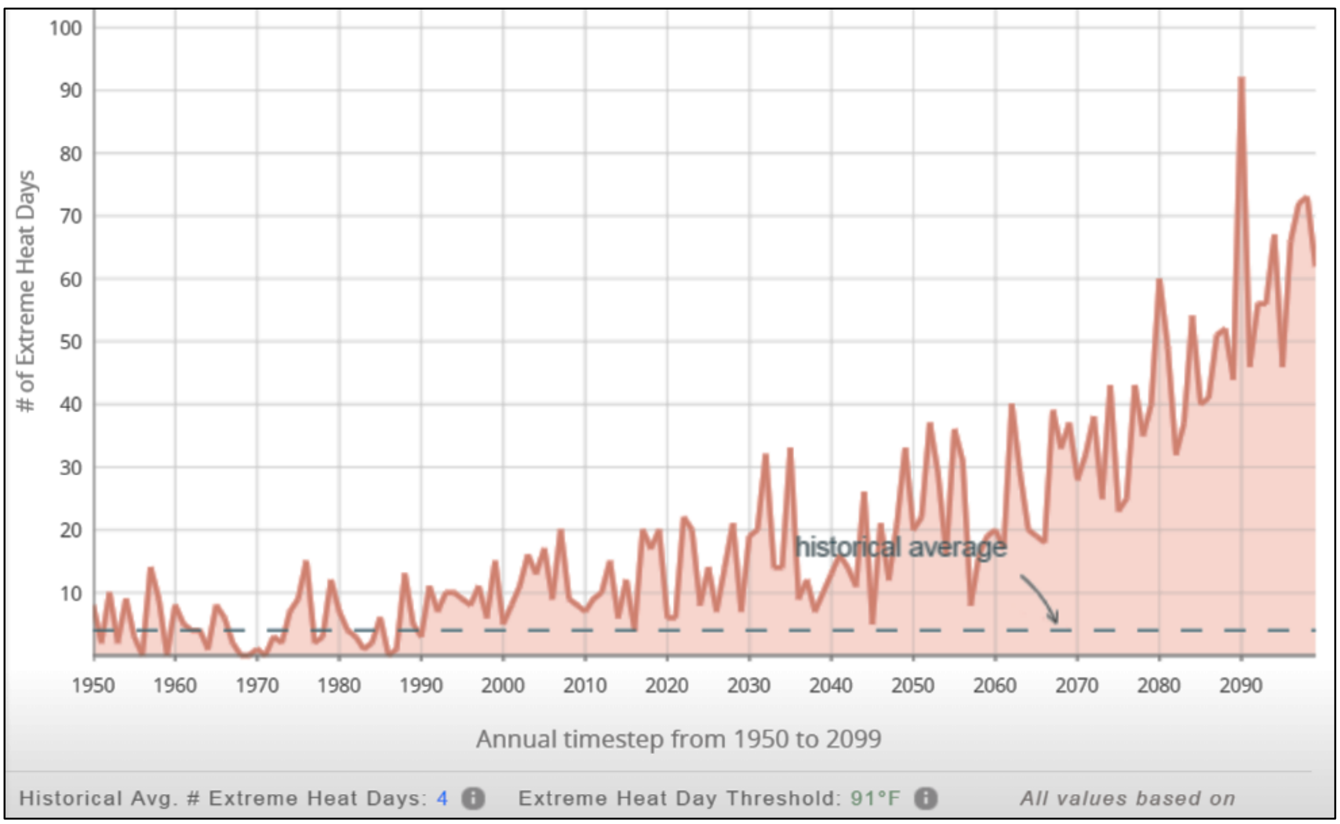


Figure 14-3. Projected Number of Extreme Heat Days by Year for OA

Wildfire

Wildfire risk is expected to change in the coming decades (see Figure 14-4). Under both high- and low-emissions scenarios, the change in area burned in Santa Clara County may slightly increase or remain about the same until 2050 and then decrease by 10 to 20 percent by 2085.

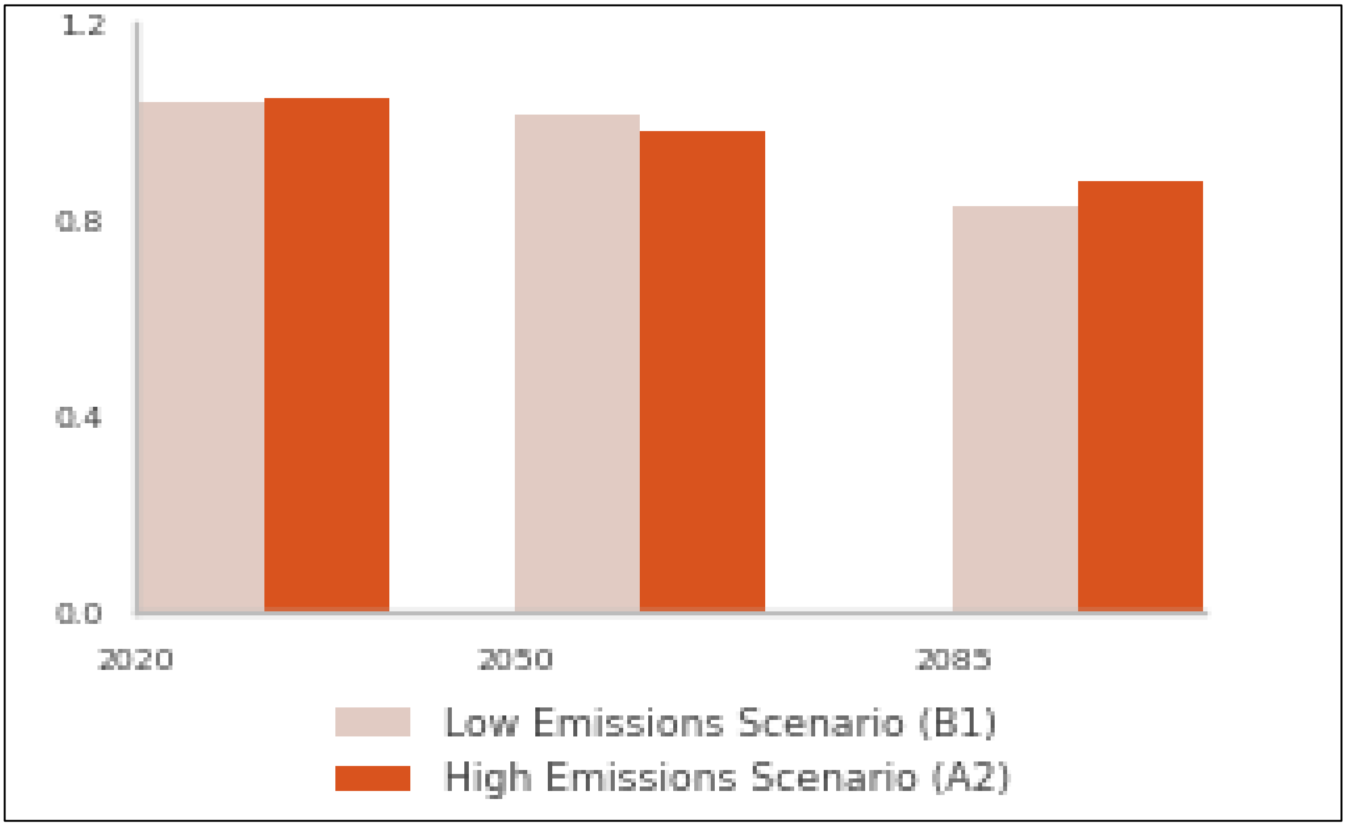


Figure 14-4. Projected Changes in Fire Risk in Santa Clara County, Relative to 2010 Levels

14.1.5 Responses to Climate Change

Communities and governments worldwide are working to address, evaluate and prepare for climate changes that are likely to impact 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, 2013).
- 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).

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

The IPCC defines adaptation as “the process of adjustment to actual or expected climate and its effects.” 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. Moreover, some initiatives and actions can both reduce greenhouse gas emissions and support adaptation to likely future conditions. The ability to adapt to changing conditions is often referred to as adaptive capacity, which is “the ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences” (IPCC, 2014).

Societies across the world are facing the need to adapt to changing conditions and to identify ways to increase their adaptive capacity. Some efforts are already underway. Farmers are altering crops and agricultural methods to deal with changing rainfall and rising temperature; architects and engineers are redesigning buildings; planners are looking at managing water supplies to deal with droughts or flooding.

Adaptive capacity goes beyond human systems, as some 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; 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. This includes the sustainable management, conservation and restoration of specific ecosystems that provide key services.

Assessment of the current efforts and adaptive capacity of the planning partners participating in this hazard mitigation plan are included in the jurisdiction-specific annexes in Volume 2.

14.2 VULNERABILITY ASSESSMENT— HAZARDS OF CONCERN

The following sections provide information on how each identified hazard of concern for this planning process may be impacted by climate change and how these impacts may alter current exposure and vulnerability to these hazards for the people, property, critical facilities and the environment in the OA.

14.2.1 Dam and Levee Failure

Climate Change Impacts on the 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 and levees. Dams and levees 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 or levee. If the hygrograph changes, it is conceivable that the dam or levee can lose some or all of its designed margin of safety, also known as freeboard.

In the case of dams, if freeboard is reduced, dam operators may be forced to release increased volumes earlier in a storm cycle in order to maintain the required margins of safety. Such early releases of increased volumes can increase flood potential downstream. According to the California Department of Water Resources, flood flows on many California rivers have been record-setting since the 1950s. This means that water infrastructure, such as dams, have been forced to manage flows for which they were not designed (DWR, 2007). The California Division of Dam Safety 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. According to the Division, climate change also 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 of the reservoir filling 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.

In the case of levees, a reduction in freeboard caused by a changing hydrograph means that a levee may no longer protect an area against the design-storm standard for which it was originally built (for example 1-percent-annual chance). This means that risk to the area that a levee is protecting from inundation will increase. Levee accreditation may be rescinded, resulting in currently protected areas being mapped within a flood hazard area.

Exposure, Sensitivity and Vulnerability

Population

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

Property

Property exposure and vulnerability to the dam failure hazard are unlikely to change as a result of climate change. However, if areas previously protected by accredited levees are mapped in a special flood hazard area, the assets considered to be exposed to the flood hazard may increase.

Critical facilities

The exposure and vulnerability of critical facilities are unlikely to change as result of climate change. Dam owners and operators are sensitive to the risk and may need to alter maintenance and operations to account for changes in the hydrograph and increased sedimentation. Critical facility owners and operators in levee failure inundation areas should always be aware of residual risk from flood events that may overtop the levee system.

Environment

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

Economy

Changes in the dam failure hazard related to climate change are unlikely to affect the local economy. Economic impacts may result from changes to the levee failure hazard if accreditation is lost.

14.2.2 Drought

Climate Change Impacts on the 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).

Because expected changes in precipitation patterns are still uncertain, the potential impacts and likelihood of drought are uncertain. DWR has noted impacts 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 provides a large amount of the water supply for the Santa Clara County OA and other parts of the state, will experience a 48- to 65-percent loss by the end of the century compared to historical averages (DWR, 2016b). Increasing temperatures may also increase net evaporation from reservoirs by 15 to 37 percent (DWR, 2013). In addition to snowpack resources, the OA’s water supply is derived from groundwater and surface water resources. Increased incidence of drought may cause a drawdown in groundwater resources without allowing for the opportunity for aquifer recharge.

Exposure, Sensitivity and Vulnerability

Population

Population exposure and vulnerability to drought are 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 are unlikely to increase as a result of increased drought resulting from climate change; however, critical facility operators may be sensitive to changes and 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. Ecosystems and biodiversity in the Bay Area are already under stress from development and water diversion activities. Prolonged or more frequent drought resulting from climate change may further stress the ecosystems in the region, which include many special status species.

Economy

Increased incidence of drought could increase the potential for impacts on the local economy. Increased drought may impact the wine industry and related tourism activities.

14.2.3 Earthquake

Climate Change Impacts on the 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 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 due to the increased saturation. Dams storing increased volumes of water due to changes in the hydrograph could fail during seismic events.

Exposure, Sensitivity and Vulnerability

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

14.2.4 Flood

Climate Change Impacts on the Hazard

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 frequency and severity of extreme climate events such as floods. Scientists project greater storm intensity with climate change, resulting in more direct runoff and flooding. High frequency flood events (e.g. 10-year floods) in particular will likely increase with a changing climate. What is currently considered a 1-percent-annual-chance (100-year flood) also may strike more often, leaving many communities at greater risk. Going forward, model calibration must happen 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 impacting water resources, and resource managers have observed the following:

- Historical hydrologic patterns can no longer be solely relied upon 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. 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 due to climate change, there is potential for more floods following fire, which increase sediment loads and water quality impacts.

Exposure, Sensitivity and Vulnerability

Population and Property

Population and property exposure and vulnerability may increase as a result of climate change impacts on the flood hazard. Runoff patterns may change, resulting in flooding in areas where it has not previously occurred.

Critical Facilities

Critical facility exposure and vulnerability may increase as a result of climate change impacts on the flood hazard. Runoff patterns may change, resulting in risk to facilities that have not historically been at risk from flooding. Additionally, changes in the management and design of flood protection critical facilities may be needed as additional stress is placed on these systems. 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.

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.

Economy

If flooding becomes more frequent, there may be impacts on the local economy. More resources may need to be directed to response and recovery efforts, and businesses may need to close more frequently due to loss of service or access during flood events.

14.2.5 Landslide

Climate Change Impacts on the Hazard

Climate change may impact 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 landslide occurrences.

Exposure, Sensitivity and Vulnerability

Population and Property

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

Critical facilities

Critical facility exposure and vulnerability would be unlikely to increase as a result of climate change impacts on 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. In addition, increased sedimentation resulting from landslides may negatively impact flood control facilities, such as dams.

Environment

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

Economy

Changes to the landslide hazard resulting from climate change are unlikely to result in impacts on the local economy.

14.2.6 Severe Weather

Climate Change Impacts on the Hazard

Climate change presents a challenge for risk management associated with severe weather. The number of weather-related disasters during the 1990s was four times that of the 1950s and led to 14 times as much in economic losses. The science for linking the severity of specific severe weather events to climate change is still evolving; however, a number or trends provide some indication of how climate change may be impacting these events. According to the *U.S. National Climate Change Assessment* (2014), there were more than twice as many high temperature records as low temperature records broken between 2001 and 2012, and heavy rainfall events are becoming more frequent and more severe.

The 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 the urban heat island effect. Evidence suggests that heat waves are already increasing, especially in western states. Extreme heat days in the OA are likely to increase.

Climate change impacts on other severe weather events such as thunderstorms and fog are still not well understood.

Exposure, Sensitivity and Vulnerability

Population and Property

Population and property exposure and vulnerability would be unlikely to increase as a direct result of climate change impacts on the severe weather hazard. Severe weather events may occur more frequently, but exposure and vulnerability will remain the same. Secondary impacts, such as the extent of localized flooding, may increase, impacting 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 on 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; however, more frequent storms and heat events and more intense rainfall may place additional stressors on already stressed systems.

Economy

Climate change impacts on the severe weather hazard may impact the local economy through more frequent disruption to services, such as power outages.

14.2.7 Tsunami

Climate Change Impacts on the Hazard

The impacts of global climate change on tsunami probability are unknown. Some scientists say that melting glaciers could induce tectonic activity, inducing earthquakes. Other scientists have indicated that underwater avalanches (also caused by melting glaciers), may also result in tsunamis. Even if climate change does not increase the frequency with which tsunamis occur, it may result in more destructive waves. As sea levels continue to rise, tsunami inundation areas would likely reach further into communities than current mapping indicates.

Exposure, Sensitivity and Vulnerability

As land area likely to be inundated by tsunami waves increases, exposure and vulnerability to the tsunami hazard may increase for population, property, critical facilities and the environment.

Changes to the tsunami hazard from climate change may result in more direct economic impacts on a greater number of businesses and economic centers, as well as the infrastructure systems that support those businesses.

14.2.8 Wildfire

Climate Change Impacts on the Hazard

Wildfire is determined 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.

Changes in climate patterns may impact the distribution and perseverance of insect outbreaks that create dead trees (increase fuel). When climate alters fuel loads and fuel moisture, forest susceptibility to wildfires changes. 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.

Exposure, Sensitivity and Vulnerability

Population

According to Cal-Adapt projections, wildfire risk in the areas surrounding the OA may actually decrease over the next century. Other areas of California and the western United States are expected to have increased risk to wildfire, with increases in annual acres burned. Although OA residents may not experience increased risk to wildfire directly, secondary impacts, such as poor air quality may increase.

Property and Critical Facilities

If wildfire risk decreases, the exposure and vulnerability of property and critical facilities would remain the same.

Environment

It is possible that the exposure and vulnerability of the environment will be impacted by changes in wildfire risk due to climate change. Natural fire regimes may change, resulting in more or less frequent or higher intensity burns. These impacts may alter the composition of the ecosystems in areas in and surrounding the OA.

Economy

As the risk from wildfire is currently projected to decrease, direct impacts on the economy would not be likely.

14.3 VULNERABILITY ASSESSMENT—SEA LEVEL RISE

14.3.1 Climate Change Impacts on the Hazard

In addition to impacts on the identified hazards of concern, climate change presents risks related to sea level rise. Sea level rise will cause currently dry areas to be permanently inundated; temporary inundation from extreme tide events and storm surge also will change. Unlike many other impacts resulting from climate change, sea level rise will have a defined extent and location. Although the extent and timing of sea level rise is still uncertain, conducting an assessment of potential areas at risk provides information appropriate for planning purposes.

14.3.2 Exposure, Sensitivity and Vulnerability

The following assessment was conducted using data provided by the San Francisco Bay Conservation and Development Commission. A sea level rise of 77 inches above current mean higher high water was assumed.

Population

Sea level rise will increase the population exposed to both permanent and temporary inundation. Currently, approximately 1.2 percent of the OA population is estimated to reside in areas subject to sea level rise impacts. The vast majority of these individuals reside in Palo Alto. Table 14-2 shows exposed population by jurisdiction.

Table 14-2. Estimated Population Residing in Sea Level Rise Inundation Areas

Jurisdiction	Estimated Population	Estimated Population Exposed	% of Population Exposed
Campbell	42,584	0	0.0%
Cupertino	58,185	0	0.0%
Gilroy	55,170	0	0.0%
Los Altos	31,353	0	0.0%
Los Altos Hills	8,658	0	0.0%
Los Gatos	31,376	0	0.0%
Milpitas	75,521	2,691	3.6%
Monte Sereno	3,475	0	0.0%
Morgan Hill	43,645	0	0.0%
Mountain View	77,925	27	0.0%
Palo Alto	68,207	13,685	20.1%
San José	1,042,094	3,529	0.3%
Santa Clara (city)	123,752	1,791	1.4%
Saratoga	30,219	0	0.0%
Sunnyvale	148,372	634	0.4%
Unincorporated County	87,352	5	0.0%
Total	**1,927,888**	**22,361**	**1.2%**

Property

There are 6,469 structures within the sea level rise inundation areas, about 88 percent of them residential. This represents about 4 percent of the OA's total replacement value. Table 14-3 shows the distribution of structure types exposed and Table 14-4 shows the estimated replacement value of exposed structures. The majority of these assets are in Sunnyvale, San José and Palo Alto.

Table 14-3. Structure Type in Sea Level Rise Inundation Areas

Jurisdiction	Residential	Commercial	Industrial	Agricultural	Religious	Government	Education	Total
Campbell	0	0	0	0	0	0	0	**0**
Cupertino	0	0	0	0	0	0	0	**0**
Gilroy	0	0	0	0	0	0	0	**0**
Los Altos	0	0	0	0	0	0	0	**0**
Los Altos Hills	0	0	0	0	0	0	0	**0**
Los Gatos	0	0	0	0	0	0	0	**0**
Milpitas	620	10	4	0	1	0	0	**635**
Monte Sereno	0	0	0	0	0	0	0	**0**
Morgan Hill	0	0	0	0	0	0	0	**0**
Mountain View	6	53	42	0	0	1	0	**102**
Palo Alto	3,799	129	71	0	7	0	8	**4,014**
San José	767	111	26	0	6	0	2	**912**
Santa Clara (city)	390	32	28	0	0	0	0	**450**
Saratoga	0	0	0	0	0	0	0	**0**
Sunnyvale	130	66	157	1	1	0	0	**355**
Unincorporated County	1	0	0	0	0	0	0	**1**
Total	**5,713**	**401**	**328**	**1**	**15**	**1**	**10**	**6,469**

Table 14-4. Structure and Contents Value in Sea Level Rise Inundation Areas

Jurisdiction	Structures Exposed	Estimated Value of Exposed Structures	Estimated Value of Exposed Contents	Estimated Total Value	% of Total Replacement Value
Campbell	0	$0	$0	$0	0.0%
Cupertino	0	$0	$0	$0	0.0%
Gilroy	0	$0	$0	$0	0.0%
Los Altos	0	$0	$0	$0	0.0%
Los Altos Hills	0	$0	$0	$0	0.0%
Los Gatos	0	$0	$0	$0	0.0%
Milpitas	635	$468,554,661	$386,407,648	$854,962,309	4.5%
Monte Sereno	0	$0	$0	$0	0.0%
Morgan Hill	0	$0	$0	$0	0.0%
Mountain View	102	$1,012,240,021	$1,110,560,396	$2,122,800,417	8.5%
Palo Alto	4,014	$2,069,879,805	$1,642,022,511	$3,711,902,316	14.4%
San José	912	$2,573,152,965	$2,275,265,284	$4,848,418,248	2.3%
Santa Clara (city)	450	$1,273,778,027	$1,228,024,465	$2,501,802,492	5.8%
Saratoga	0	$0	$0	$0	0.0%
Sunnyvale	355	$2,632,745,163	$3,074,816,827	$5,707,561,990	13.3%
Unincorporated County	1	$262,260	$131,130	$393,390	0.0%
Total	**6,469**	**$10,030,612,900**	**$9,717,228,260**	**$19,747,841,162**	**4.1%**

Critical Facilities

There are 185 critical facilities (5 percent of the total) located in OA areas subject to impacts from sea level rise. The majority of these facilities are infrastructure lifeline related facilities (65 percent) in Table 14-5.

Table 14-5. Critical Facilities in Sea Level Rise Inundation Areas

Jurisdiction	Emergency Response / Public Health & Safety	Infrastructure Lifeline	Military Facilities	Recovery Facilities	Socioeconomic Facilities	Hazardous Materials	Total
Campbell	0	0	0	0	0	0	0
Cupertino	0	0	0	0	0	0	0
Gilroy	0	0	0	0	0	0	0
Los Altos	0	0	0	0	0	0	0
Los Altos Hills	0	0	0	0	0	0	0
Los Gatos	0	0	0	0	0	0	0
Milpitas	0	15	0	0	2	1	18
Monte Sereno	0	0	0	0	0	0	0
Morgan Hill	0	0	0	0	0	0	0
Mountain View	1	13	0	0	0	2	16
Palo Alto	0	30	0	0	15	5	50
San José	2	25	0	0	5	7	39
Santa Clara (city)	0	19	0	0	4	8	31
Saratoga	0	0	0	0	0	0	0
Sunnyvale	1	18	0	0	0	10	29
Unincorporated County	0	1	0	0	0	1	2
Total	4	121	0	0	26	34	185

Environment

All sea level rise inundation areas are exposed and vulnerable to impacts. Important coastal habitat may be lost as sea level rise permanently inundates areas, or it may be damaged due to extreme tide and storm surge events. Saltwater intrusion into freshwater resources may occur, further altering habitat and ecosystems. Protective ecosystem services may be lost as land area and wetlands are permanently inundated.

Economy

Sea level rise will impact the local economy. The tourism industry may be impacted as historic coastal properties are inundated. Critical facilities and other important assets may be damaged by temporary inundation, resulting in loss of services such as power or wastewater treatment. Coastal businesses may relocate to other areas rather than face high costs from increased risk to storm surge and costs associated with managed retreat. Local tax revenue may decline as areas that were previously occupied by houses and businesses are permanently inundated.

Future Development

The land area of the OA will be reduced as sea level rise permanently inundates areas. This will have significant impacts on land use and planning in local communities. Local general plans in the OA will guide this future development.

14.4 ISSUES

The major issues for climate change are the following:

- Planning for climate change related impacts can be difficult due to inherent uncertainties in projection methodologies.
- Average temperatures are expected to continue to increase in the OA, which may lead to a host of primary and secondary impacts, such as an increased incidence of heat waves.
- Expected changes in precipitation patterns are still poorly understood and could have significant impacts on the water supply and flooding in the OA.
- Some impacts of climate change are poorly understood such as potential impacts on the frequency and severity of earthquakes, thunderstorms and tsunamis.
- Heavy rain events may result in inland stormwater flooding after stormwater management systems are overwhelmed.
- Permanent and temporary inundation resulting from sea level rise has the potential to impact significant portions of the population and assets in the OA.

15. OTHER HAZARDS OF INTEREST

15.1 GENERAL BACKGROUND

In addition to the hazards of concern presented in the preceding chapters, four other hazards of interest were identified for inclusion in this plan:

- Intentional criminal, malicious acts, including acts of terrorism, cyber threats, and active threats.
- Technological incidents that arise accidentally from human activities such as the manufacture, transportation, storage and use of hazardous materials; transportation accidents; pipeline failure and release; and utility failure.
- Epidemics and pandemics of human disease.
- Fog

Although the DMA does not require an assessment of these hazards, the Working Group decided to include them in this hazard mitigation plan for the following reasons:

- This plan takes a proactive approach to disaster preparedness to protect the public safety of all citizens.
- Preparation for and response to an event involving these hazards of interest will involve many of the same staff, 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 those beyond the natural hazards of concern.
- The likelihood of an event involving one of these hazards of interest in the Santa Clara County OA is greater than some of the identified natural hazards in this plan.
- The planning partners participate with the Bay Area Urban Area Security Initiative, ensuring a regional capacity to prevent, protect against, respond to, and recover from terrorist activities. The Santa Clara County Sheriff's Department is a member agency of the South Bay Terrorism Early Warning Group (TEWG) to interdict terrorism in local communities.

This chapter summarizes available information on the identified hazards of interest. It profiles them, but they are not fully assessed and ranked like the primary hazards of concern. Mitigation actions for these hazards are not mandatory under 44 CFR Section §201.6(c)(2)(i)).

DEFINITIONS

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.

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 quantity, 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.

Fog— Visible cloud water droplets that are low-lying and influenced by nearby bodies of water, topography, and wind conditions.

15.1.1 Intentional Hazards

Terrorism and Weapons of Mass Destruction

Terrorist activities are those that involve an illegal use of force, are intended to intimidate or coerce, and are committed in support of political or social objectives. FEMA defines terrorism as 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 cyber-terrorism (FEMA 386-7). The following are potential methods used by terrorists that could affect the OA as a direct target or collaterally:

- Bombings; improvised explosive devices
- Suicide attacks
- Chemical or biological weapons
- Radiological dispersal device
- Vehicle/aircraft attacks
- Incendiary devices/arson
- Conventional firearms/mass shootings
- Secondary attacks
- Cyber-terrorism
- Agro-terrorism
- Kidnappings/assassinations
- Nuclear weapons (fission or thermonuclear)

Three important considerations distinguish terrorism hazards from other types of hazards:

- Terrorism evokes very strong emotional reactions, ranging from anxiety, to fear, to anger, to despair, to depression, which must be taken into consideration for planning.
- There is limited scientific understanding of how some terrorist weapons, such as biological and radiological agents, affect the population at large.
- In the case of biological and radiological 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.

The Federal Bureau of Investigation (FBI) categorizes two types of terrorism in the United States:

- 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 coordinates 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 activities are foreign-based or directed by groups outside the United States, or whose activities transcend national boundaries. Examples include the 1993 bombing of the World Trade Center, the U.S. Capitol, and Mobil Oil's corporate headquarters and the attacks of September 11, 2001 at the World Trade Center and the Pentagon.

Those involved with terrorism response, including law enforcement, fire and rescue, 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.

Table 15-1 provides a hazard profile summary for terrorism-related hazards. Most terrorist events in the United States have been involved detonated and undetonated explosive devices, tear gas, pipe bombs, and firebombs.

Table 15-1. Event Profiles for Terrorism

Hazard	Application Mode[a]	Hazard Duration[b]	Static/Dynamic Characteristics[c]	Mitigating and Exacerbating Conditions[d]
Conventional Bomb	Detonation of explosive device on or near target; delivery via person, vehicle, or projectile.	Instantaneous; additional secondary devices, 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/aerosol contaminants dispersed using sprayers or other aerosol generators; liquids vaporizing from puddles/ containers; or munitions.	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.
Arson/ 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.	Mitigation 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.

Hazard	Application Mode[a]	Hazard Duration[b]	Static/Dynamic Characteristics[c]	Mitigating and Exacerbating Conditions[d]
Biological Agent	Liquid or solid contaminants dispersed using sprayers/ aerosol generators or by point or line sources such as munitions, covert deposits, and moving sprayers.	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 humans or animals.	Altitude of release above ground 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.
Radiological Agent	Radioactive contaminants dispersed using sprayers/ aerosol generators, or by point or line sources such as munitions.	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.

Hazard	Application Mode[a]	Hazard Duration[b]	Static/Dynamic Characteristics[c]	Mitigating and Exacerbating Conditions[d]
Intentional Hazardous Material Release (fixed facility or transportation)	Solid, liquid, and/or gaseous contaminants 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.	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.

a. Application Mode—application mode describes the human acts or unintended events necessary to cause the hazard to occur.
b. Duration—duration is the length of time the hazard is present. For example, a chemical warfare agent such as mustard gas, if un-remediated, can persist for hours or weeks under the right conditions.
c. Dynamic or Static Characteristics—these 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.
d. Mitigation 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.

Source: FEMA 386-7

The effects of terrorism can include injuries, loss of life, property damage, or disruption of services such as electricity, water supplies, transportation, or communications. Effects may be immediate or delayed. 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 terrorism, the unpredictability of human beings must be considered. People with a desire to perform such acts may seek out targets of opportunity that may not fall into established lists of critical areas or facilities. First responders in the Santa Clara County OA train to respond not only to organized terrorism events, but also to random acts by individuals who may choose to harm others and destroy property. While education, heightened awareness, and early warning of unusual circumstances may deter terrorism, intentional acts that harm people and property are possible at any time. Public safety entities must react to the threat, locating, isolating, and neutralizing further damage and investigating potential scenes and suspects to bring criminals to justice.

Cyber Threats

A cyber threat is an intentional and malicious crime that compromises the digital infrastructure of a person or organization, often for financial or terror-related reasons. Such attacks vary in nature and are perpetrated using digital mediums or sometimes social engineering to target human operators. Generally, attacks last minutes to days, but large-scale events and their impacts can last much longer. As information technology continues to 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).

Cyber threats differ by motive, attack type and perpetrator profile. Motives range from the pursuit of financial gain to political or social aims. Cyber threats are difficult to identify and comprehend. Types of threats include using viruses to erase entire systems, breaking into systems and altering files, using someone's personal computer to attack others, or stealing confidential information. The spectrum of cyber risks is limitless, with threats having a wide-range of effects on the individual, community, organizational, and national threat (FEMA, 2013).

This risk assessment includes cyber-attacks and cyberterrorism. The terms often are used interchangeably, though they are not the same. While all cyberterrorism is a form of cyber-attack, not all cyber-attacks are cyberterrorism.

Cyber-Attacks

Public and private computer systems are subject to a variety of cyber-attacks, from blanket malware infection to targeted attacks on system capabilities. Cyber-attacks seek to breach IT security measures designed to protect an individual or organization. The initial attack is followed by more severe attacks for the purpose of causing harm, stealing data, or financial gain. Organizations are prone to attacks that can be either automated or targeted. Table 15-2 describes the most common cyber-attack mechanisms faced by organizations today.

Table 15-2. Common Mechanisms for Cyber Attacks

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	Man-in-the-Middle attacks mirror victims and endpoints for online information exchange. In this type of attack, the attacker communicates with the victims, who believe they are interacting with a legitimate endpoint website. The attacker is also communicating with the actual endpoint website by impersonating the victim. As the process goes through, the attacker 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.

Source: Danielson, 2015

With millions of threats created each day, the importance of protection against cyber-attacks becomes a necessary function of everyday operations for individuals, government facilities, and businesses. The increasing dependency on technology for vital information storage and the often automated method of infection means higher stakes for the success of measurable protection and education.

Since 2013, a new type of cyber-attack 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 stored on the system. The victim then receives a message that demands a fee in the form of electronic currency or cryptocurrency, such as Bitcoin, for the decryption code (see Figure 15-1). In October 2015, the FBI said that commonly used ransomware is so difficult to override, that victims should pay the ransom to retrieve their data (Danielson, 2015).

Figure 15-1. Pop-Up Message Indicating Ransomware Infection

Cyberterrorism

Cyberterrorism is the use of 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. Such disruptions can be driven by religious, political, or other motives. Like traditional terrorism tactics, cyberterrorism seeks to evoke very strong emotional reactions, but it does so through information technology rather than a physically violent or disruptive action. Cyberterrorism has three main types of objectives (Kostadinov, 2012):

- Organizational— cyberterrorism with an organizational objective includes specific functions outside of or in addition to a typical cyber-attack. 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— cyberterrorism with undermining as an objective seeks to hinder the normal functioning of 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. Undermining attacks on computers include the following (Waldron, 2011):
    - ❖ Directing conventional kinetic weapons against computer equipment, a computer facility, or transmission lines to create a physical attack that disrupts the reliability of equipment.
    - ❖ Using electromagnetic energy, most commonly in the form of an electromagnetic pulse, to create an electronic attack against computer equipment or data transmissions. By overheating circuitry or jamming communications, an electronic attack disrupts the reliability of equipment and the integrity of data.
    - ❖ Using malicious code directed against computer processing code, instruction logic, or data. The code can generate a stream of malicious network packets that disrupt data or logic by exploiting vulnerability in computer software, or a weakness in computer security practices. This type of cyber-attack can disrupt the reliability of equipment, the integrity of data, and the confidentiality of communications (Wilson, 2008).
- Destructive— the destructive objective for cyberterrorism is what organizations fear most. Through the use of computer technology and the Internet, the 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.

Active Threats

Active Shooter

Active shooter attacks are typically motivated by the desire to maximize human casualties. They are differentiated from other attack types by the indiscriminate nature of the victims, who often are targets of opportunity. Active shooter attacks range from “lone wolf” shooters who act alone and without any organizational affiliation to organized groups acting in concert to achieve a specific objective. Active shooter tactics sometimes employ a blend of lone shooters and multi-person teams as part of a larger assault.

Active shooters may use small arms, light weapons, or a combination of the two depending on the type of attack. Small arms are revolvers, automatic pistols, rifles, shotguns, assault rifles, light machine guns, etc. Light weapons are medium caliber and explosive ordinance, grenade launchers, rocket propelled grenades, etc. Attackers can increase their likelihood of success by using a wider array of weapons, including improvised explosive devices.

Biological Threats

Biological hazards include disease-causing microorganisms and pathogens, such as bacteria and viruses, that multiply within a host and cause an infection. Some bacteria and viruses can spread from one individual to another. Infections typically occur as a result of airborne exposure, skin contact, or ingestion. In general, exposure to bacteria and viruses can occur through inhalation (as is the case with airborne *B. anthracis* spores, which cause anthrax), ingestion of contaminated food or water (the case with *E. coli*, which causes gastrointestinal infection), contact with infected individuals, or contact with contaminated surfaces (which may be harboring, for example, viruses that cause influenza). Domestic and transnational threat groups have considered targeting heating, ventilation, and air conditioning systems of large commercial buildings.

Anthrax has been used as a weapon for nearly 100 years and is one of the most likely agents to be used in a biological threat. Its spores are easily found in nature, can be produced in a lab, and can last for a long time. It can be released quietly and without anyone knowing. Microscopic spores can be put into powders, sprays, food, and water. Due to their size, victims may not be able to see, smell or taste them (CDC, 2016). Terrorists may release anthrax spores in public places. In 2001, letters containing powdered anthrax spores were sent through the U.S. mail, causing skin and lung anthrax in 22 people. Five people died, all due to lung anthrax (San Francisco Department of Health, 2016).

If a biological attack were to occur in the Santa Clara County OA, a large number of personnel could be impacted. Buildings in the impacted area and transportation infrastructure might be closed for investigation and cleanup. These areas would not be accessible until cleanup is completed, which would impact the businesses. Hospitals could become overwhelmed with people coming in fearing contamination. Residents and businesses may need to shelter in place in the area of the attack.

Chemical Threats

Chemical weapons are poisonous vapors, aerosols, liquids, and solids that have toxic effects on humans, animals, and plants. Exposure pathways include inhalation, skin contact, ingestion or injection. Depending on the severity of exposure, impacts may include temporary illness or injury, permanent medical conditions, or death. An attack using chemical threats can come without warning. Signs of a chemical release include difficulty breathing; eye irritation; losing coordination; nausea; or a burning sensation in the nose, throat and lungs (Ready.gov, 2016b). Harmful chemicals that could be used in an attack include the following (U.S. Department of Homeland Security, 2004):

- Chemical weapons developed for military use (warfare agents).
- Toxic industrial and commercial chemicals that are produced, transported, and stored in the making of petroleum, textiles, plastics, fertilizers, paper, foods, pesticides, household cleaners, and other products.
- Chemical toxins of biological origin such as ricin.

Recently, there have been reports of chlorine found in explosive devices, mortars, rockets, and missiles. Chlorine has been used in the past, mainly in blunt, terrorist-style attacks. Some experts believe that groups are trying to advance their technology for deploying the chemical in combat operations (Tilghman, 2015). Chlorine is an acutely toxic industrial compound that can cause severe coughing, pulmonary, eye and skin irritation, and even death at higher concentrations (USACHPPM, 2015).

A chemical release in the Santa Clara County OA could lead to closure of streets and major transportation routes (including bridges) for extended periods of time, causing transportation delays and traffic. Many homes and businesses would also be impacted as they would need to be evacuated for an extended period of time. There could also be impact on the environment and/or natural resources that would require cleanup. Hazardous material response teams and fire-rescue would be needed to respond to the incident and coordinate cleanup efforts.

Explosive Devices

Improvised explosive device (IED) attacks are a favored method of terrorist groups around the world. The evolution in explosive materials and firing devices and their ease of concealment and delivery have increased the effectiveness of this hazard. IED attacks are typically motivated by the desire to maximize human casualties. Explosive incidents account for 70 percent of all terrorist attacks worldwide. These types of attacks range from small-scale letter bombs to large-scale attacks on specific buildings. According to the FBI, 172 improvised explosive devices were reported in the United States between October 2012 and April 2013.

IEDs generally consist of TNT equivalent explosives (e.g. black or smokeless powder) in a container (e.g. galvanized pipe, paint can, etc.). These propellants are easily purchased on the commercial market. IEDs may also contain added shrapnel to induce greater casualties or shaped charges that direct the force of the explosive toward the target. Devices may be hidden in everyday objects such as briefcases, flowerpots or garbage cans, or on the person of the attacker in the case of suicide bombers. The most commonly used container is galvanized pipe, followed by PVC pipe. When shrapnel is added to the device, the type of shrapnel varies—BBs and other small pieces of hardware are common, as are glass and gravel.

An attack using IEDs or other explosive device in the Santa Clara County OA has potential large-scale consequences that may require multi-agency and multi-jurisdictional coordination. Depending on the location of the attack, businesses and other venues may be closed for investigation and due to damage. If the attack occurred in or near residences, evacuations and/or sheltering may occur.

Fire as a Weapon

The use of fire for criminal, gang, and terrorist activities, as well as targeting first responders, is not new. The World Health Organization estimates that 195,000 people die each year from fire. According to the Global Terrorism Database, an average of 7,258 people die annually from terrorism, and that includes deaths in conflict zones such as Afghanistan and Iraq (Stewart, 2013).

15.1.2 Technological Hazards

Technological hazards are associated with human activities such as the manufacture, transportation, storage and the use of hazardous materials. Incidents related to these hazards are assumed to be accidental with unintended consequences. Technological hazards can be categorized as follows:

- Hazardous materials incidents.
- Transportation incidents.
- Pipeline and tank hazards.
- Utility failure.

Hazardous Materials Incidents

A hazardous material is any substance that is flammable, combustible, corrosive, poisonous, toxic, explosive or radioactive. Hazardous materials are present across the United States in facilities that produce, store, or use them. For example, water treatment plants use chlorine on-site to eliminate bacterial contaminants, and dry cleaning businesses may use solvents that contain perchloroethylene. Even the natural gas used in homes and businesses is a dangerous substance when a leak occurs. Hazardous materials are transported along interstate highways and railways daily. 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. It is possible to identify and prepare for a fixed-site incident because laws require those facilities to notify state and local authorities about what is being used or produced at the site.

- Hazardous Materials Transportation Incident—This is any event resulting in uncontrolled release during transport of materials that can pose a risk to health, safety, and property. Transportation incidents are difficult to prepare for because there is little if any notice about what materials could be involved should an accident happen. These incidents can occur anywhere, although most occur on major federal or state highways or major rail lines. In addition to materials such as chlorine that are shipped throughout the country by rail, thousands of shipments of radiological materials (mostly medical materials and low-level radioactive waste) take place via ground transportation across the United States. Many incidents occur in sparsely populated areas and affect few people. However, hazardous materials have been involved in accidents in areas with much higher population densities, such as the January 6, 2005 train accident in Graniteville, South Carolina that released chlorine gas killing nine, injuring 500, and causing the evacuation of 5,400 residents.
- Pipeline Hazardous Materials Incident—Numerous natural gas pipelines, heating oil, and petroleum pipelines run through the Santa Clara County OA and surroundings. These are used to provide these products to utilities in the region and to transport the materials from production facilities to end users.

Federal regulations govern the transportation of hazardous materials in all modes of transportation: air, highway, rail and water (Title 49, Code of Federal Regulations; Transportation, Code of Federal Regulations, Hazardous Materials Regulations). Title 49 CFR lists thousands of hazardous materials, including gasoline, insecticides, household cleaning products, and radioactive materials. California regulated substances that have the greatest probability of adversely impacting the community are listed in state code (Title 19, Division 2, Chapter 4.5, Sections 2735-2785; Hazardous Material Management Plan/Hazardous Material Inventory).

Santa Clara County has four Certified Unified Program Agencies that administer hazardous materials, hazardous waste and underground storage tank programs within their jurisdictions.

- Hazardous Materials Compliance Division of the Santa Clara County Department of Environmental. Health (for all areas of Santa Clara County other than the cities of Santa Clara, Gilroy, and Sunnyvale).
- Santa Clara City Fire Department.
- Gilroy Building, Life and Environmental Safety.
- Sunnyvale Department of Public Safety.

Participating Agencies are local fire agencies that coordinate their activities under a memorandum of understanding with Santa Clara County Department of Environmental Health:

- Milpitas Fire Department.
- Mountain View Fire Department.
- Palo Alto Fire Department.
- Santa Clara County Fire Department.

Transportation Incidents

Transportation incidents are those involving air, road or rail travelers resulting in death or serious injury. The potential for transportation accidents that block movement through the OA is significant, as is the likelihood of hazardous material incidents resulting from a traffic or rail accident.

The Bay Area has a number of airports, including the San Francisco International Airport, Oakland International Airport, and San José International Airport, as well as San Martin Airport and Reid Hillview Airport, which are smaller municipal airports that enhance the potential for an air disaster. Major transportation routes in the OA include the following:

- Major highways include Interstates 880 (Nimitz Freeway) and 280; U.S. Highway 101 and Highway 237; and State Routes 87, 85, and 17.
- 42.2 miles of light rail serving Santa Clara County is operated by the Santa Clara Valley Transportation Authority (VTA), which oversees public transit services in the county. The Santa Clara VTA is continuing development for Phase II of its BART Silicon Valley Extension. The project planning includes a 5.1-mile-long subway tunnel through downtown San José and four additional stations, at Alum Rock, Downtown San José, Diridon, and Santa Clara. Construction of Phase II is anticipated to begin as additional funding is secured in 2019, based on the preliminary schedule (Santa Clara VTA, 2017).
- Amtrak has a train station in San José at Santa Clara University.
- The Santa Clara Depot, in the City of Santa Clara, is served by the Caltrain from San Francisco and the Altamont Corridor Express from Stockton.
- The Great America station in the City of Santa Clara hosts Amtrak's *Capitol Corridor* trains and Altamont Corridor Express trains. The station is close to Levi's Stadium and California's Great America.
- There are 15 Caltrain stations in the OA. Caltrain is a commuter rail between San Francisco, San Mateo and Santa Clara counties.
- The Santa Fe railroad has a right of way that parallels U.S. Highway 101 through the eastern edge of the county.
- Daily commuter traffic is very high in the OA due to Silicon Valley's dense-employment population.

Pipeline Hazards

Pipeline Systems and Risks

Around 1945, the United States invested in the development of a nation-wide system of pipelines for the purpose of transporting natural gas and petroleum products. The majority of these materials are moved by hazardous liquid and gas transport operators through a system of pipelines ranging in diameter from 20 to 42 inches. These pipes reach from the material origin wells to their final destination in refineries that further process the material for use and transport over 50 percent of the United States' energy supply. 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.

Transmission pipelines are those that transport raw material for further refinement. These pipes are large and far reaching, operating under high pressure. Distribution pipelines are those that provide processed materials to end users. These are smaller in diameter, some as small as a half an inch, and operate under lower pressure. Failures of distribution and transmission pipelines can occur when pipes corrode, are damaged during excavation, are incorrectly operated, or are damaged by other forces. More serious accidents occur on distribution pipelines than on any other type due to their number, intricate networking, and location in highly populated areas.

The greatest risk to the public regarding pipelines is the unintended release of a material being transported through the system. These materials are hazardous and have the capability to severely impact the surrounding environment, population, and property. These impacts may lead to severe injury or death. Combustible material transported through these pipelines may ignite or explode. Hazardous liquids may contaminate water systems. Families that rely on the transported material to heat their households may experience disruption of service. Pipeline failures also have the potential to negatively impact the economy, causing business interruptions or severely damaging vital infrastructure.

Depending on the pipeline material, age of the system, and transported product, pipelines may experience one or more general types of corrosion. Table 15-3 identifies corrosion types and a description of each.

Table 15-3. Corrosion Types

Corrosion Type	Description
External	External corrosion occurs due to environmental conditions on the outside of the pipe.
Internal	Corrosion on the internal wall of a natural gas pipeline can occur when the pipe wall is exposed to water and contaminants in the gas, such as O_2, H_2S, CO_2, or chlorides.
Atmospheric	Atmospheric corrosion occurs on a steel surface in a thin wet film created by the humidity in the air in combination with impurities.
Stress Cracking	Stress corrosion cracking is the initiation of cracks and their propagation, possibly up to complete failure of a component, due to the combined action of tensile mechanical loading and a corrosive medium.

Source: PHMSA, 2011

Pipeline material plays an important role in the possibility of experiencing a pipeline failure. Between 2006 and 2010, for both hazardous liquid and gas transmission pipelines, the main causes for failure were corrosion, material or welding failure, or damage due to excavation (PHMSA, 2011). Plastic pipes installed for natural gas distribution systems from the 1960s through the early 1980s may be vulnerable to cracking, resulting in gas leakage and potential hazards to the public. Hundreds of thousands of miles of plastic pipe have been installed, with a significant amount installed prior to the mid-1980s. While distribution systems may widely vary in terms of construction material, nearly all transmission pipeline systems are constructed from high-strength steel treated with an anti-corrosive chemical (PHMSA, date unknown).

Pipelines are monitored by system control and data acquisition systems that measure flow rate, temperature and pressure. These systems transfer real-time data via satellite from the pipelines to a control center where valves, pumps, and motors are remotely operated. If tampering with a 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 Oversight

Pipelines are regulated in California by the Office of the State Fire Marshal Pipeline Safety Division. CERCLA, the Emergency Planning and Community Right-to-Know Act, and California law require responsible parties to report hazardous material releases if certain criteria are met. CERCLA requires that all releases of hazardous substances exceeding reportable quantities be reported by the responsible party to the National Response Center. If an accidental chemical release exceeds the Right-to-Know Act applicable minimal reportable quantity, the facility must notify state emergency response commissions and local emergency planning committees 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.

The California Public Utilities Commission (CPUC) serves as the state regulation authority regarding pipeline operations. The CPUC conducts operation and maintenance compliance inspections and accident investigations. It reviews utilities’ reports and records, conducts construction inspections, conducts special studies, and takes action in response to complaints and inquiries from the public on issues regarding gas pipeline safety. The CPUC also endorses the system safety approach embodied in federal government regulations.

The U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) is responsible for providing federal regulatory oversight of transmission pipelines. The agency’s Integrity Management Program is a transmission pipeline program started in 2000. This program focuses on regulations for transmission pipeline in high consequence areas, such as pipelines passing through high population centers or particularly sensitive ecological areas. The Integrity Management Program specifies how pipeline operators must identify, prioritize, assess, repair, and validate the integrity of their pipelines through comprehensive analysis.

PHMSA's 2005 *Distribution Integrity Management Program Phase One* report found a lack of risk-based assessment in managing distribution pipeline systems. A guidance document was developed to assist operators in deciding what actions are needed to comply with standards of the distribution integrity management program (PHMSA, no date).

In 2002, PHMSA released control guidelines for gas leakage. The guidelines included a regulatory classification for leakage severity, as shown in Table 15-4.

Table 15-4. Leak Classification

Grade	Description	Examples	Action Criteria
1	A leak that represents an existing or probable hazard to persons or property and requires immediate repair or continuous action until the conditions are no longer hazardous.	• Any leak which, in the judgment of operating personnel at the scene is regarded as an immediate hazard • Escaping gas that has ignited • Any indication of gas which has migrated into or under a building or into a tunnel • Any reading at the outside wall of a building or where gas would likely migrate to an outside wall of a building • Any leak that can be seen, heard, or felt and which is in any location that may endanger the general public or property	Requires prompt action to protect life and property. Action may require one or more of the following: • Implementing a company emergency plan • Evacuating premises • Blocking off an area • Rerouting traffic • Eliminating sources of ignition • Venting the area • Stopping the flow of gas by closing valves or other means • Notifying police and fire departments
2	A leak that is recognized as being non-hazardous at the time of detection, but requires scheduled repair based on probable future hazard.	• Any leak which, under frozen or other adverse soil conditions, would likely migrate to the outside wall of a building *(Note: This type of Grade 2 leak must be repaired ahead of seasonal freeze/thaw conditions)* • Any leak which, in the judgment of operating personnel at the scene, is of sufficient magnitude to justify scheduled repair	Leaks should be repaired or cleared within one calendar year but no later than 15 months from the date they were reported. In determining the repair priority, criteria such as the following should be considered: • Amount and migration of gas • Proximity of gas to buildings and subsurface elements • Extent of pavement • Soil type and soil conditions such as frost cap, moisture and natural venting
3	A leak that is non-hazardous at the time of detection and can be reasonably expected to remain non-hazardous. Because petroleum gas is heavier than air and will collect in low areas instead of dissipating, few leaks can safely be classified as Grade 3.	• Any reading under a street in areas without wall-to-wall paving where it is unlikely the gas could migrate to the outside wall of a building	These leaks should be re-evaluated during the next scheduled survey, or within 15 months of the date reported, whichever occurs first, until the leak is re-graded or no longer results in a reading.

Source: PHMSA, 2002

Pipeline Locations

Approximately 300,000 miles of gas transmission pipelines and 170,000 miles of hazardous liquid pipelines move their products throughout the United States every day. Transmission pipelines connect urban areas, and only occasionally traverse highly populated areas. Nearly all distribution pipelines, however, are concentrated in highly populated areas.

Distribution pipelines serve homes and businesses and thus are located where people live and work. Because of the extensive reach of the distribution system, incidents have the potential to be far reaching. For example, a pipeline leak may release material into a migration pathway, such as a sewer line, and reach an ignition source far from the location of the actual leak. Due to the far-reaching underground and unpredictable nature of the pipeline failure hazard, it is difficult to gauge the extent to which the hazard affects the Santa Clara County OA. Minor pipe leaks may remain undetected for years until identified during renovation, excavation, or maintenance. In some scenarios, such leaks may go undetected until the severity has increased, resulting in a noticeable smell or, in the worst case scenario, an explosion.

Utility Failure

Utility failure is defined as any interruption or loss of utility service due to disruption of service transmission caused by accident, sabotage, natural hazards, or equipment failure. A significant utility failure is defined as any incident of a long duration, which would require the involvement of the local and/or state emergency management organizations to coordinate provision of food, water, heating, cooling, and shelter. Widespread outages can occur without warning or as a result of a forecasted event. Generally, warning times are short in the case of utility failure. In cases where a failure is caused by natural hazards, greater warning time is possible.

Except for the cities of Palo Alto and Santa Clara, Pacific Gas and Electric (PG&E) is responsible for operating and maintaining the electrical transmission and distribution system in the OA. The utility supplies electricity to an approximate population of 1.7 million residential and business customers in 1,260 square miles of the OA. PG&E has both overhead and underground lines throughout the OA. The County of Santa Clara Board of Supervisors recently approved joining the Silicon Valley Clean Energy Authority, creating a local Community Choice Energy Authority that will offer competitive electricity rates and greener electricity sources as early as 2017.

Wastewater and potable water utility restoration are essential to community continuity and recovery. Interruption of these services may have cascading economic and environmental impacts.

Utility failure can cause secondary hazards:

- Chemical accidents can occur after power is restored to industrial facilities. Power interruptions at chemical handling plants are of particular concern because of the potential for a chemical spill during restart (EPA, 2001).
- Without proper procedures for backup of data and systems, the loss of data, systems, and telecommunications is a risk incurred by utility failure. Data and telecommunications provide a primary method for service to the community by the government and the private sector. A loss of data or a system could result in loss of emergency dispatch capabilities, emergency planning services, infrastructure monitoring capabilities, access to statistical data, and loss of financial and personnel records. Loss of communication capability by first responders could have negative impacts on public safety. Backup systems such as amateur radio operators may be required during disaster to augment communications capabilities. Power outages can also lead to instances of civil disturbance, including looting.

15.1.3 Epidemic and Pandemic

An outbreak or an epidemic exists when there are more cases of a particular disease than expected in a given area, or among a specific group of people, over a particular period of time. In an outbreak or epidemic, it is presumed that the cases are related to one another or that they have a common cause (CDC, 2011).

The Santa Clara County Department of Public Health is responsible to protect and improve the health of the community within the OA. The public health department responds to public health related emergencies and disasters and supports field responders at medical and rescue incidents. The OA has numerous health care facilities within its borders, including the following:

- The Stanford Health Care-Stanford Hospital in Stanford.
- El Camino Hospital in Mountain View.
- Santa Clara Medical Center, in Santa Clara.
- Good Samaritan Hospital in San José.
- Kaiser Permanente San José Medical Center.
- Lucile Packard Children’s Hospital at Stanford.

The following sections describe commonly recognized human health hazards that are a concern in the OA.

Influenza

Epidemics of the flu typically occur in the fall and winter. Because flu seasons fluctuate in length and severity, a single estimate cannot be used to summarize influenza-associated deaths. The U.S. Centers for Disease Control (CDC) estimates that from 2010-2011 to 2013-2014, influenza-associated deaths in the United States ranged from 12,000 (during 2011-2012) to 56,000 (during 2012-2013).

H1N1

In April 2009, the World Health Organization (WHO) issued a health advisory on an outbreak of influenza-like illness caused by a new subtype of influenza A (A/H1N1) in Mexico and the United States. The disease spread rapidly, and in June the WHO declared an H1N1 pandemic, marking the first global pandemic since the 1968 Hong Kong flu. In October, the U.S. declared H1N1 a national emergency. In August 2010, the WHO declared an end to the pandemic globally. H1N1 viruses and seasonal influenza viruses are co-circulating in many parts of the world. It is likely that the 2009 H1N1 virus will continue to spread for years to come, like a regular seasonal influenza virus.

H5N1/H7N9

The highly pathogenic H5N1avian influenza virus is an influenza A subtype that occurs mainly in birds, causing high mortality among birds and domestic poultry. Outbreaks of highly pathogenic H5N1 among poultry and wild birds are ongoing in a number of countries.

H5N1 virus infections of humans are rare and most cases have been associated with direct poultry contact during poultry outbreaks. Rare cases of limited human-to-human spread of H5N1 virus may have occurred, but there is no evidence of sustained human-to-human transmission. Nonetheless, because all influenza viruses have the ability to change and mutate, scientists are concerned that H5N1 viruses one day could be able to infect humans more easily and spread more easily from one person to another, potentially causing another pandemic.

While the H5N1 virus does not now infect people easily, infection in humans is much more serious when it occurs than is infection with H1N1. More than half of people reported infected with H5N1 have died. Figure 15-2 summarizes human cases of the virus through 2013.

Infections in humans and poultry by a new avian influenza A virus (H7N9) continue to be reported in China. While mild illness in human cases has been seen, most patients have had severe respiratory illness and some have died. The only case identified outside of China was recently reported in Malaysia.

Source: World Health Organization, 2013

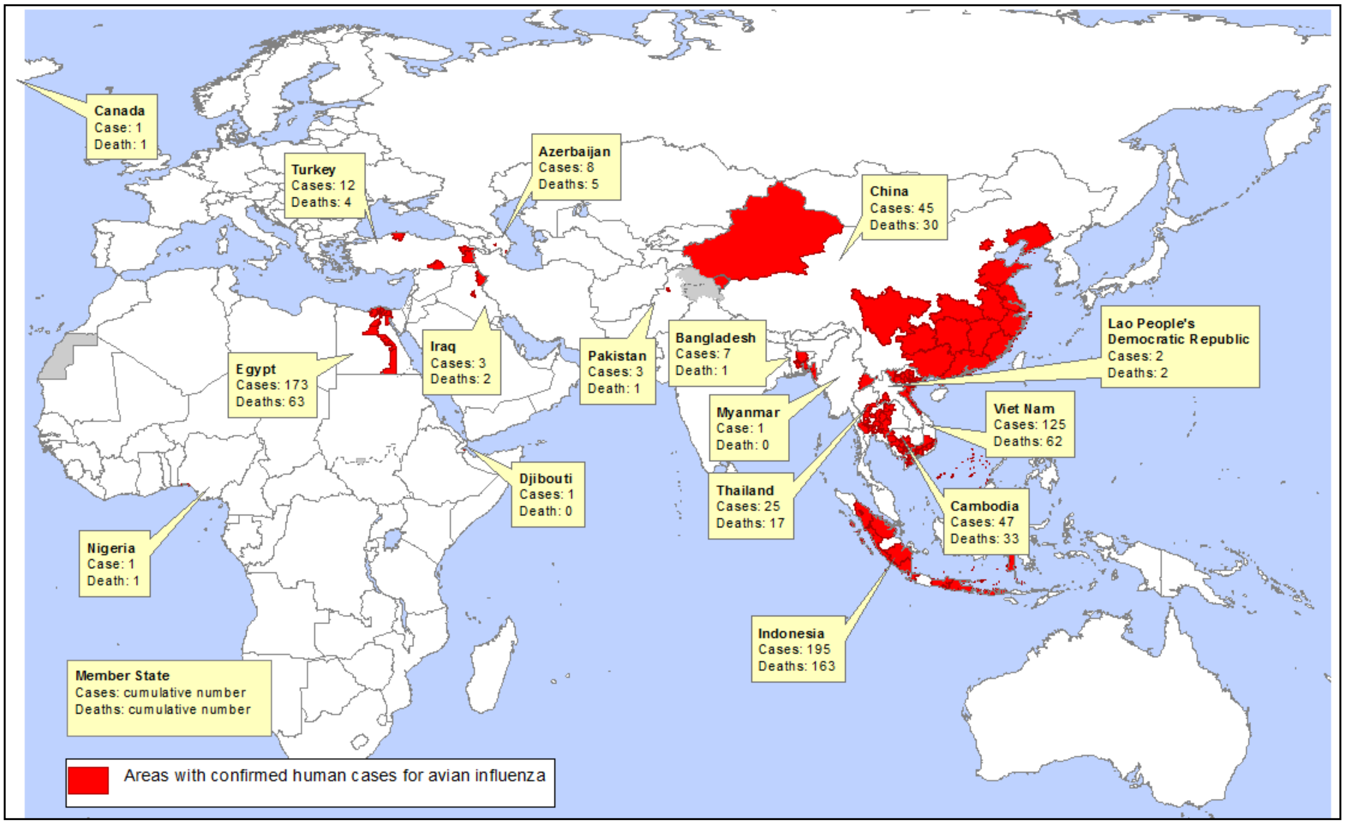


Figure 15-2. Areas with Confirmed Human Cases of H5N1 2003-2013

Source investigation by Chinese authorities is ongoing. Many of the people infected with H7N9 reportedly have had contact with poultry. However some cases reportedly have not had such contact. Close contacts of confirmed H7N9 patients are being followed to determine whether any human-to-human spread of H7N9 is occurring. No sustained person-to-person spread of the H7N9 virus has been found at this time. However, based on previous experience with avian flu viruses, some limited human-to-human spread of this the virus would not be surprising.

As of the publication of this document, H5N1 and the new H7N9 virus have not been detected in people or birds in the United States.

Smallpox

Smallpox is a sometimes fatal infectious disease. There is no specific treatment, and the only prevention is vaccination. Symptoms include raised bumps on the face and body of an infected person. The oldest evidence of smallpox was found on the body of Pharaoh Ramses V of Egypt who died in 1157 BC.

Outbreaks have occurred from time to time for thousands of years, but the disease is now eradicated after a successful worldwide vaccination program. The last case of smallpox in the United States was in 1949. The last naturally occurring case in the world was in Somalia in 1977. As of the publication of this document, there are no cases of smallpox in the world. Currently only two locations in the world have samples of smallpox: the CDC in Atlanta and the Ivanovsky Institute of Virology in Russia.

After the disease was eliminated, routine vaccination among the general public was stopped. Therefore, any cases of smallpox in the world would be considered an immediate international emergency. In 2003, the Wisconsin

Division of Public Health conducted an investigation of state residents who became ill after having contact with prairie dogs. The cases appeared in May and June of 2003, and symptoms in the human cases included fever, cough, pox-like rash and swollen lymph nodes. CDC laboratory test results indicated that the cause of the human illness was Monkeypox, an orthopox virus that could be transmitted by prairie dogs. This outbreak, and the potential use of smallpox as a weapon of bioterrorism, brought the fear of smallpox back to the forefront of the population. A detailed nationwide smallpox response plan created at the end of 2002 is designed to quickly contain a potential outbreak and vaccinate the population.

Viral Hemorrhagic Fevers

Viral hemorrhagic fevers (VHFs) are a group of illnesses caused by several distinct families of viruses. VHF describes a multisystem syndrome (multiple systems in the body are affected). Characteristically, the overall vascular system is damaged and the body's ability to regulate itself is impaired. These symptoms are often accompanied by hemorrhage (bleeding); however, the bleeding itself is rarely life-threatening. While some types of hemorrhagic fever viruses can cause relatively mild illnesses, many cause severe, life-threatening disease.

The viruses that cause VHFs are distributed over much of the globe. However, because each virus is associated with one or more particular host species, the virus and the disease it causes are usually seen only where the host species live. Some hosts, such as the rodent species carrying several of the New World arenaviruses, live in geographically restricted areas. Therefore, the risk of getting VHFs caused by these viruses is restricted to those areas. Other hosts range over continents, such as the rodents that carry viruses that cause the Hantavirus pulmonary syndrome in North and South America, or the rodents that carry viruses that cause hemorrhagic fever with renal syndrome in Europe and Asia.

Ebola

The 2014 Ebola virus outbreak was unprecedented in geographical reach and impact on health care systems across the globe. This was the largest and deadliest Ebola virus outbreak ever recorded. It was the first time the West African countries of Guinea, Liberia, Sierra Leone, Nigeria, Mali, and Senegal saw the virus. Ebola is more common in Central African countries, such as the Democratic Republic of Congo and Sudan, where it was first discovered in 1976. It was also the first time that Ebola made it to the United States and Europe, prompting world-wide preparedness and response efforts. Figure 15-3 shows areas that ultimately were affected. The outbreak was closely monitored and traveler screenings were developed for those returning from West Africa.

In August 2014 two U.S. healthcare workers returned to the United States for treatment for Ebola. The case that most impacted the health care system in the United States was a patient diagnosed with Ebola in Dallas, Texas who died due to Ebola in October 2014. The nurse who provided care for him later tested positive for Ebola. This caused responses across the country from hospitals, emergency medical teams, fire departments and public health agencies to enhance isolation precautions, develop emergency policies, train with personal protective equipment and conduct multi-agency emergency exercises in case the spread of Ebola became a pandemic.

Before the 2014 outbreak, only 2,200 cases of Ebola had been recorded and 68 percent were fatal. Twenty percent of new Ebola infections were linked to burial traditions in which family and community members wash and touch dead bodies before burial. In Guinea, 60 percent of Ebola infections were linked to traditional burial practices.

Plague

Plague is a potentially fatal infectious disease of animals and humans caused by the *Yersinia pestis* bacterium. People usually get plague from being bitten by a flea that is carrying the plague bacterium or by handling an infected animal. Today, modern antibiotics are effective against plague, but if an infected person is not treated promptly, the disease is likely to cause illness or death.

Source: World Health Organization, 2014

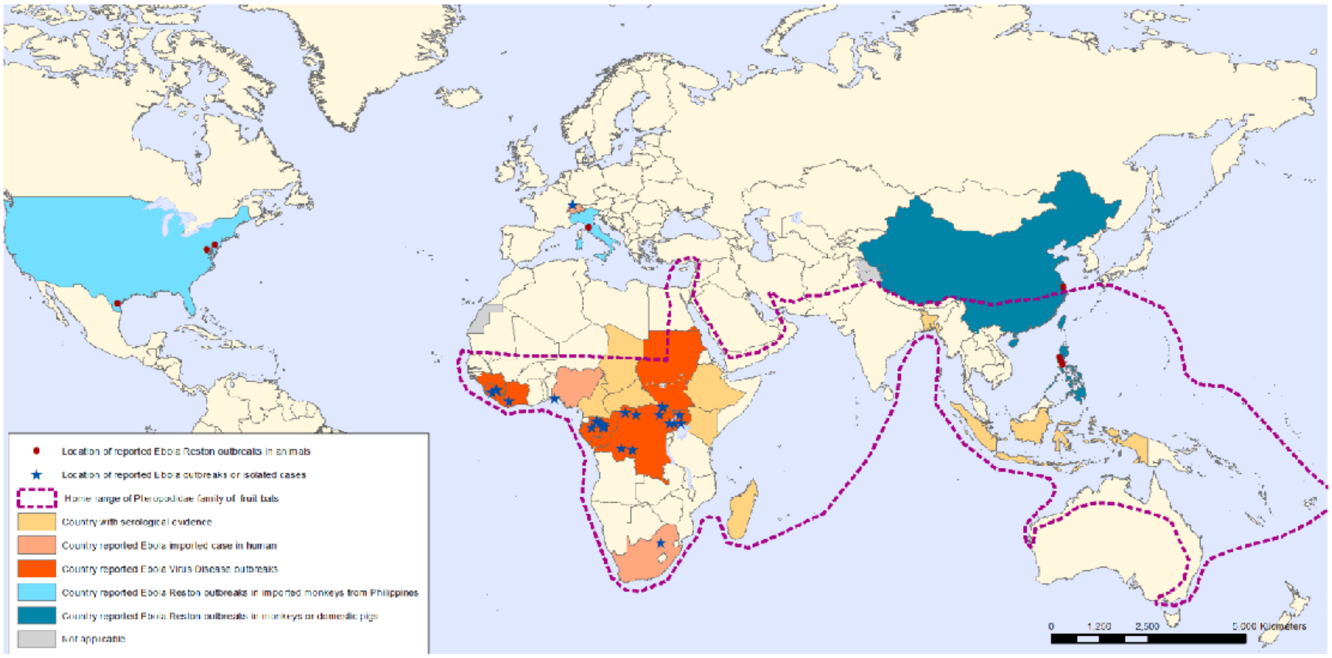


Figure 15-3. 2014 Distribution of Ebola Virus Outbreaks in Humans and Animals

Plague is an ancient disease but outbreaks throughout the world continue. Major plague epidemics occurred in the middle of the sixth century in Egypt, Europe and Asia; during the 14th century in Europe, following caravan routes; in the 18th century in Austria and the Balkans; and in the late 19th century worldwide (but mostly in China and India). Manchuria in 1910–1911 witnessed about 60,000 deaths due to pneumonic plague with a repeat in 1920–1921. A minor outbreak occurred as recently as the summer of 1994 in Surat, India, closely following an earthquake in September 1993. Globally, the WHO reports 1,000 to 3,000 cases of plague every year.

In North America, plague is found in certain animals and their fleas from the Pacific Coast to the Great Plains, and from southwestern Canada to Mexico. The last urban plague epidemic in the United States occurred in Los Angeles in 1924-25. Since then, human plague in the U.S. has occurred as mostly scattered cases in rural areas (an average of 10 to 15 persons each year per the CDC). Most human cases in the United States occur in northern New Mexico, northern Arizona, southern Colorado, California, southern Oregon, and far western Nevada.

Zika Virus

Zika is a disease transmitted by yellow fever mosquito (*Aedes aegypti)* and the Asian tiger mosquito *(Aedes albopictus)*. An *Aedes* mosquito can only transmit Zika virus after it bites a person who has this virus in their blood. The most common symptoms of Zika are fever, rash, joint pain, and conjunctivitis (red eyes). The illness is usually mild, with symptoms lasting for several days to a week after being bitten by an infected mosquito. People usually do not get sick enough to go to the hospital, and they rarely die from the Zika virus. For this reason, many people might not realize they have been infected. However, Zika virus infection during pregnancy can cause a serious birth defect called microcephaly (abnormally small head and brain), as well as other severe fetal brain defects. Once a person has been infected, he or she is likely to be protected from future infections. Zika virus is not spread through casual contact, but can be spread by infected men to their sexual partners. There is a growing association between Zika and Guillain-Barré Syndrome, a disease affecting the nervous system.

The mosquitos that carry Zika are not native to California, but infestations have been reported in multiple counties in California. In April 2016, both Santa Clara and San Mateo counties reported Zika virus cases. The counties recorded one case each, both linked to individuals who contracted the mosquito-borne virus while traveling outside the United States. Thus far in California, Zika virus infections have been documented only in people who were infected while traveling outside the United States or through sexual contact with an infected traveler. From 2015 to the publishing of this document, there has been no local mosquito-borne transmission of Zika virus in California (Mercury News, April 1, 2016).

Severe Acute Respiratory Syndrome

Severe Acute Respiratory Syndrome (SARS) is a viral respiratory illness caused by a coronavirus (SARS-CoV). SARS was first reported in Asia in February 2003. Over the next few months, the illness spread to more than two dozen countries in North America, South America, Europe, and Asia before the global outbreak was contained. According to the WHO, 8,098 people worldwide became sick with SARS during the 2003 outbreak and 774 died. In the United States, only eight people had laboratory evidence of SARS-CoV infection. All of these people had traveled to parts of the world where SARS was present. SARS did not spread more widely in the United States.

In general, SARS begins with a high fever, headache, an overall feeling of discomfort and body aches. Some people also have mild respiratory symptoms at the outset. About 10 percent to 20 percent of patients have diarrhea. After two to seven days, SARS patients may develop a dry cough. Most patients develop pneumonia.

The main way that SARS seems to spread is by close person-to-person contact. The virus that causes SARS is thought to be transmitted most readily by respiratory droplets produced when an infected person coughs or sneezes. Droplet spread can happen when droplets from the cough or sneeze of an infected person are propelled a short distance (generally up to 3 feet) through the air and deposited on the mucous membranes of the mouth, nose, or eyes of persons nearby. The virus also can spread when a person touches a surface or object contaminated with infectious droplets and then touches his or her mouth, nose, or eyes. It is also possible that the SARS virus might spread more broadly through the air or by other ways that are not now known.

As of May 2005, according to the CDC, there was no remaining sustained SARS transmission anywhere in the world. However, CDC has developed recommendations and guidelines to help public health and healthcare officials plan for and respond quickly to the reappearance of SARS if it occurs again. Lessons learned from the SARS outbreak helped healthcare facilities and communities successfully plan and respond to the 2009 H1N1 pandemic.

15.1.4 Fog

Fog is a cloud near the ground. It 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, cause 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, nearby bodies of water, and wind conditions.

Fog in the Santa Clara County OA has different origins depending on the time of year. In 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 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 has records of at least four officers whose deaths were indirectly caused by or exacerbated by dense fog and poor visibility (California Highway Patrol, 2016).

15.2 HAZARD PROFILE

15.2.1 Past Events

State of California

Intentional Hazards

According to the CalOES Terrorism Response Plan, 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. Since 2000, the following terrorist activities have occurred in California:

- On December 2, 2015, 16 people were killed and 22 were seriously injured in an Islamic terrorist attack at the Inland Regional Center in San Bernardino, which consisted of a mass shooting with a semi-automatic pistol and rifle, and an attempted pipe bombing.
- On November 4, 2015, one person was killed and four were injured as the result of a student stabbing two students and two staff at the University of California, Merced; the attacker was shot and killed by police.
- On November 1, 2013, one person was killed and seven were injured in a shooting attack at Los Angeles International Airport; one TSA officer was killed, two TSA officers and several civilians were injured.
- On February 28, 2008, one person was injured in Los Angeles by animal rights activists attempting a home invasion of a biomedical researcher.
- On November 29, 2005, four people in Santa Cruz were injured from incendiary attacks by suspected animal rights activists.
- On August 1, 2012, four men in Riverside were arrested for plotting attacks on American military staff and bases overseas (Almendrala, 2012).
- On July 4, 2002, two people were killed and four were injured by an Egyptian gunman at the El Al ticket counter at the Los Angeles International Airport (CNN.2003).

Technological Hazards

No comprehensive source exists for technological hazard incidents in California. Given the complex system of transportation networks, the large population, and the number of businesses in California, incidents occur on a regular basis throughout the state, as reported by the news media.

Epidemic/Pandemic

The most recent data for influenza in the State of California is for the 2014-2015 flu season. The CDPH received 42,812 reports of cases tested positive for influenza. California was impacted by the Enterovirus D68 outbreak in 2014. By October 2014, there were 32 reported cases in the state. Five of those cases were reported in Santa Clara County (Bay City News, 2016). In 2015, California experienced a norovirus outbreak. Between October and December, there were 32 confirmed cases of norovirus (CDPH, 2015b).

Regional

Intentional Hazards

Terrorism Incidents

The South Bay Area has not experienced a major regional terrorism event. Santa Clara County recently hosted the 2016 Super Bowl, which may have increased exposure of the area for potential future terrorist events. Other past events in the region include the following:

- Eco-terrorism—In 2006, three suspected Earth Liberation Front members were arrested in connection with an alleged plot to blow up U.S. Forest Service facilities, cellular phone towers and power-generating stations at various locations in Northern California. The Los Angeles Times reported the FBI and U.S. attorney's office declined to provide details about the alleged evidence against the three, but stated they believe their investigation foiled attacks on a number of sites (Krikorian, 2006).
- Domestic terrorism—On December 3, 1999, the FBI arrested two anti-government militia members who planned a bomb attack at the Suburban Propane facility in Elk Grove, CA. The alleged plot involved a plan to blow up the Suburban Propane site, which stores about 24 million gallons of liquefied propane and is located a mile from residential homes. According to the Sacramento Bee, the plot resulted in heightened on-site security and a year-long investigation resulting in the two arrests.

Cyber Incidents

- In December 2015, the University of California at Berkeley experienced a massive cyber-attack that left upwards of 80,000 people exposed to cyber-crime. The university is one of the largest employers in the Bay Area, and this cyber-attack reached beyond jurisdictional and county lines to affect the entire Bay Area (Bay City News, 2015).
- In August 2015, the FBI stated that San Francisco's Bay Area had suffered more than a dozen attacks on its fiber optic infrastructure in the preceding year. The attacks resulted in slow Internet service and disruption of financial transactions and emergency phone calls. The incidents occurred in clusters on single nights around the East Bay and in San José, at the heart of Silicon Valley. This led officials to believe the attacks were intentional. Beyond that, officials had yet to find a motive, or any suspects (Fitzgerald, 2015).
- On December 1, 2014, a global cyber-attack shut down web access to agenda, minutes, and video for many Bay Area government agencies, including Alameda County. The San Francisco-based company Granicus, which provides web services for government agencies nationwide, reported the outage (Johnson, 2014).

Technological Incidents

Transportation Incidents

The Bay Area has not experienced an aircraft accident that caused widespread devastation throughout the region. Aircraft accidents have been localized and somewhat contained.

Hazardous Materials Incidents

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 Incidents

The Bay Area has not experienced a regional pipeline event, but on September 9, 2010, a PG&E 30-inch natural gas line exploded in a neighborhood of San Bruno, approximately 30 miles from the Santa Clara County OA, killing eight people and injuring 58. The fires from the explosion incinerated 38 homes.

Utility Failure

The Bay Area has not experienced a regional widespread utility failure event, as utility failure is often localized.

Local

Intentional Incidents

Terrorism Incidents

In 2014 at PG&E Corporation's Metcalf transmission substation in San José, an unknown person entered an underground vault and cut telephone cables. Within half an hour, snipers opened fire on a nearby electrical substation. Shooting for 19 minutes, the persons were able to knock out 17 giant transformers that funnel power to Silicon Valley. Electric-grid officials were able to reroute power around the site and requested power plants in Silicon Valley to produce more electricity, but it took utility workers 27 days to conduct repairs and make the substation functional. The Wall Street Journal reported the incident has been called "the most significant incident of domestic terrorism involving the grid that has ever occurred." There have been no arrests or persons charged for the incident (Smith, 2014).

Cyber Incidents

On April 9, 2009, fiber-optic cable lines belonging to AT&T at two locations were intentionally cut, knocking out phones and access to 911 emergency services to thousands of residential customers and businesses in southern Santa Clara County, in Santa Cruz and San Benito counties and along the Peninsula, (SF Gate, 2009).

Technological Incidents

Transportation Incidents

The Santa Clara County OA has not experienced a crash of a commercial aircraft or large private plane. However, a number of general aviation aircraft incidents have occurred at Reid-Hillview Airport and Mineta San José International Airport. These incidents are typically localized and contained.

On March 21, 2008, at approximately 7:10 p.m., a southbound two-car light rail train derailed just north of the Virginia station in San José. Four people, including the train operator, were injured, and the train was heavily damaged. The East Bay Times reported that, at the time of the accident, trains were operating on a single track through the area because of construction at three nearby light rail stations. The train involved was attempting to switch between tracks when it derailed. Another partial derailment occurred on July 15, 2013, with 12 passengers aboard. CBS San Francisco report there were no deaths or injuries from the accident.

There have been occasional single vehicle and pedestrian fatality accidents in Santa Clara County.

Hazardous Materials Incidents

Santa Clara county and its incorporated cities have experienced many localized accidental hazardous materials incidents. Four major highways in the OA provide vehicle routes for the transportation of large quantities of hazardous materials: U.S.101, I-880, I-680, and I-280. U.S. 101 and I-880 are the most heavily traveled in terms of truck traffic and are the most frequent location of hazardous materials spills on major roads.

Pipeline Incidents

According to PHMSA, the OA has experienced the following incidents related to pipeline failure:

- In 2011, PG&E had a natural gas leak due to material weld equipment failure in Santa Clara County.
- In 2012, PG&E had a natural gas leak due to excavation damage to a pipe in Santa Clara County.
- In 2014, PG&E had a natural gas leak due to corrosion of a pipe in Santa Clara County.

Between 2000 and 2016, the County of Santa Clara experienced 339 pipeline incidents with 0 injuries and 0 fatalities (PHMSA, 2016). In addition, at any given time, pipelines may experience small leaks that are remain unnoticed until discovered by a utilities company or member of the public.

Utility Failure

The Santa Clara County OA has not experienced an emergency level utility failure, but does regularly experience smaller inconvenient outages.

Epidemic/Pandemic

In Santa Clara County, during the 2009 H1N1 influenza pandemic, there were 91 severe cases, 87 intensive care cases, and 21 deaths (CDPH, 2011). Between January 1, 2010 and April 4, 2011, 560 confirmed, probable, or suspect cases of pertussis were reported to the Santa Clara County Public Health Department, with 30 hospitalizations and no pertussis-related deaths.

In April 2016, Santa Clara was one of the first counties to report a Zika virus case. Santa Clara and San Mateo recorded one case each, both linked to individuals who contracted the mosquito-borne virus while traveling outside the United States. From 2015 through April 2016 there has been no local mosquito-borne transmission of Zika virus in California (Mercury News, April 1, 2016).

15.2.2 Location

Intentional Incidents

Terrorism

The State of California, Office of Homeland Security, and local governments have identified high profile targets for potential terrorists within their jurisdictions. Large business centers, high visibility tourist attractions, transportation providers, and critical infrastructure in Santa Clara County may become a target for terrorism and can present security challenges of an ongoing nature. Multiple incidents can happen simultaneously, and typically require a multi-agency, multi-jurisdictional response (California Department of Toxic Substances Control, 2016).

Cyber Threats

Municipalities and private businesses within the Santa Clara County OA are susceptible to the most current and common cyber-attacks, such as socially engineered Trojans, unpatched software, phishing attacks, network-traveling worms, and advanced persistent threats. Many of these attacks are engineered to automatically seek technological vulnerabilities. Possible cyberterrorist targets include the banking industry, power plants, air traffic control centers, and water systems.

Technological Incidents

Transportation Hazard

Established truck routes in many jurisdictions in the OA may have a higher potential for hazardous material incidents as a result of traffic accidents. The following transportation corridors and infrastructures have the potential for transportation incidents:

- Interstates 880 (Nimitz Freeway) and 280.
- U.S. Highway 101 and Highway 237.
- State Routes 87, 85, and 17.
- The Mineta San José International Airport, which serves approximately 27,000 passengers daily; the airport is served by 12 major airlines, with direct flights to 30 cities and service to more than 180 destinations.
- The Reid-Hillview and South County general aviation airports.
- Public transit regional hub facilities in San José.
- Three major Bay Area rail lines serving approximately 40,000 riders every weekday from Diridon Station in San José: CalTrain; Capitol Corridor (Amtrak); and Altamont Commuter Express.
- Two VTA light rail lines serving 62 stations in the OA over 42 miles.
- 73 VTA bus routes in the OA that collectively serve 144,000 average weekday riders.
- Feb. 17, 2010, a twin-engine Cessna taking off moments earlier from Palo Alto Airport in dense fog struck a PG&E transformer tower, then plummeted toward Beech Street in Palo Alto, shearing off a wing on the roof before bursting into flames. All three of the plane's passengers were killed instantly.

Hazardous Materials

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; hospitals that store radioactive materials, flammable materials and other hazardous substances; or manufacturers, processors, distributors, and recycling plants for chemical industries that store a variety of chemicals on site (FEMA, 2013). Fixed sites include buildings or property where hazardous materials are manufactured or stored.

The Toxic Substances Control Act of 1976 (TSCA) provides the EPA 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 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. No TSCA facilities are identified in the Santa Clara County area.

Hazardous waste information is contained in the Resource Conservation and Recovery Act Information databases (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 EPA offices. This regulation is governed by the RCRA, as amended by the Hazardous and Solid Waste Amendments of 1984. There are 576 RCRA facilities in the San José and Palo Alto areas of the county.

The following are associated with specific risks related to hazardous materials:

- Business and Industrial Areas—Manufacturing, business, and light industrial firms that make semiconductor devices, satellite equipment and systems, computers-electronics manufacturers, semiconductor manufacturing equipment, computer peripherals, government offices, and e-commerce are major employers in the Santa Clara County OA. These businesses are concentrated in San José, Sunnyvale, Cupertino, Santa Clara, Mountain View, and Palo Alto, which could be areas of concern for hazardous materials. Each business is required to file a detailed, confidential plan with the local fire department regarding materials on-site and safety measures taken to protect the public.

- Agricultural—Agricultural crops in the OA are primarily nursery crops, mushrooms, bell peppers, spinach and wine grapes. While the use of pesticides is regulated, accidental releases of pesticides, fertilizers, and other agricultural chemicals may be harmful to humans and the environment. Agricultural pesticides are transported daily in and around the Santa Clara County OA en-route to their destination in rural areas of the county.
- Illegal Drug Operations—Illegal operations such as laboratories for methamphetamine pose a significant threat. Laboratory residues are often dumped along roadways or left in rented hotel rooms, creating a serious health threat to unsuspecting individuals and to the environment.
- Illegal Dumping—Hazardous wastes such as used motor oil, solvents, or paint are occasionally dumped in remote areas of the Santa Clara County OA or along roadways, creating a potential health threat to unsuspecting individuals and to the environment.
- Radioactive Materials—Licensed carriers transport radioactive materials along several transportation routes (Interstate 880 and 280, Highways 101 and 237) through the OA. Cities within the OA are notified in advance of these shipments and commit resources as a standby measure should an accident occur.

Pipeline Hazard

Figure 15-4 is a map of gas transmission and hazardous liquid pipelines in the Santa Clara County OA. The primary operators for the gas transmission pipelines are Chevron Pipeline Company, Kinder Morgan, PG&E, and Wickland Oil Company.

Source: National Pipeline Mapping System, 2016

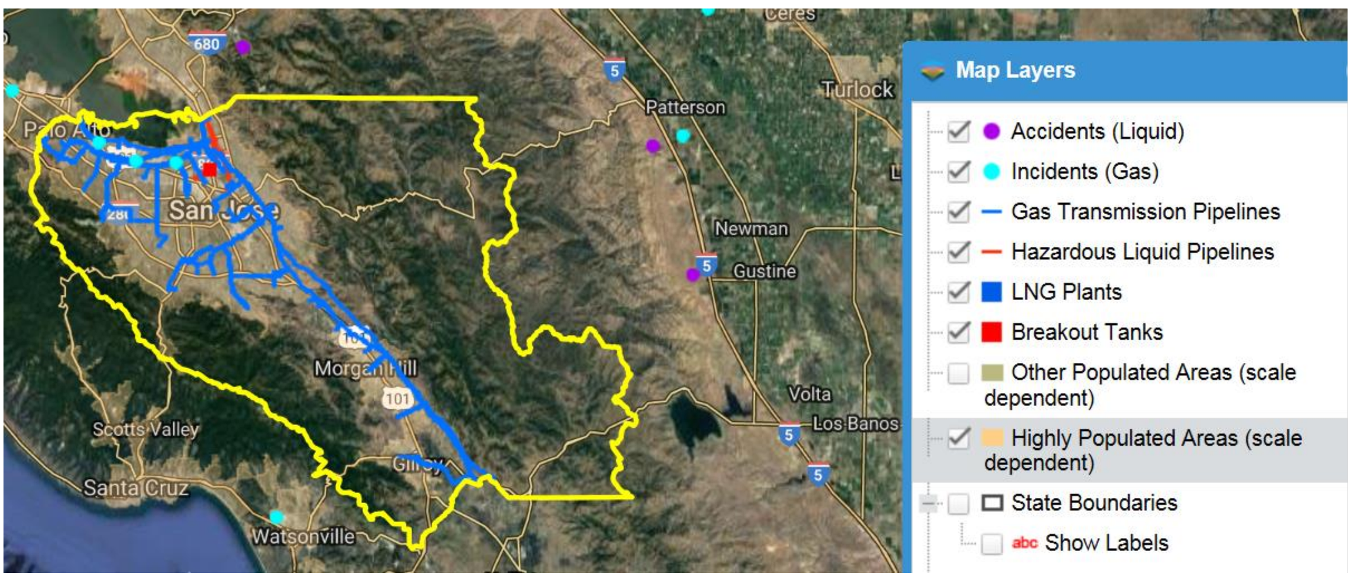


Figure 15-4. Transmission and Hazardous Liquid Pipelines

Pipelines in the OA include the following:

- The San José Terminal, owned by Kinder Morgan—A break-out tank in the City of San José.
- The Bay Area Pipeline, owned by Chevron Pipeline Co.—A 7.85-mile hazardous liquid pipeline used for transporting gasoline, diesel, or jet fuel.
- The SJC pipeline, owned by Wickland Oil Company—A 1.98-mile hazardous liquid pipeline that transports jet fuel to the airport.

- The SFPP Concord-San José pipeline, owned by Kinder Morgan—A 5.64-mile hazardous liquid pipeline that transport multi-products.
- Nine additional PG&E natural gas lines across the length of the OA.

Utility Failure

Utility failure or loss of utility service can be caused by accident, sabotage, natural hazards, or equipment failure, although loss of utilities across the entire county are atypical.

Epidemic/Pandemic

The epidemic/pandemic hazard has not geographic-specific aspect within the Santa Clara County OA. People throughout the entire OA are susceptible to contagious disease.

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). The Santa Clara County OA, therefore, is more likely to experience fog than many other parts of the country.

The Bay Area, including the Santa Clara County OA, 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 10ºF 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, as certain cities in the OA may experience fog while clear skies predominate only a few miles away. Westerly 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.

15.2.3 Frequency, Exposure, Vulnerability

Frequency, exposure, and vulnerability to the identified hazards of interest and response priorities to such hazards are described in detail in the following plans:

- Santa Clara County Operational Area Emergency Operations Plan and Annexes—The Santa Clara County OA Emergency Operations Plan is an all hazards document describing the OA's Emergency Operations organization, compliance with relevant legal statutes, other guidelines, and critical components of the Emergency Response System. The Emergency Operations Plan consists of threat summaries based on a Santa Clara County OA hazard analysis. This hazard analysis was conducted by Santa Clara County OES staff, providing a description of the local area, risk factors and the anticipated nature of situations that could occur in the Santa Clara County OA. The Emergency Operations Plan is activated during extraordinary emergency situations associated with large-scale disasters affecting the Santa Clara County OA.
- Countywide Medical Response System—This Santa Clara County Public Health Department plan outlines the efforts to prepare for response to a disaster that has a medical/health component. The Countywide Medical Response System plan is focused on the goal of terrorism preparedness, and addresses topics such as risk communications, decontamination, personal protective equipment, mass prophylaxis, education, training and exercises. Each topic identifies participating agencies, including fire,

law enforcement, hospitals, emergency management, schools, the medical examiner, mental health services, and many others. The plan further enumerates a list of responsibilities to the Countywide Medical Response System for each identified agency, as well as a list of public health commitments through the system that will assist those agencies.

- Hazardous Materials Business Plans—Hazardous materials business plans are implemented by Certified Unified Program Agencies within their jurisdictions, along with local fire departments to protect human health and the environment from hazardous materials incidents.
- Fog—The fog typical for the San Francisco Bay Area is known as advection fog. This type of fog forms when warm, moist and stable air is blown across a cooler surface (land or water). The air temperature falls until the dew point is reached and condensation occurs. Fog typically occurs in the Bay Area in the June, July and August. It is usually foggy in the morning, with fog burning off as the temperatures rise. There is currently no available data on the number of fog days observed over a time frame for Santa Clara County. However, there are on average 257 sunny days per year in Santa Clara County (www.bestplaces.net/climate/city/california/san_jose). This leaves an average of 108 days a year when fog may occur within the OA.

15.3 IDENTIFIED NEEDS

This assessment of the hazards of interest led to identification of the following needs throughout the OA:

- Continue regular and redundant emergency preparedness training for field level responders (police, fire, and public works) and public information staff in order to respond quickly in the event of a disaster associated with the identified hazards of interest. Enhance awareness training for all local government employees to recognize threats or suspicious activity in order to prevent an incident from occurring.
- Continue all facets of hazardous materials team training and response through commitment of resources from the Environmental Health Department, local fire departments, and potential funding through homeland security budgets.
- Continue to improve response times for public safety throughout the OA so as to reduce exposure to human-caused incidents. Maintain appropriate staffing levels of public safety personnel to address vulnerabilities identified in this chapter.
- Continue to implement the hazardous materials business plan with enhancements, as warranted by the type of uses in the OA and new technologies in preventing hazardous materials incidents.
- Continue to work proactively with industrial businesses regarding placards and labeling of containers, emergency plans and coordination, standardized response procedures, and notification of the types of materials being transported through the Santa Clara County OA. On at least an annual basis, conduct random inspections of transporters as allowed by the business; install mitigating techniques at critical locations; implement routine hazard communication initiatives; enhance security along the transportation corridors; and continuously look to the use of safer alternative products to conduct all business and transportation operations.
- 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. Further develop response capabilities based on emerging threats.
- Commit support to the Bay Area Urban Area Security Initiative by dedicating fire, emergency medical services, emergency management grant managers, and police personnel to the program as funded with Homeland Security grants.
- Participate in the CalOES Disaster Resistant California annual conference and other training sessions sponsored by regional, state and federal agencies.
- Use Crime Prevention Through Environmental Design in future planning efforts as well as enhancing existing infrastructure and buildings to prevent or mitigate human-cause incidents. Crime Prevention

Through Environmental Design is an urban planning design process that integrates crime prevention with neighborhood design and community development. The process 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. It 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 may be sponsored by the U.S. Department of Homeland Security San José office, the Bay Area Urban Area Security Initiative, local government offices of homeland security, grant funds through CalOES, or FEMA. Training exercises test and evaluate the ability to coordinate the activities of local and state government first responders, volunteer organizations and the private sector in responding to terrorism and technological hazards. The trainings enhance interagency coordination, provide training to staff, test response and recovery capabilities, and implement the Standardized Emergency Management System, the National Incident Management System, and the California and national mutual aid systems.
- Work with the private sector to enhance and create business continuity plans to be followed in the event of an emergency.
- Review existing automatic aid and mutual aid agreements with other public safety agencies to identify opportunities for enhancement.
- Identify, relocate or construct a redundant Emergency Operations Center in a location away from hazards.
- Maintain an emergency services information line that the public can contact 24 hours a day during an emergency to ask questions of emergency staff.
- Coordinate with all school districts in the OA and individual cities to ensure that their emergency preparedness plans include preparation for human-caused incidents.
- Encourage local businesses to adopt information technology and telecommunications recovery plans.
- Promote 72-hour self-sufficiency through the United Neighborhoods of Santa Clara County and other neighborhood associations, emergency preparedness efforts through local governments, emergency preparedness websites of local governments, civic organizations and the private sector, public outreach, and other means. Ensure inclusion of program information for people with disabilities and others with access and functional needs.
- Prepare and present the human-caused hazard risk and preparedness program to the public through meetings, town hall gatherings, and preparedness fairs and outreach.
- Maintain any and all citizen advisory groups and periodically e-mail emergency preparedness information including human-caused hazard preparedness instructions and reminders.
- Support disease prevention through vaccination and personal emergency and disaster preparation to help reduce the impacts of human health hazards.
- Integrate medical and response personnel in a unified command to provide care when needed in response to human health hazards.
- Adequately train and supply medical and response personnel.
- Carry out up-to-date and functional all-hazard contingency planning.
- Develop a system for informing the public with a unified message about the human health hazard.
- Provide health agencies and facilities with surge capacity management and adaptation to the rising number and needs of the region.

Santa Clara County Operational Area Hazard Mitigation Plan

PART 3—MITIGATION STRATEGY

16. GOALS AND OBJECTIVES

Hazard mitigation plans must identify goals for reducing long-term vulnerabilities to identified hazards (44 CFR Section 201.6(c)(3)(i)). The Core Planning Group established a guiding principle, a set of goals and measurable objectives for this plan, based on data from the preliminary risk assessment and the results of the public involvement strategy. The guiding principle, goals, objectives and actions in this plan all support each other. Goals were selected to support the guiding principle. Objectives were selected that met multiple goals. Actions were prioritized based on the action meeting multiple objectives.

16.1 GUIDING PRINCIPLE

A guiding principle focuses the range of objectives and actions to be considered. This is not a goal because it does not describe a hazard mitigation outcome, and it is broader than a hazard-specific objective. The guiding principle for this hazard mitigation plan is as follows:

> *Carefully plan for the maintenance and enhancement of a disaster-resistant Operational Area by reducing the current and future potential loss of life, property damage, and environmental degradation from various hazards, while accelerating economic recovery from those hazards.*

16.2 GOALS

The following are the mitigation goals for this plan:

1. Actively develop community awareness, understanding, and interest in hazard mitigation and empower the Operational Area to engage in the shaping of associated mitigation policies and programs.
2. Minimize potential for loss of life, injury, social impacts, and dislocation due to hazards.
3. Minimize potential for damage to property, economic impacts, and unusual public expense due to hazards.
4. Provide essential information to the whole community that promotes personal preparedness and includes advice to reduce personal vulnerability to hazards.
5. Encourage programs and projects that promote community resiliency by maintaining the functionality of critical Operational Area resources, facilities, and infrastructure.
6. Promote an adaptive and resilient Operational Area that proactively anticipates the impacts of climate change.

The effectiveness of a mitigation strategy is assessed by determining how well these goals are achieved.

16.3 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. Develop and provide updated information about threats, hazards, vulnerabilities, and mitigation strategies to state, regional, and local agencies, as well as private sector groups.
2. Improve understanding of the locations, potential impacts, and linkages among threats, hazards, vulnerability, and measures needed to protect life.
3. Encourage the incorporation of mitigation best management measures into plans, codes, and other regulatory standards for public, private, and non-governmental entities within the Operational Area.
4. Inform the public on the risk exposure to natural hazards and ways to increase the public's capability to prevent, prepare, respond, recover, and mitigate impacts of these events.
5. Establish and maintain partnerships in the identification and implementation of mitigation measures in the Operational Area.
6. Advance community and natural environment sustainability and resilience to future impacts through preparation and implementation of state, regional, and local projects.
7. Reduce repetitive property losses from all hazards.
8. Where feasible and cost-effective, encourage property protection measures for vulnerable structures located in hazard areas.
9. Improve systems that provide warning and emergency communications.

17. MITIGATION ALTERNATIVES

Catalogs of natural hazard mitigation alternatives were developed that present a broad range of alternatives to be considered for use in the OA, in compliance with 44 CFR (Section 201.6(c)(3)(ii)). One catalog was developed for each natural hazard of concern evaluated in this plan. The catalogs present alternatives that are categorized in two ways:

- By who would have responsibility for implementation:
  - ❖ Individuals (personal scale).
  - ❖ Businesses (corporate scale).
  - ❖ Government (government scale).
- By what the alternative would do:
  - ❖ Manipulate the flooding hazard.
  - ❖ Reduce exposure to the flooding hazard.
  - ❖ Reduce vulnerability to the flooding hazard.
  - ❖ Increase the ability to respond to or be prepared for the flooding hazard.

Hazard mitigation actions 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 established goals and objectives, and are within the capabilities of the planning partners to implement. Some of these actions may not be feasible based on the selection criteria identified for this plan. The purpose of the catalog was to provide a list of what could be considered to reduce risk of the flood hazard within the OA. Actions in the catalog that are not included for the partnership's action plan were not selected for one or more of the following reasons:

- The action is not feasible.
- The action is already being implemented.
- There is an apparently more cost-effective alternative.
- The action does not have public or political support.

The following sections present the catalogs for each hazard are presented in Table 17-1 through Table 17-8.

Table 17-1. Alternatives to Mitigate the Dam and Levee Failure Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ Relocate out of dam failure inundation areas. • **Reduce vulnerability to the hazard:** ❖ Elevate home to appropriate levels. • **Increase the ability to respond to or be prepared for the hazard:** ❖ 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.	• **Manipulate the hazard:** ❖ Remove dams. ❖ Remove levees. ❖ Harden dams. • **Reduce exposure to the hazard:** ❖ Replace earthen dams with hardened structures. • **Reduce vulnerability to the hazard:** ❖ Flood-proof facilities within dam failure inundation areas. • **Increase the ability to respond to or be prepared for the hazard:** ❖ Educate employees on the probable impacts of a dam failure. ❖ Develop a continuity of operations plan.	• **Manipulate the hazard:** ❖ Remove dams. ❖ Remove levees. ❖ Harden dams. • **Reduce exposure to the hazard:** ❖ 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 to the hazard:** ❖ Adopt higher floodplain standards in mapped dam failure inundation areas. ❖ Retrofit critical facilities within dam failure inundation areas. • **Increase the ability to respond to or be prepared for the hazard:** ❖ 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 17-2. Alternatives to Mitigate the Drought Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ None • **Reduce vulnerability to the hazard:** ❖ Drought-resistant landscapes ❖ Reduce water system losses ❖ Modify plumbing systems (through water saving kits) • **Increase the ability to respond to or be prepared for the hazard:** ❖ Practice active water conservation	• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ None • **Reduce vulnerability to the hazard:** ❖ Drought-resistant landscapes ❖ Reduce private water system losses • **Increase the ability to respond to or be prepared for the hazard:** ❖ Practice active water conservation	• **Manipulate the hazard:** ❖ Groundwater recharge through stormwater management • **Reduce exposure to the hazard:** ❖ Identify and create groundwater backup sources • **Reduce vulnerability to the hazard:** ❖ Water use conflict regulations ❖ Reduce water system losses ❖ Distribute water saving kits • **Increase the ability to respond to or be prepared for the hazard:** ❖ 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 17-3. Alternatives to Mitigate the Earthquake Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ Locate outside of hazard area (off soft soils) • **Reduce vulnerability to the hazard:** ❖ 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 • **Increase the ability to respond to or be prepared for the hazard:** ❖ 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	• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ Locate or relocate mission-critical functions outside hazard area where possible • **Reduce vulnerability to the hazard:** ❖ Build redundancy for critical functions and facilities ❖ Retrofit critical buildings and areas housing mission-critical functions • **Increase the ability to respond to or be prepared for the hazard:** ❖ 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	• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ Locate critical facilities or functions outside hazard area where possible • **Reduce vulnerability to the hazard:** ❖ Harden infrastructure ❖ Provide redundancy for critical functions ❖ Adopt higher regulatory standards • **Increase the ability to respond to or be prepared for the hazard:** ❖ Provide better hazard maps ❖ Provide technical information and guidance ❖ Enact tools to help manage development in hazard areas (e.g., 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% 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.

Table 17-4. Alternatives to Mitigate the Flooding Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• **Manipulate the hazard:** ❖ Clear storm drains and culverts ❖ Use low-impact development techniques • **Reduce exposure to the hazard:** ❖ Locate outside of hazard area ❖ Elevate utilities above base flood elevation ❖ Use low-impact development techniques • **Reduce vulnerability to the hazard:** ❖ Raise structures above base flood elevation ❖ Elevate items within house above base flood elevation ❖ Build new homes above base flood elevation ❖ Flood-proof structures • **Increase the ability to respond to or be prepared for the hazard:** ❖ Buy flood insurance ❖ Develop household plan, such as retrofit savings, communication with outside, 72-hour self-sufficiency during and after an event	• **Manipulate the hazard:** ❖ Clear storm drains and culverts ❖ Use low-impact development techniques • **Reduce exposure to the hazard:** ❖ Locate critical facilities or functions outside hazard area ❖ Use low-impact development techniques • **Reduce vulnerability to the hazard:** ❖ Build redundancy for critical functions or retrofit critical buildings ❖ Provide flood-proofing when new critical infrastructure must be located in floodplains • **Increase the ability to respond to or be prepared for the hazard:** ❖ Keep cash reserves for reconstruction ❖ Support and implement hazard disclosure for sale of property in risk zones. ❖ Solicit cost-sharing through partnerships with others on projects with multiple benefits.	• **Manipulate the hazard:** ❖ 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 to the hazard:** ❖ 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, 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 • **Reduce vulnerability to the hazard:** ❖ Harden infrastructure, bridge replacement program ❖ Provide redundancy for critical functions and infrastructure ❖ Adopt regulatory standards such as freeboard standards, cumulative substantial improvement or damage, lower substantial damage threshold; compensatory storage, non-conversion deed restrictions. ❖ Stormwater management regulations and master planning. ❖ Adopt "no-adverse impact" floodplain management policies that strive to not increase the flood risk on downstream communities. • **Increase the ability to respond to or be prepared for the hazard:** ❖ 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 and collect data to define risks and vulnerability ❖ Train emergency responders ❖ Create an elevation inventory of structures in the floodplain ❖ Develop and implement a public information strategy ❖ Charge a hazard mitigation fee ❖ Integrate floodplain management policies into other planning mechanisms within the OA. ❖ 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

Table 17-5. Alternatives to Mitigate the Landslide/Mass Movement Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• **Manipulate the hazard:** ❖ Stabilize slope (dewater, armor toe) ❖ Reduce weight on top of slope ❖ Minimize vegetation removal and the addition of impervious surfaces. • **Reduce exposure to the hazard:** ❖ Locate structures outside of hazard area (off unstable land and away from slide-run out area) • **Reduce vulnerability to the hazard:** ❖ Retrofit home • **Increase the ability to respond to or be prepared for the hazard:** ❖ Institute warning system, and develop evacuation plan ❖ Keep cash reserves for reconstruction ❖ Educate yourself on risk reduction techniques for landslide hazards	• **Manipulate the hazard:** ❖ Stabilize slope (dewater, armor toe) ❖ Reduce weight on top of slope • **Reduce exposure to the hazard:** ❖ Locate structures outside of hazard area (off unstable land and away from slide-run out area) • **Reduce vulnerability to the hazard:** ❖ Retrofit at-risk facilities • **Increase the ability to respond to or be prepared for the hazard:** ❖ Institute warning system, and develop evacuation plan ❖ Keep cash reserves for reconstruction ❖ Develop a continuity of operations plan ❖ Educate employees on the potential exposure to landslide hazards and emergency response protocol.	• **Manipulate the hazard:** ❖ Stabilize slope (dewater, armor toe) ❖ Reduce weight on top of slope • **Reduce exposure to the hazard:** ❖ 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 to the hazard:** ❖ Adopt higher regulatory standards for new development within unstable slope areas. ❖ Armor/retrofit critical infrastructure against the impact of landslides. • **Increase the ability to respond to or be prepared for the hazard:** ❖ 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 ❖ Develop and adopt a continuity of operations plan ❖ Educate the public on the landslide hazard and appropriate risk reduction alternatives.

Table 17-6. Alternatives to Mitigate the Severe Weather Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ None • **Reduce vulnerability to the hazard:** ❖ 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) • **Increase the ability to respond to or be prepared for the hazard:** ❖ Trim or remove trees that could affect power lines ❖ Promote 72-hour self-sufficiency ❖ Obtain a NOAA weather radio. ❖ Obtain an emergency generator.	• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ None • **Reduce vulnerability to the hazard:** ❖ Relocate critical infrastructure (such as power lines) underground ❖ Reinforce or relocate critical infrastructure such as power lines to meet performance expectations ❖ Install tree wire • **Increase the ability to respond to or be prepared for the hazard:** ❖ 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.	• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ None • **Reduce vulnerability to the hazard:** ❖ Harden infrastructure such as locating utilities underground ❖ Trim trees back from power lines • **Increase the ability to respond to or be prepared for the hazard:** ❖ Support programs such as "Tree Watch" that proactively manage problem areas through use of selective removal of hazardous trees, tree replacement, etc. ❖ 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

Table 17-7. Alternatives to Mitigate the Tsunami Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ Locate outside of hazard area • **Reduce vulnerability to the hazard:** ❖ Apply personal property mitigation techniques to your home such as anchoring your foundation and foundation openings to allow flow through • **Increase the ability to respond to or be prepared for the hazard:** ❖ Develop and practice a household evacuation plan. ❖ Support/participate in the Redwood Coast Tsunami Working Group. ❖ Educate yourself on the risk exposure from the tsunami hazard and ways to minimize that risk.	• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ Locate structure or mission critical functions outside of hazard area whenever possible • **Reduce vulnerability to the hazard:** ❖ Mitigate personal property for the impacts of tsunami • **Increase the ability to respond to or be prepared for the hazard:** ❖ Develop and practice a corporate evacuation plan. ❖ Support/participate in the Redwood Coast Tsunami Working Group. ❖ Educate employees on the risk exposure from the tsunami hazard and ways to minimize that risk	• **Manipulate the hazard:** ❖ Build wave abatement structures (e.g. the "Jacks" looking structure designed by the Japanese) • **Reduce exposure to the hazard:** ❖ Locate structure or functions outside of hazard area whenever possible. ❖ Harden infrastructure for tsunami impacts. ❖ Relocate identified critical facilities located in tsunami high hazard areas. • **Reduce vulnerability to the hazard:** ❖ Adopt higher regulatory standards that will provide higher levels of protection to structures built in a tsunami inundation area. ❖ Utilize tsunami mapping once available, to guide development away from high risk areas through land use planning • **Increase the ability to respond to or be prepared for the hazard:** ❖ Create a probabilistic tsunami map for the OA. ❖ Provide incentives to guide development away from hazard areas. ❖ Develop a tsunami warning and response system. ❖ Provide residents with tsunami inundation maps ❖ Join NOAA's Tsunami Ready program ❖ Develop and communicate evacuation routes ❖ Enhance the public information program to include risk reduction options for the tsunami hazard

Table 17-8. Alternatives to Mitigate the Wildfire Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• **Manipulate the hazard:** ❖ Clear potential fuels on property such as dry overgrown underbrush and diseased trees • **Reduce exposure to the hazard:** ❖ Create and maintain defensible space around structures ❖ Locate outside of hazard area ❖ Mow regularly • **Reduce vulnerability to the hazard:** ❖ Create and maintain defensible space around structures and provide water on site ❖ Use fire-retardant building materials ❖ Create defensible spaces around home • **Increase the ability to respond to or be prepared for the hazard:** ❖ Employ techniques from the National Fire Protection Association's Firewise Communities program to safeguard home ❖ Identify alternative water supplies for fire fighting ❖ Install/replace roofing material with non-combustible roofing materials.	• **Manipulate the hazard:** ❖ Clear potential fuels on property such as dry underbrush and diseased trees • **Reduce exposure to the hazard:** ❖ Create and maintain defensible space around structures and infrastructure ❖ Locate outside of hazard area • **Reduce vulnerability to the hazard:** ❖ 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. • **Increase the ability to respond to or be prepared for the hazard:** ❖ Support Firewise community initiatives. ❖ Create /establish stored water supplies to be utilized for firefighting.	• **Manipulate the hazard:** ❖ Clear potential fuels on property such as dry underbrush and diseased trees ❖ Implement best management practices on public lands. • **Reduce exposure to the hazard:** ❖ 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 to the hazard:** ❖ 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 the ability to respond to or be prepared for the hazard:** ❖ 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 ❖ 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

18. AREA-WIDE ACTION PLAN AND IMPLEMENTATION

The Working Group reviewed the catalogs of hazard mitigation alternatives and selected area-wide actions to be included in a hazard mitigation action plan. The selection of area-wide actions was based on the risk assessment of identified hazards of concern and the defined hazard mitigation goals and objectives. Table 18-1 lists the recommended hazard mitigation actions that make up the action plan. The timeframe indicated in the table is defined as follows:

- Short Term = to be completed in 1 to 5 years.
- Long Term = to be completed in greater than 5 years.
- Ongoing = currently being funded and implemented under existing programs.

Table 18-1. Santa Clara County Operational Area Action Plan

Hazards Addressed	Objectives Met	Lead Agency	Funding Options	Timeframe
Action SCOA-1—Continue to maintain a website that will house the operational-area hazard mitigation plan, its progress reports, and all components of the plan's maintenance strategy to provide the planning partners and public ongoing access to the plan and its implementation.				
All	1, 2, 3, 4, 5, 6, 9	Santa Clara County OES	Santa Clara County OES Operating Budget	Ongoing
Action SCOA-2— Continue to leverage, support and enhance ongoing, regional public education and awareness programs as a method to educate the public on risk, risk reduction and community resilience.				
All	1, 2, 4, 9	Santa Clara County OES and all planning partners	Local	Ongoing
Action SCOA-3—Continue ongoing communication and coordination in the implementation of the Santa Clara County Operational Area Hazard Mitigation Plan.				
All	1, 2, 3, 4, 5, 6, 7, 8, 9	Santa Clara County OES and all planning partners	Local	Ongoing
Action SCOA-4—Continue to support the use, development and enhancement of a regional crisis communications system				
All	1, 4, 5, 9	Santa Clara County OES and all planning partners	Local, possible grant funding (FEMA, DHS, NWS, NOAA)	Ongoing
Action SCOA-5—Strive to capture time-sensitive, perishable data—such as high water marks, extent and location of hazard, and loss information—following hazard events to support future updates to the risk assessment.				
All	2, 3, 6	Santa Clara County OES and all planning partners	Local, FEMA (PA)	Short-term
Action SCOA-6—Identify new and comprehensive hazard datasets to improve and augment future updates to the risk assessment				
All	2, 3, 5, 6, 7, 8	Santa Clara County OES and all planning partners	Local	Ongoing

18.1.1 Benefit-Cost Review

The action plan must be prioritized according to a benefit/cost analysis of the proposed projects and their associated costs (44 CFR, Section 201.6(c)(3)(iii)). The benefits of proposed projects were weighed against estimated costs as part of the project prioritization process. The benefit/cost analysis was not of the detailed variety required by FEMA for project grant eligibility under Hazard Mitigation Assistance grants. A less formal approach was used because some projects may not be implemented for up to 10 years, and associated costs and benefits could change dramatically in that time. Therefore, a review of the apparent benefits versus the apparent cost of each project was performed. Parameters were established for assigning subjective ratings (high, medium, and low) to the costs and benefits of these projects.

Cost ratings were defined as follows:

- High—Existing funding will not cover the cost of the project; implementation would require new revenue through an alternative source (for example, bonds, grants, and fee increases).
- Medium—The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.
- Low—The project could be funded under the existing budget. The project is part of or can be part of an ongoing existing program.

Benefit ratings were defined as follows:

- High—Project will provide an immediate reduction of risk exposure for life and property.
- Medium—Project will have a long-term impact on the reduction of risk exposure for life and property, or project will provide an immediate reduction in the risk exposure for property.
- Low—Long-term benefits of the project are difficult to quantify in the short term.

Using this approach, projects with positive benefit versus cost ratios (such as high over high, high over medium, medium over low, etc.) are considered cost-beneficial and are prioritized accordingly.

For many of the strategies identified in this action plan, financial assistance may be available through Hazard Mitigation Assistance grants, all of which require detailed benefit/cost analyses. These analyses will be performed on projects at the time of application using the FEMA benefit-cost model. For projects not seeking financial assistance from grant programs that require detailed analysis, "benefits" can be defined according to parameters that meet the goals and objectives of this plan.

18.1.2 Area-Wide Action Plan Prioritization

Table 18-2 lists the priority of each area-wide action.

Table 18-2. Prioritization of Operational Area-Wide Mitigation Actions

Action #	# of Objectives Met	Benefits	Costs	Do Benefits Equal or Exceed Costs?	Is project Grant Eligible?	Can Project be Funded under Existing Programs/ Budgets?	Priority (High, Med., Low)
SCOA-1	7	Medium	Low	Yes	No	Yes	High
SCOA-2	4	High	Medium	Yes	Yes	Yes	High
SCOA-3	9	High	Medium	Yes	Yes	Yes	High
SCOA-4	4	Medium	Medium	Yes	Yes	Yes	High
SCOA-5	3	Medium	Medium	Yes	Yes	No	High
SCOA-6	6	High	Medium	Yes	Yes	Yes	High

A qualitative benefit-cost review was performed for each of these actions. The priorities are defined as follows:

- High Priority—A project that meets multiple objectives (i.e., multiple hazards), has benefits that exceed cost, has funding secured or is an ongoing project and meets eligibility requirements for Hazard Mitigation Assistance grants. High priority projects can be completed in the short term (1 to 5 years).
- Medium Priority—A project that meets goals and objectives, that has benefits that exceed costs, and for which funding has not been secured but that is grant eligible under Hazard Mitigation Assistance grants or other grant programs. Project can be completed in the short term, once funding is secured. Medium priority projects will become high priority projects once funding is secured.
- Low Priority—A project 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 Hazard Mitigation Assistance grant funding, and for which the time line for completion is long term (1 to 10 years). Low priority projects may be eligible for other sources of grant funding from other programs.

18.1.3 Analysis of Area-Wide Mitigation Actions

Each recommended action was classified based on the hazard it addresses and the type of mitigation it involves. Table 18-3 shows the classification based on this analysis.

Table 18-3. Analysis of Mitigation Actions

Hazard Event	Actions That Address the Hazard, by Mitigation Type						
	Prevention	Property Protection	Public Education and Awareness	Natural Resource Protection	Emergency Services	Structural Projects	Climate Resilient
Dam/Levee Failure	SCOA-3, SCOA-6	SCOA-5	SCOA-1, SCOA-2, SCOA-3, SCOA-4	SCOA-6	SCOA-4, SCOA-6		SCOA-2, SCOA-5
Drought	SCOA-3	SCOA-5	SCOA-1, SCOA-2, SCOA-3, SCOA-4	SCOA-6	SCOA-4, SCOA-6		SCOA-2
Earthquake	SCOA-3	SCOA-5	SCOA-1, SCOA-2, SCOA-3, SCOA-4	SCOA-6	SCOA-4, SCOA-6		SCOA-2
Flooding	SCOA-3, SCOA-5	SCOA-5	SCOA-1, SCOA-2, SCOA-3, SCOA-4	SCOA-6	SCOA-4, SCOA-6		SCOA-2, SCOA-5
Landslide/Mass Movement	SCOA-3	SCOA-5	SCOA-1, SCOA-2, SCOA-3, SCOA-4	SCOA-6	SCOA-4, SCOA-6		SCOA-2, SCOA-5
Severe Weather	SCOA-3	SCOA-5	SCOA-1, SCOA-2, SCOA-3, SCOA-4	SCOA-6	SCOA-4, SCOA-6		SCOA-2
Wildfire	SCOA-3	SCOA-5	SCOA-1, SCOA-2, SCOA-3, SCOA-4	SCOA-6	SCOA-4, SCOA-6		SCOA-2, SCOA-5

Mitigation types used for this categorization are as follows:

- Prevention—Government, administrative or regulatory actions that influence the way land and buildings are developed to reduce hazard losses. Includes planning and zoning, floodplain laws, capital improvement programs, open space preservation, and storm water management regulations.
- Property Protection—Modification of buildings or structures to protect them from a hazard or removal of structures from a hazard area. Includes acquisition, elevation, relocation, structural retrofit, storm shutters, and shatter-resistant glass.
- Public Education and Awareness—Actions to inform citizens and elected officials about hazards and ways to mitigate them. Includes outreach projects, real estate disclosure, hazard information centers, and school-age and adult education.

- Natural Resource Protection—Actions that minimize hazard loss and preserve or restore the functions of natural systems. Includes sediment and erosion control, stream corridor restoration, watershed management, forest and vegetation management, and wetland restoration and preservation.
- Emergency Services—Actions that protect people and property during and immediately after a hazard event. Includes warning systems, emergency response services, and the protection of essential facilities.
- Structural Projects—Actions that involve the construction of structures to reduce the impact of a hazard. Includes dams, setback levees, floodwalls, retaining walls, and safe rooms.
- Climate Resilient—Actions that minimize the impacts of climate change via an aquifer storage and recovery system to increase water supply for drought mitigation and a flood diversion and storage project to reduce flood risk.

18.2 PLAN ADOPTION

A hazard mitigation plan must document that it has been formally adopted by the governing bodies of the jurisdictions requesting federal approval of the plan (44 CFR Section 201.6(c)(5)). For multi-jurisdictional plans, each jurisdiction requesting approval must document that is has been formally adopted. This plan will be submitted for a pre-adoption review to CalOES and FEMA Region IX prior to adoption. Once pre-adoption approval has been provided, all planning partners will formally adopt the plan. DMA compliance and its benefits cannot be achieved until the plan is adopted. Copies of the resolutions adopting this plan for all planning partners can be found in Appendix C of this volume.

18.3 PLAN MAINTENANCE STRATEGY

A hazard mitigation plan must present a plan maintenance process that includes the following (44 CFR Section 201.6(c)(4)):

- A section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan over a 5-year cycle.
- 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.
- 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 Hazard Mitigation Plan remains an active and relevant document and that the planning partners maintain their eligibility for applicable funding sources. The plan maintenance process includes a schedule for monitoring and evaluating the plan annually and producing an updated plan every five years. This chapter also describes how public participation will be integrated throughout the plan maintenance and implementation process. It also explains how the mitigation strategies outlined in this Plan will be incorporated into existing planning mechanisms and programs, such as comprehensive land-use planning processes, capital improvement planning, and building code enforcement and implementation. The Plan's format allows sections to be reviewed and updated when new data become available, resulting in a plan that will remain current and relevant.

Pursuant to 44CFR 201.6(c)(4)(i), the plan maintenance matrix shown in Table 18-4 provides a synopsis of responsibilities for plan monitoring, evaluation, and update, which are discussed in further detail in the sections below.

Table 18-4. Plan Maintenance Matrix

Task	Approach	Timeline	Lead Responsibility	Support Responsibility
Monitoring	Preparation of status updates and action implementation tracking as part of submission for Annual Progress Report.	January to February or upon comprehensive update to General Plan or major disaster	Jurisdictional points of contact identified in Volume 2 annexes	Jurisdictional implementation lead identified in Volume 2 annexes
Evaluation	Review the status of previous actions as submitted by the monitoring task lead and support to assess the effectiveness of the plan; compile and finalize the Annual Progress Report	Finalized progress report completed by March 1 of each year	Core Planning Group (via Santa Clara County OES); Plan Maintenance element	Jurisdictional points of contacts identified in Volume 2 annexes
Update	Reconvene the planning partners, at a minimum, every 5 years to guide a comprehensive update to review and revise the plan.	Every 5 years or upon comprehensive update to General Plan or major disaster	Core Planning Group (via Santa Clara County OES); Plan Maintenance element	Jurisdictional points of contacts identified in Volume 2 annexes

18.3.1 Plan Implementation

The effectiveness of the hazard mitigation plan depends on its implementation and 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 the planning partners can implement over the next 5 years. The Working Group has established goals and objectives and have prioritized mitigation actions that will be implemented through existing plans, policies, and programs.

The Core Planning Group, in coordination with the Working Group, will have lead responsibility for overseeing the overall plan implementation and maintenance strategy. Plan implementation and evaluation will be a shared responsibility among all planning partners and agencies identified as lead agencies in the mitigation action plans and according to local governing protocols (see planning partner annexes in Volume 2 of this plan).

18.3.2 Plan Maintenance Element

The Working Group is a total volunteer body that oversaw the development of the Plan and made recommendations on key elements of the plan, including the maintenance strategy. It was the Working Group's position that an oversight committee with representation similar to that of the Working Group should have an active role in the plan maintenance strategy. Therefore, it is recommended that a Plan Maintenance element remain a viable body involved in key elements of the plan maintenance strategy. The Plan Maintenance element should include representation from all planning partners and other stakeholders in the OA.

The principal role of the Plan Maintenance element will be to review the annual progress report and provide input to the Core Planning Group (via Santa Clara County OES) and the Emergency Operational Area Council (EOAC) on possible enhancements to be considered at the next update. Future plan updates may be overseen by a new working group, similar to the one that participated in this update. Keeping an interim Plan Maintenance element intact will therefore provide a head start on future updates. Data compilation for the progress report is the responsibility of each planning partner, not the responsibility of the Plan Maintenance element. The Plan Maintenance element's role will simply be to review the progress report in order to identify issues needing to be addressed by future plan updates.

18.3.3 Annual Progress Report Requirement

The minimum task of each planning partner will be the evaluation of the progress of its individual action plan during a 12-month performance period. This review will include the following:

- Summary of any hazard events that occurred during the performance period and the impact these events had on the OA.
- 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 determine if the timeline for identified projects needs 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).
- Impact of any other planning programs or actions that involve hazard mitigation.

The Core Planning Group has created a streamlined approach for preparing a progress report. A template for future progress reports is provided in Appendix B of this volume. The Plan Maintenance element will provide feedback to the Core Planning Group on items included in the template. The Core Planning Group will then prepare a formal annual report on the progress of the plan. This report should be used as follows:

- Posted on the Santa Clara County OES website page dedicated to the hazard mitigation plan.
- Provided to the local media through a press release.
- Presented to planning partner governing bodies to inform them of the progress of actions implemented during the reporting period.
- Conducted between January and February of each year to position the Operational Area for Pre-Disaster Mitigation funding opportunities beginning March 1.

Annual progress reporting is not a requirement specified under 44 CFR, but is a requirement for credit under the CRS program activity 510. However, it may enhance the planning partners' opportunities for funding. 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 the other partners. Each planning partner was informed of these protocols at the beginning of this planning process (in the "Planning Partner Expectations" package provided at the start of the process), and each partner acknowledged these expectations with submittal of a letter of intent to participate in this process.

18.3.4 Twice-Yearly Progress Report Option

During the planning process, the Core Planning Group and Working Group identified an added benefit for twice-yearly progress reporting during the plan performance period. Twice-yearly progress reporting, while not mandated as part of this plan maintenance procedure, can provided added benefit in the following areas:

- Community Rating System (CRS) recertification preparation for CRS communities.
- Streamlined coordination and assessment to pursue grant funds following a disaster declaration.
- Continuity of knowledge to prevent plan maintenance lapse due to staff turnover.

Community Rating System

Twice-yearly progress reporting will serve a primary benefit to communities participating in CRS. As part of annual recertification for the CRS program with no formal audit, CRS communities are required to report on the status of their mitigation initiatives. These re-certifications occur on October 1 of each year, approximately six months after the annual progress reporting period that will be led by the Core Planning Group. As such, twice-yearly reporting is recommended to capture any additional progress achieved since the annual progress report development. To meet this recertification timeline, the CRS communities should strive to complete twice-yearly progress reports between August and September each year.

It is understood by the CRS participating communities within the OA that a formal progress report is to be submitted with its annual recertification once a community receives credit for planning under CRS activity 510. If there has been no change in status of any action during the period for the initial progress reporting and the due date for the CRS annual recertification (October 1), then submittal of the initial report will suffice for CRS progress reporting requirements. However, a community can receive additional credit points under CRS activity 510 for fully committing to twice-yearly progress reporting.

Post-Disaster Funding

Once a major disaster occurs in the OA, Hazard Mitigation Grant Program funds may become available on a competitive basis. Planning partners may choose to update their progress on their selected strategies for the purpose of identifying appropriate projects for which to pursue HMGP funds. Additionally, planning partners may identify appropriate multi-jurisdictional initiatives specific to the hazard and damage experienced, in order to tailor their grant submissions for maximum benefit. The occurrence of a presidentially declared disaster in the OA that triggers grant funding may also trigger a formal update to this hazard mitigation plan, as described below.

Staff Turnover

During any given year, staff turnover may disrupt normal operations of participation planning partners. If key points of contact leave, knowledge for action plan progress or standard practices may be lost. By conducting a twice-yearly progress report prior to a major staff change, jurisdictions provide a road map for knowledge transfer between outgoing and incoming staff.

Twice-Yearly Progress Reporting Assistance

Santa Clara County OES will provide assistance to jurisdictions seeking to conduct a progress report outside of the annual progress reporting period. This assistance may include providing a copy of the most recently completed annual progress report and guidance on how to review and report on the mitigation action list, recommendations on prioritization.

18.3.5 Plan Update

Local hazard mitigation plans must be reviewed, revised if appropriate, and resubmitted for approval in order to remain eligible for benefits under the DMA (44 CFR, Section 201.6(d)(3)). The planning partners intend to update the hazard mitigation plan on a 5-year cycle from the date of initial plan adoption. This cycle may be accelerated to less than 5 years based on the following triggers:

- A Presidential Disaster Declaration that impacts the OA.
- A hazard event that causes loss of life.
- A comprehensive update of a planning partner’s general plan.

It will not be the intent of future updates to develop a complete new hazard mitigation plan for the OA. The update will, at a minimum, include the following elements:

- The update process will be convened through a new Working Group.
- The hazard risk assessment will be reviewed and, if necessary, updated using best available information and technologies.
- The action plans will be reviewed and revised to account for any actions 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 prior to adoption.

- Planning partner governing bodies will adopt the updated plan.

18.3.6 Grant Monitoring and Coordination

The Working Group recognized the importance of having an annual coordination period that helps each planning partner become aware of upcoming mitigation grant opportunities identifies multi-jurisdiction projects to pursue. Grant monitoring will be the responsibility of the Core Planning Group (via Santa Clara County OES) as part of the annual progress report coordination responsibilities. Santa Clara County OES will keep the planning partners apprised of Hazard Mitigation Assistance grant openings and provide technical guidance and expertise in developing the HMA sub-applicant package. In cases where jurisdictions wish to pursue funding for multi-jurisdiction initiatives, Santa Clara County OES will provide each participating jurisdiction with the guidance needed to complete a joint sub-applicant package.

Santa Clara County OES intends to be a resource to the planning partnership in the support of project grant writing and development. The degree of this support will depend on the level of assistance requested by the partnership during open windows for grant applications. It is not Santa Clara County OES's intent to lead any grant application effort for any specific planning partner requesting assistance. It will be the role of Santa Clara County OES staff to provide support to a lead jurisdiction by providing or identifying resources for project development, scoping, feasibility, grant writing, environmental/historic preservation application, and benefit/cost analyses. As part of grant monitoring and coordination, Santa Clara County OES agrees to provide the following:

- Notification to planning partners about impending grant opportunities.
- A current list of eligible, jurisdiction-specific projects for funding pursuit consideration.
- Notification about mitigation priorities for the fiscal year to assist the planning partners in the selection of appropriate projects.
- Training on the FEMA benefit-cost analysis tool upon request.
- Training on the sub-applicant system (eGrants) upon request.
- Grant writing technical assistance upon request.
- Technical review of the completed sub-applicant package upon request.

Grant monitoring and coordination is expected to occur on an annual basis in coordination with the annual progress report or as needed based on the availability of non-HMA or post-disaster funding opportunities.

18.3.7 Continuing Public Involvement

The public will continue to be apprised of the plan's progress through the Santa Clara County OES website and by providing copies of annual progress reports to the media. Each planning partner has agreed to provide links to the hazard mitigation plan website on their individual jurisdictional websites to increase avenues of public access to the plan. Santa Clara County OES has agreed to maintain the hazard mitigation plan website. This site will not only house the final plan, it will become the one-stop shop for information regarding the plan, the partnership and plan implementation. Upon initiation of future update processes, a new public involvement strategy will be initiated based on guidance from a new working group. This strategy will be based on the needs and capabilities of the planning partnership at the time of the update. At a minimum, this strategy will include the use of local media outlets within the OA.

Through this planning process, the Working Group recognized a need to develop a crisis communication strategy. The Working Group identified the benefit of a sole-source outlet for providing public information. During the planning process, the Santa Clara County Fire Department's public information officer provided guidance to jurisdictional public information officers in regards to messaging and public response via social media. During the performance period, a single messaging system to be designated by Santa Clara County OES will be established on behalf of the whole partnership.

18.3.8 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 general plans of the planning partners are considered to be integral parts of this plan. The planning partners, through adoption of general plans and zoning ordinances, have planned for the impact of natural hazards. The plan development process provided them with the opportunity to review and expand on policies contained within these planning mechanisms. The planning partners used their general plans and the hazard mitigation plan as complementary documents that work together to achieve the goal of reducing risk exposure to the citizens of the OA. An update to a general plan may trigger an update to the hazard mitigation plan.

All municipal planning partners are committed to creating a linkage between the hazard mitigation plan and their individual general plans by identifying a mitigation action as such and giving that action a high priority. Additionally, all planning partners are committed to being in full compliance with California Assembly Bill 2140 and Senate Bill 379, which promote the integration of local hazard mitigation plans and general plans and mandate that these plans address climate change. Other planning processes and programs to be coordinated with the recommendations of the hazard mitigation plan include the following:

- Emergency response plans.
- Training and exercise of emergency response plans.
- Debris Management Plans.
- Recovery Plans.
- Capital improvement programs.
- Municipal codes.
- Community design guidelines.
- Water-efficient landscape design guidelines.
- Stormwater management programs.
- Water system vulnerability assessments.
- Community Wildfire Protection Plans.
- Comprehensive Flood Hazard Management Plans.
- Resiliency Plans.
- Community Development Block Grant-Disaster Recovery action plans.
- Public information/Education plans.

Some action items do not need to be implemented through regulation. Instead, these items can be implemented through the 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 will be incorporated via the update process.

REFERENCES

Almendrala, Anna. 2012. "Terror Arrests: 4 California Men Arrested, Charged With Plotting To Wage 'Violent Jihad'." Article accessed online at http://www.huffingtonpost.com/2012/11/20/four-california-men-arrested-terror_n_2162612.html.

Association of Bay Area Governments (ABAG). 2010. Taming Natural Disasters; Multi-Jurisdictional Local Hazard Mitigation Plan for the San Francisco Bay Area. 2010 Update of the 2005 Plan.

Association of Bay Area Governments (ABAG). 2016. Santa Clara County Earthquake Hazard. Page of the Association of Bay Area Governments Resilience Program web site. Accessed online at: http://resilience.abag.ca.gov/earthquakes/santaclara/

Bay City News. 2016. "4 New Cases of Children with Enterovirus Confirmed in Santa Clara County." Article accessed online at http://www.nbcbayarea.com/news/local/4-New-Cases-of-Children-with-Enterovirus-Confirmed-in-Santa-Clara-County-279501292.html

CAL FIRE. 2016. Incident Information page of the CAL FIRE website. Accessed November 2016 at http://cdfdata.fire.ca.gov/incidents/incidents_archived

California Department of Conservation. 2017. Hayward Fault Fact Sheet web page. Accessed online at http://www.conservation.ca.gov/index/Pages/HaywardFaultFactSheet.aspx

California Department of Toxic Substances Control. 2016. EnviroStor data management system of the California Department of Toxic Substances Control website. Accessed online at http://www.envirostor.dtsc.ca.gov/public/

California Department of Water Resources (DWR). 2013. The California Water Plan. Available online at http://www.waterplan.water.ca.gov/docs/cwpu2013/Final/Vol2_SanFranciscoBayRR.pdf

California Department of Water Resources (DWR). 2016. DWR Levee Repair Website. Accessed Nov 2016 at http://www.water.ca.gov/levees/

California Department of Water Resources (DWR). 2016b. Climate Change page of California DWR website. Accessed online at http://www.water.ca.gov/climatechange/

California Division of Safety of Dams. 2017. Listing of Dams. Accessed online at http://www.water.ca.gov/damsafety/damlisting/index.cfm

California Emergency Management Agency (Cal EMA). 2012. California Climate Adaptation Planning Guide. Available online at: http://resources.ca.gov/docs/climate/APG_Understanding_Regional_Characteristics.pdf

California Employment Development Department. 2015. County to County Commute Patterns. Webpage accessed online at http://www.labormarketinfo.edd.ca.gov/data/county-to-county-commute-patterns.html

California Office of Emergency Services (CalOES). 2013. State of California Multi-Hazard Mitigation Plan. Accessed online at http://hazardmitigation.calema.ca.gov/plan/state_multi-hazard_mitigation_plan_shmp

CNN. 2003. "FBI, Justice: El Al attack was terrorism; Ruling backs previous report on 2002 airport shooting." Article accessed online at http://www.cnn.com/2003/US/West/04/12/airport.shooting/

FEMA 2010. http://www.fema.gov . Website accessed 2009,2010, 2011

FEMA. 2001. Understanding Your Risks; Identifying Hazards and Determining your Risks. FEMA (386-2). August 2001

FEMA. 2002. Getting Started; Building support for Mitigation Planning; FEMA (386-1). September 2002

FEMA. 2003. Developing the Mitigation Plan; Identifying Mitigation Actions and Implementing Strategies. FEMA (386-3). April 2003

FEMA. 2004. Using Hazus for Risk Assessment, How to Guide, FEMA (433). August 2004

FEMA. 2007. FEMA, National Flood Insurance Program, Community Rating System; CRS Coordinator's Manual FIA-15/2007 OMB No. 1660-0022.

FEMA. 2011. Local Mitigation Plan Review Guide. October 1, 2011.

FEMA. 2016. FEMA Community Rating System Communities and their Classes. Web page accessed online at https://www.fema.gov/media-library/assets/documents/15846

FEMA. 2017. FEMA Disaster Declarations Summary - Open Government Dataset. Accessed online at https://www.fema.gov/media-library/assets/documents/28318?id=6292

Fitzgerald, Drew. 2015. "Attacks on Fiber Networks in California Baffle FBI; Authorities have yet to nail down a motive or culprit for more than a dozen breaches in the Bay Area." Article accessed online at https://www.wsj.com/articles/attacks-on-fiber-networks-in-california-baffle-fbi-1439417515

Intergovernmental Panel on Climate Change (IPCC). 2014. Climate Change 2014: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Parts A, B and Annexes. Accessed online at: http://www.ipcc.ch/report/ar5/wg2/

International Strategy for Disaster Reduction. 11/11/2008. "Disaster Risk Reduction Strategies and Risk Management Practices: Critical Elements for Adaptation to Climate Change"

Krikorian, Greg. 2006. "3 Eco-Terror Suspects Held in Northern California Plot." Article accessed online at http://articles.latimes.com/2006/jan/14/local/me-elf14

L.A. Times. 2016. Fire Imperils 2,000 Homes Near San José: Raging Arson Blaze in Mountain Area Forces Widespread Evacuations. Accessed November 2016 at http://articles.latimes.com/1985-07-10/news/mn-7612_1_homes-near-san-jose .

Michigan Tech University. 2016. How Are Earthquake Magnitudes Measured? Web page on Michigan Tech's UPSeis website. Accessed May 2016 at http://www.geo.mtu.edu/UPSeis/intensity.html

National Academies of Sciences, Engineering and Medicine. 2017. The "Ripple Effect." Web page accessed online at https://www.nap.edu/read/2027/chapter/8

National Aeronautics and Space Administration (NASA). 2004. NASA Earth Observatory News Web Site Item, dated August 2, 2004. Accessed online at http://earthobservatory.nasa.gov/Newsroom/view.php?id=25145

National Aeronautics and Space Administration (NASA). 2016. Global Climate Change: Vital Signs of the Planet. The website of NASA. Last updated September 15, 2016. Accessed online at: http://climate.nasa.gov/vital-signs/carbon-dioxide/

National Aeronautics and Space Administration (NASA). 2017. NASA, NOAA Data Show 2016 Warmest Year on Record Globally. Web page accessed February 24, 2017 at https://www.nasa.gov/press-release/nasa-noaa-data-show-2016-warmest-year-on-record-globally

National Oceanic and Atmospheric Administration (NOAA). 2010. http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms. NOAA, National Climatic Data Center website, accessed 2010

National Oceanic and Atmospheric Administration (NOAA). 2015. Severe Weather 101; Thunderstorm Basics. Web page of the National Severe Storms Laboratory. Accessed online at http://www.nssl.noaa.gov/education/svrwx101/thunderstorms/

National Oceanic and Atmospheric Administration (NOAA). 2016. National Centers for Environmental Information Estimated Tsunami Travel Times to Coastal Locations. Webpage accessed online at https://maps.ngdc.noaa.gov/viewers/ttt_coastal_locations/

National Oceanic and Atmospheric Administration (NOAA). 2017. National Centers for Environmental Information Storm Events Database. Accessed online at https://www.ncdc.noaa.gov/stormevents/

National Weather Service (NWS). 2016b. Weather Fatalities Chart for 2015. Accessed online at http://www.nws.noaa.gov/om/hazstats/images/hazstat-chart15-lg.gif

OTA (Congressional Office of Technology Assessment). 1993. Preparing for an Uncertain Climate, Vol. I. OTA–O–567. U.S. Government Printing Office, Washington, D.C.

Santa Clara Valley Transportation Authority. 2017. Future BART Stations page of Santa Clara Valley Transportation Authority website. Accessed online at http://www.vta.org/bart/stationsphaseII

Santa Clara Valley Water District (SCVWD). 2016. Where Does Your Water Come From? Page of the Santa Clara Valley Water District web site. Accessed 10/5/2016 at http://www.valleywater.org/Services/WhereDoesYourWaterComeFrom.aspx.

Santa Clara Valley Water District (SCVWD). 2016b. Imported Water: Vital to Santa Clara County. Page of the Santa Clara Valley Water District web site. Accessed online at http://www.valleywater.org/ImportedWater/.

Santa Clara Valley Water District (SCVWD). 2017. West valley page of the Santa Clara Valley Water District web site. Accessed January 9, 2017 at http://www.valleywater.org/services/WestValley.aspx

SF Gate. 2009. “Sabotage attacks knock out phone service; Access severed for hundreds of thousands.” Article accessed online at http://www.sfgate.com/bayarea/article/Sabotage-attacks-knock-out-phone-service-3245380.php

Smith, Rebecca. 2014. “Assault on California Power Station Raises Alarm on Potential for Terrorism; April Sniper Attack Knocked Out Substation, Raises Concern for Country’s Power Grid.” Article accessed online at https://www.wsj.com/articles/SB10001424052702304851104579359141941621778

Spatial Hazard Events and Losses Database for the United States maintained by the University of South Carolina’s (USC) Hazard Research Lab

Stanford University National Performance of Dams Program. 2017. NPDP Dams Database. Accessed online at https://npdp.stanford.edu/dams_database

Tree Mortality Task Force. 2017. Tree Mortality: Facts and Figures. April 2017. Accessed online at http://www.fire.ca.gov/treetaskforce/downloads/TMTFMaterials/Facts_and_Figures_April_2017.pdf

U.S. Army Corps of Engineers. 2016. Oakland Harbor Navigation Improvement (-50 foot) Project SCH No. 97072051 Final Environmental Impact Statement/Report. May 1998, updated January 2000. U.S. Army Corps of Engineers San Francisco District, Port of Oakland. Accessed November 2016.

U.S. Army Corps of Engineers. 2016b. National Inventory of Dams. Accessed online at https://catalog.data.gov/dataset/national-inventory-of-dams

U.S. Army Corps of Engineers. 2016c. National Levee Database.

U.S. Department of Agriculture (USDA). 2016. Cause of Loss Historical Data Files. Website page accessed online at http://www.rma.usda.gov/data/cause.html

U.S. Department of Agriculture, Natural Resources Conservation Service. 2015. Supplement to the Soil Survey of the Santa Clara Area, California, Western Part. (Accessible online at: http://soils.usda.gov/survey/printed_surveys/)

U.S. Environmental Protection Agency (EPA). 2016a. Climate Change Indicators in the United States. The website of the EPA. Last updated August 11, 2016. Accessed online at: https://www.epa.gov/climate-indicators/climate-change-indicators-atmospheric-concentrations-greenhouse-gases

U.S. Environmental Protection Agency (EPA). 2016b. Climate change indicators in the United States, 2016. Fourth edition. EPA 430-R-16-004. www.epa.gov/climate-indicators.

U.S. Geological Survey (USGS). 1987. The Morgan Hill, California, Earthquake of April 24, 1984, U.S. Geological Survey Bulletin 1639.

U.S. Geological Survey (USGS). 1989. The Severity of an Earthquake. U.S. Government Printing Office: 1989-288-913. Accessed online at: http://pubs.usgs.gov/gip/earthq4/severity_text.html

U.S. Geological Survey (USGS). 2008. An Atlas of ShakeMaps for Selected Global Earthquakes. U.S. Geological Survey Open-File Report 2008-1236. Prepared by Allen, T.I., Wald, D.J., Hotovec, A.J., Lin, K., Earle, P.S. and Marano, K.D.

U.S. Geological Survey (USGS). 2010. PAGER—Rapid Assessment of an Earthquake's Impact. U.S. Geological Survey Fact Sheet 2010-3036. September 2010.

U.S. Geological Survey (USGS). 2017. Land Subsidence in the Santa Clara Valley. Page of the USGS web site. Accessed 1/30/2017 at https://ca.water.usgs.gov/land_subsidence/santa-clara-valley-subsidence.html,

U.S. Geological Survey (USGS). 2017b. Current Conditions for California: Streamflow. Page of the USGS web site. Accessed 1/16/2017 at https://waterdata.usgs.gov/ca/nwis/current/?type=flow&group_key=county_cd ,,

U.S. Geological Survey (USGS). 2017c. Land Subsidence: Cause & Effect. Page of the USGS web site. Accessed online at https://ca.water.usgs.gov/land_subsidence/california-subsidence-cause-effect.html

U.S. Global Change Research Program (USGCRP). 2009. Global Climate Change Impacts in the United States, Thomas R. Karl, Jerry M. Melillo and Thomas C. Peterson, (eds.). Cambridge University Press.

GLOSSARY

ACRONYMS

°F—Degrees Fahrenheit

ABAG—Association of Bay Area Governments

ADA—Americans with Disabilities Act

API—Advanced Persistent Threat

ASPA—Aboveground petroleum storage tank

ATC—(Federal) Air Traffic Controller

BACERP—Bay Area Climate and Energy Resilience Project

BART—Bay Area Rapid Transit System

BPR—Bottom pressure recorder

CAL FIRE—California Department of Forestry and Fire Protection

CalOES—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

cfs—cubic feet per second

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 Maps

DHS—Department of Homeland Security

DMA—Disaster Mitigation Act

DOF—Department of Finance

DWR—Department of Water Resources

EA—Electronic Attack

EMA—Emergency Managers Association

EMP—Electromagnetic Pulse

EPA—U.S. Environmental Protection Agency

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

FERC—Federal Energy Regulatory Commission

FHSZ—Fire Hazard Severity Zone

FIRM—Flood Insurance Rate Map

FMA—Flood Mitigation Insurance

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—Hazards, United States-Multi Hazard

HMGP—Hazard Mitigation Grant Program

HMI—Hazard Mitigation Insurance

HMP—Hazard Mitigation Plan

IBC—International Building Code

IPCC—Intergovernmental Panel on Climate Change

IRC—International Residential Code

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

MCI—Mass casualty incident

MITM—Man in the middle

mm—Millimeter

MM—Modified Mercalli

mm/yr—Millimeters per year

MM—Modified Mercalli Scale

mph—Miles per hour

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

PDI—Palmer Drought Index

PDM—Pre-Disaster Mitigation Grant Program

PDSI—Palmer Drought Severity Index

PG&E—Pacific Gas and Electric

PGA—Peak Ground Acceleration

PHDI—Palmer Hydrological Drought Index

PTWC—Pacific Tsunami Warning Center

RCRA—Resource Conservation and Recovery Act

SCA—(Bay Area Water) Supply Conservation Agency

SCADA—Supervisory Control and Data Acquisition

SERC—State Emergency Response Commission

SFHA—Special Flood Hazard Area

SFO—San Francisco International Airport

SFPUC—San Francisco Public Utilities Commission

SHELDUS—Special Hazard Events and Losses Database for the US

SPCC—Spill Prevention Control and Countermeasures

SPI—Standardized Precipitation Index

SRA—State responsibility area

TSCA—Toxic Substances Control Act

UN—United Nations

USDA—United States Department of Agriculture

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

DEFINITIONS

100-Year Flood: The term “100-year flood” can be misleading. The 100-year flood does not necessarily occur once every 100 years. Rather, it is the flood that has a 1 percent chance of being equaled or exceeded in any given year. Thus, the 100-year flood could occur more than once in a relatively short period of time. The Federal Emergency Management Agency (FEMA) defines it as the 1 percent annual chance flood, which is now the standard definition used by most federal and state agencies and by the National Flood Insurance Program (NFIP).

Acre-Foot: An acre-foot is the amount of water it takes to cover 1 acre to a depth of 1 foot. This measure is used to describe the quantity of storage in a water reservoir. An acre-foot is a unit of volume. One acre foot equals 7,758 barrels; 325,829 gallons; or 43,560 cubic feet. An average household of four will use approximately 1 acre-foot of water per year.

Asset: An asset is any man-made or natural feature that has value, including people; buildings; infrastructure, such as bridges, roads, sewers, and water systems; lifelines, such as electricity and communication resources; and environmental, cultural, or recreational features such as parks, wetlands, and landmarks.

Base Flood: The flood having a 1% chance of being equaled or exceeded in any given year, also known as the “100-year” or “1% chance” flood. The base flood is a statistical concept used to ensure that all properties subject to the National Flood Insurance Program (NFIP) are protected to the same degree against flooding.

Basin: A basin is the area within which all surface water—whether from rainfall, snowmelt, springs, or other sources—flows to a single water body or watercourse. The boundary of a river basin is defined by natural topography, such as hills, mountains, and ridges. Basins are also referred to as “watersheds” and “drainage basins.”

Benefit: A benefit is a net project outcome and is usually defined in monetary terms. Benefits may include direct and indirect effects. For the purposes of benefit-cost analysis of proposed mitigation measures, benefits are limited to specific, measurable, risk reduction factors, including reduction in expected property losses (buildings, contents, and functions) and protection of human life.

Benefit/Cost Analysis: A benefit/cost analysis is a systematic, quantitative method of comparing projected benefits to projected costs of a project or policy. It is used as a measure of cost effectiveness.

Building: A building is defined as a structure that is walled and roofed, principally aboveground, and permanently fixed to a site. The term includes manufactured homes on permanent foundations on which the wheels and axles carry no weight.

Capability Assessment: A capability assessment provides a description and analysis of a community's current capacity to address threats associated with hazards. The assessment includes two components: an inventory of an agency's mission, programs, and policies, and an analysis of its capacity to carry them out. A capability assessment is an integral part of the planning process in which a community's actions to reduce losses are identified, reviewed, and analyzed, and the framework for implementation is identified. The following capabilities were reviewed under this assessment:

- Legal and regulatory capability
- Administrative and technical capability
- Fiscal capability

Community Rating System (CRS): The CRS is a voluntary program under the NFIP that rewards participating communities (provides incentives) for exceeding the minimum requirements of the NFIP and completing activities that reduce flood hazard risk by providing flood insurance premium discounts.

Critical Area: An area defined by state or local regulations as deserving special protection because of unique natural features or its value as habitat for a wide range of species of flora and fauna. A sensitive/critical area is usually subject to more restrictive development regulations.

Critical Facility: Facilities and infrastructure that are critical to the health and welfare of the population. These become especially important after any hazard event occurs. For the purposes of this plan, critical facilities include:

- Structures or facilities that produce, use, or store highly volatile, flammable, explosive, toxic and/or water reactive materials;
- Hospitals, nursing homes, and housing likely to contain occupants who may not be sufficiently mobile to avoid death or injury during a hazard event.
- Police stations, fire stations, vehicle and equipment storage facilities, and emergency operations centers that are needed for disaster response before, during, and after hazard events, and
- Public and private utilities, facilities and infrastructure that are vital to maintaining or restoring normal services to areas damaged by hazard events.
- Government facilities.

Cubic Feet per Second (cfs): Discharge or river flow is commonly measured in cfs. One cubic foot is about 7.5 gallons of liquid.

Dam: Any artificial barrier or controlling mechanism that can or does impound 10 acre-feet or more of water.

Dam Failure: Dam failure refers to a partial or complete breach in a dam (or levee) that impacts its integrity. Dam failures occur for a number of reasons, such as flash flooding, inadequate spillway size, mechanical failure of valves or other equipment, freezing and thawing cycles, earthquakes, and intentional destruction.

Debris Avalanche: Volcanoes are prone to debris and mountain rock avalanches that can approach speeds of 100 mph.

Debris Flow: Dense mixtures of water-saturated debris that move down-valley; looking and behaving much like flowing concrete. They form when loose masses of unconsolidated material are saturated, become unstable, and move down slope. The source of water varies but includes rainfall, melting snow or ice, and glacial outburst floods.

Debris Slide: Debris slides consist of unconsolidated rock or soil that has moved rapidly down slope. They occur on slopes greater than 65 percent.

Disaster Mitigation Act of 2000 (DMA); The DMA is Public Law 106-390 and is the latest federal legislation enacted to encourage and promote proactive, pre-disaster planning as a condition of receiving financial assistance under the Robert T. Stafford Act. The DMA emphasizes planning for disasters before they occur. Under the DMA, a pre-disaster hazard mitigation program and new requirements for the national post-disaster hazard mitigation grant program (HMGP) were established.

Drainage Basin: A basin is the area within which all surface water- whether from rainfall, snowmelt, springs or other sources- flows to a single water body or watercourse. The boundary of a river basin is defined by natural topography, such as hills, mountains and ridges. Drainage basins are also referred to as **watersheds** or **basins**.

Drought: Drought is a period of time without substantial rainfall or snowfall from one year to the next. Drought can also be defined as the cumulative impacts of several dry years or a deficiency of precipitation over an extended period of time, which in turn results in water shortages for some activity, group, or environmental function. A hydrological drought is caused by deficiencies in surface and subsurface water supplies. A socioeconomic drought impacts the health, well-being, and quality of life or starts to have an adverse impact on a region. Drought is a normal, recurrent feature of climate and occurs almost everywhere.

Earthquake: An earthquake is defined as a sudden slip on a fault, volcanic or magmatic activity, and sudden stress changes in the earth that result in ground shaking and radiated seismic energy. Earthquakes can last from a few seconds to over 5 minutes, and have been known to 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. Casualties may result from falling objects and debris as shocks shake, damage, or demolish buildings and other structures.

Exposure: Exposure is defined as the number and dollar value of assets considered to be at risk during the occurrence of a specific hazard.

Extent: The extent is the size of an area affected by a hazard.

Fire Behavior: Fire behavior refers to the physical characteristics of a fire and is a function of the interaction between the fuel characteristics (such as type of vegetation and structures that could burn), topography, and weather. Variables that affect fire behavior include the rate of spread, intensity, fuel consumption, and fire type (such as underbrush versus crown fire).

Fire Frequency: Fire frequency is the broad measure of the rate of fire occurrence in a particular area. An estimate of areas most likely to burn is based on past fire history or fire rotation in the area, fuel conditions, weather, ignition sources (such as human or lightning), fire suppression response, and other factors.

Flash Flood: A flash flood occurs with little or no warning when water levels rise at an extremely fast rate

Flood Insurance Rate Map (FIRM): FIRMs are the official maps on which the Federal Emergency Management Agency (FEMA) has delineated the Special Flood Hazard Area (SFHA).

Flood Insurance Study: A report published by the Federal Insurance and Mitigation Administration for a community in conjunction with the community's Flood Insurance rate Map. The study contains such background data as the base flood discharges and water surface elevations that were used to prepare the FIRM. In most cases, a community FIRM with detailed mapping will have a corresponding flood insurance study.

Floodplain: Any land area susceptible to being inundated by flood waters from any source. A flood insurance rate map identifies most, but not necessarily all, of a community's floodplain as the Special Flood Hazard Area (SFHA).

Floodway: Floodways are areas within a floodplain that are reserved for the purpose of conveying flood discharge without increasing the base flood elevation more than 1 foot. Generally speaking, no development is allowed in floodways, as any structures located there would block the flow of floodwaters.

Floodway Fringe: Floodway fringe areas are located in the floodplain but outside of the floodway. Some development is generally allowed in these areas, with a variety of restrictions. On maps that have identified and delineated a floodway, this would be the area beyond the floodway boundary that can be subject to different regulations.

Fog: Fog refers to a cloud (or condensed water droplets) near the ground. Fog forms when air close to the ground can no longer hold all the moisture it contains. Fog 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, cause 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 are known to be substantial.

Freeboard: Freeboard is the margin of safety added to the base flood elevation.

Frequency: For the purposes of this plan, frequency refers to how often a hazard of specific magnitude, duration, and/or extent is expected to occur on average. Statistically, a hazard with a 100-year frequency is expected to occur about once every 100 years on average and has a 1 percent chance of occurring any given year. Frequency reliability varies depending on the type of hazard considered.

Fujita Scale of Tornado Intensity: Tornado wind speeds are sometimes estimated on the basis of wind speed and damage sustained using the Fujita Scale. The scale rates the intensity or severity of tornado events using numeric values from F0 to F5 based on tornado wind speed and damage. An F0 tornado (wind speed less than 73 miles per hour (mph)) indicates minimal damage (such as broken tree limbs), and an F5 tornado (wind speeds of 261 to 318 mph) indicates severe damage.

Goal: A goal is a general guideline that explains what is to be achieved. Goals are usually broad-based, long-term, policy-type statements and represent global visions. Goals help define the benefits that a plan is trying to achieve. The success of a hazard mitigation plan is measured by the degree to which its goals have been met (that is, by the actual benefits in terms of actual hazard mitigation).

Geographic Information System (GIS): GIS is a computer software application that relates data regarding physical and other features on the earth to a database for mapping and analysis.

Hazard: A hazard is a source of potential danger or adverse condition that could harm people and/or cause property damage.

Hazard Mitigation Grant Program (HMGP): Authorized under Section 202 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, the HMGP is administered by FEMA and provides grants to states, tribes, and local governments to implement hazard mitigation actions after a major disaster declaration. The purpose of the program is to reduce the loss of life and property due to disasters and to enable mitigation activities to be implemented as a community recovers from a disaster

Hazards U.S. Multi-Hazard (Hazus) Loss Estimation Program: Hazus is a GIS-based program used to support the development of risk assessments as required under the DMA. The Hazus software program assesses risk in a quantitative manner to estimate damage and losses associated with natural hazards. Hazus is FEMA's nationally applicable, standardized methodology and software program and contains modules for estimating potential losses from earthquakes, floods, and wind hazards. Hazus has also been used to assess vulnerability (exposure) for other hazards.

Hydraulics: Hydraulics is the branch of science or engineering that addresses fluids (especially water) in motion in rivers or canals, works and machinery for conducting or raising water, the use of water as a prime mover, and other fluid-related areas.

Hydrology: Hydrology is the analysis of waters of the earth. For example, a flood discharge estimate is developed by conducting a hydrologic study.

Intensity: For the purposes of this plan, intensity refers to the measure of the effects of a hazard.

Inventory: The assets identified in a study region comprise an inventory. Inventories include assets that could be lost when a disaster occurs and community resources are at risk. Assets include people, buildings, transportation, and other valued community resources.

Landslide: Landslides can be described as the sliding movement of masses of loosened rock and soil down a hillside or slope. Fundamentally, slope failures occur when the strength of the soils forming the slope exceeds the pressure, such as weight or saturation, acting upon them.

Lightning: Lightning is an electrical discharge resulting from the buildup of positive and negative charges within a thunderstorm. When the buildup becomes strong enough, lightning appears as a "bolt," usually within or between clouds and the ground. A bolt of lightning instantaneously reaches temperatures approaching 50,000ºF. The rapid heating and cooling of air near lightning causes thunder. Lightning is a major threat during thunderstorms. In the United States, 75 to 100 Americans are struck and killed by lightning each year (see http://www.fema.gov/hazard/thunderstorms/thunder.shtm).

Liquefaction: Liquefaction is the complete failure of soils, occurring when soils lose shear strength and flow horizontally. It is most likely to occur in fine grain sands and silts, which behave like viscous fluids when liquefaction occurs. This situation is extremely hazardous to development on the soils that liquefy, and generally results in extreme property damage and threats to life and safety.

Local Government: Any county, municipality, city, town, township, public authority, school district, special district, intrastate district, council of governments (regardless of whether the council of governments is incorporated as a nonprofit corporation under State law), regional or interstate government entity, or agency or instrumentality of a local government; any Indian tribe or authorized tribal organization, or Alaska Native village or organization; and any rural community, unincorporated town or village, or other public entity.

Magnitude: Magnitude is the measure of the strength of an earthquake, and is typically measured by the Richter scale. As an estimate of energy, each whole number step in the magnitude scale corresponds to the release of about 31 times more energy than the amount associated with the preceding whole number value.

Mass movement: A collective term for landslides, debris flows, and lahars.

Mitigation: A preventive action that can be taken in advance of an event that will reduce or eliminate the risk to life or property.

Mitigation Actions: Mitigation actions are specific actions to achieve goals and objectives that minimize the effects from a disaster and reduce the loss of life and property.

Objective: For the purposes of this plan, an objective is defined as a short-term aim that, when combined with other objectives, forms a strategy or course of action to meet a goal. Unlike goals, objectives are specific and measurable.

Peak Ground Acceleration: Peak Ground Acceleration (PGA) is a measure of the highest amplitude of ground shaking that accompanies an earthquake, based on a percentage of the force of gravity.

Preparedness: Preparedness refers to actions that strengthen the capability of government, citizens, and communities to respond to disasters.

Presidential Disaster Declaration: These declarations are typically made for events that cause more damage than state and local governments and resources can handle without federal government assistance. Generally, no specific dollar loss threshold has been established for such declarations. A Presidential Disaster Declaration puts into motion long-term federal recovery programs, some of which are matched by state programs, designed to help disaster victims, businesses, and public entities.

Probability of Occurrence: The probability of occurrence is a statistical measure or estimate of the likelihood that a hazard will occur. This probability is generally based on past hazard events in the area and a forecast of events that could occur in the future. A probability factor based on yearly values of occurrence is used to estimate probability of occurrence.

Repetitive Loss Property: Any NFIP-insured property that, since 1978 and regardless of any changes of ownership during that period, has experienced:

- Four or more paid flood losses in excess of $1000.00; or
- Two paid flood losses in excess of $1000.00 within any 10-year period since 1978 or
- Three or more paid losses that equal or exceed the current value of the insured property.

Return Period (or Mean Return Period): This term refers to the average period of time in years between occurrences of a particular hazard (equal to the inverse of the annual frequency of occurrence).

Riverine: Of or produced by a river. Riverine floodplains have readily identifiable channels. Floodway maps can only be prepared for riverine floodplains.

Risk: Risk is the estimated impact that a hazard would have on people, services, facilities, and structures in a community. Risk measures the likelihood of a hazard occurring and resulting in an adverse condition that causes injury or damage. Risk is often expressed in relative terms such as a high, moderate, or low likelihood of sustaining damage above a particular threshold due to occurrence of a specific type of hazard. Risk also can be expressed in terms of potential monetary losses associated with the intensity of the hazard.

Risk Assessment: Risk assessment is the process of measuring potential loss of life, personal injury, economic injury, and property damage resulting from hazards. This process assesses the vulnerability of people, buildings, and infrastructure to hazards and focuses on (1) hazard identification; (2) impacts of hazards on physical, social, and economic assets; (3) vulnerability identification; and (4) estimates of the cost of damage or costs that could be avoided through mitigation.

Risk Ranking: This ranking serves two purposes, first to describe the probability that a hazard will occur, and second to describe the impact a hazard will have on people, property, and the economy. Risk estimates are based on the methodology used to prepare the risk assessment for this plan. The following equation shows the risk ranking calculation:

Risk Ranking = Probability + Impact (people + property + economy)

Robert T. Stafford Act: The Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 100-107, was signed into law on November 23, 1988. This law amended the Disaster Relief Act of 1974, Public Law 93-288. The Stafford Act is the statutory authority for most federal disaster response activities, especially as they pertain to FEMA and its programs.

Special Flood Hazard Area: The base floodplain delineated on a Flood Insurance Rate Map. The SFHA is mapped as a Zone A in riverine situations and zone V in coastal situations. The SFHA may or may not encompass all of a community's flood problems

Stakeholder: Any person or public or private entity that owns or operates facilities that would benefit from the mitigation actions of this plan, and/or has an authority or capability to support mitigation actions identified by this plan.

Stream Bank Erosion: Stream bank erosion is common along rivers, streams and drains where banks have been eroded, sloughed or undercut. However, it is important to remember that a stream is a dynamic and constantly changing system. It is natural for a stream to want to meander, so not all eroding banks are "bad" and in need of repair. Generally, stream bank erosion becomes a problem where development has limited the meandering nature of streams, where streams have been channelized, or where stream bank structures (like bridges, culverts, etc.) are located in places where they can actually cause damage to downstream areas. Stabilizing these areas can help protect watercourses from continued sedimentation, damage to adjacent land uses, control unwanted meander, and improvement of habitat for fish and wildlife.

Steep Slope: Different communities and agencies define it differently, depending on what it is being applied to, but generally a steep slope is a slope in which the percent slope equals or exceeds 25%. For this study, steep slope is defined as slopes greater than 33%.

Thunderstorm: A thunderstorm is a storm with lightning and thunder produced by cumulonimbus clouds. Thunderstorms usually produce gusty winds, heavy rains, and sometimes hail. Thunderstorms are usually short in duration (seldom more than 2 hours). Heavy rains associated with thunderstorms can lead to flash flooding during the wet or dry seasons.

Tornado: 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 funnel clouds. On a local scale, tornadoes are the most intense of all atmospheric circulations, and winds can reach destructive speeds of more than 300 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.

Vulnerability: Vulnerability describes how exposed or susceptible an asset is to damage. Vulnerability depends on an asset's construction, contents, and the economic value of its functions. Like indirect damage, the vulnerability of one element of the community is often related to the vulnerability of another. For example, many businesses depend on uninterrupted electrical power. Flooding of an electric substation would affect not only the substation itself but businesses as well. Often, indirect effects can be much more widespread and damaging than direct effects.

Watershed: A watershed is an area that drains downgradient from areas of higher land to areas of lower land to the lowest point, a common drainage basin.

Wildfire: These terms refer to any uncontrolled fire occurring on undeveloped land that requires fire suppression. The potential for wildfire is influenced by three factors: the presence of fuel, topography, and air mass. Fuel can include living and dead vegetation on the ground, along the surface as brush and small trees, and in the air such as tree canopies. Topography includes both slope and elevation. Air mass includes temperature, relative humidity, wind speed and direction, cloud cover, precipitation amount, duration, and the stability of the atmosphere at the time of the fire. Wildfires can be ignited by lightning and, most frequently, by human activity including smoking, campfires, equipment use, and arson.

Windstorm: Windstorms are generally short-duration events involving straight-line winds or gusts exceeding 50 mph. These gusts can produce winds of sufficient strength to cause property damage. Windstorms are especially dangerous in areas with significant tree stands, exposed property, poorly constructed buildings, mobile homes (manufactured housing units), major infrastructure, and aboveground utility lines. A windstorm can topple trees and power lines; cause damage to residential, commercial, critical facilities; and leave tons of debris in its wake.

Zoning Ordinance: The zoning ordinance designates allowable land use and intensities for a local jurisdiction. Zoning ordinances consist of two components: a zoning text and a zoning map.

Santa Clara County Operational Area Hazard Mitigation Plan

Appendix A. Public Outreach Materials

A. PUBLIC OUTREACH MATERIALS

To Be Completed

Appendix B. Progress Report Template

B. PROGRESS REPORT TEMPLATE

Reporting Period: *(Insert reporting period)*

Background: __[Client Name]__ and participating local cities and districts developed a hazard mitigation plan to reduce risk from all hazards by identifying resources, information, and strategies for risk reduction. The federal Disaster Mitigation Act of 2000 requires state and local governments to develop hazard mitigation plans as a condition for federal disaster grant assistance. To prepare the plan, the participating planning partners organized resources, assessed risks from natural hazards, developed planning goals and objectives, reviewed mitigation alternatives, and developed an action plan to address probable impacts from natural hazards. By completing this process, these jurisdictions maintained compliance with the Disaster Mitigation Act, achieving eligibility for mitigation grant funding opportunities afforded under the Robert T. Stafford Act. The plan can be viewed on-line at:

INSERT LINK

Summary Overview of the Plan's Progress: The performance period for the Hazard Mitigation Plan became effective on _____, 2017, with the final approval of the plan by FEMA. The initial performance period for this plan will be 5 years, with an anticipated update to the plan to occur before _______, 2022. As of this reporting period, the performance period for this plan is considered to be __% complete. The Hazard Mitigation Plan has targeted __ hazard mitigation actions to be pursued during the 5-year performance period. As of the reporting period, the following overall progress can be reported:

- __ out of __ actions (__%) reported ongoing action toward completion.
- __ out of __ actions (__%) were reported as being complete.
- __ out of __ actions (___%) reported no action taken.

Purpose: The purpose of this report is to provide an annual update on the implementation of the action plan identified in the Hazard Mitigation Plan. The objective is to ensure that there is a continuing and responsive planning process that will keep the Hazard Mitigation Plan dynamic and responsive to the needs and capabilities of the planning partners. This report discusses the following:

- Natural hazard events that have occurred within the last year.
- Changes in risk exposure within the OA.
- Mitigation success stories.
- Review of the action plan.
- Changes in capabilities that could impact plan implementation.
- Recommendations for changes/enhancement.

The Plan Maintenance Element: The plan maintenance element, made up of planning partners and other stakeholders within the OA, reviewed and approved this progress report at its annual meeting held on ______, 201_. It was determined through the plan's development process that a plan maintenance element would remain in service to oversee maintenance of the plan. At a minimum, the plan maintenance element will provide technical review and oversight on the development of the annual progress report. It is anticipated that there will be turnover in the membership annually, which will be documented in the progress reports. For this reporting period, the Plan Maintenance element membership is as indicated in Table 1.

Table 1. Plan Maintenance Element Members

Name	Title	Jurisdiction/Agency

Natural Hazard Events within the OA: During the reporting period, there were __ natural hazard events in the OA that had a measurable impact on people or property. A summary of these events is as follows:

- ______________________________
- ______________________________

Changes in Risk Exposure in the OA: *(Insert brief overview of any natural hazard event in the OA that changed the probability of occurrence or ranking of risk for the hazards addressed in the hazard mitigation plan)*

Mitigation Success Stories: *(Insert brief overview of mitigation accomplishments during the reporting period)*

Review of the Action Plan: Table 2 reviews the action plan, reporting the status of each action. Reviewers of this report should refer to the Hazard Mitigation Plan for more detailed descriptions of each action and the prioritization process.

Address the following in the "status" column of the following table:

- Was any element of the action carried out during the reporting period?
- If no action was completed, why?
- Is the timeline for implementation for the action still appropriate?
- If the action was completed, does it need to be changed or removed from the action plan?

Table 2. Action Plan Matrix

Action Taken? (Yes or No)	Time Line	Priority	Status	Status (X, O,✓)
Action #__—____________________[description]				
Action #__—____________________[description]				
Action #__—____________________[description]				
Action #__—____________________[description]				
Action #__—____________________[description]				
Action #__—____________________[description]				
Action #__—____________________[description]				
Action #__—____________________[description]				
Action #__—____________________[description]				
Action #__—____________________[description]				
Action #__—____________________[description]				
Action #__—____________________[description]				
Action #__—____________________[description]				
Action #__—____________________[description]				
Action #__—____________________[description]				
Action #__—____________________[description]				
Action #__—____________________[description]				
Action #__—____________________[description]				
Action #__—____________________[description]				

Completion status legend:
✓= Project Completed
O = Action ongoing toward completion
X = No progress at this time

Changes That May Impact Implementation of the Plan: *(Insert brief overview of any significant changes in the OA that would have a profound impact on the implementation of the plan. Specify any changes in technical, regulatory and financial capabilities identified during the plan's development)*

Recommendations for Changes or Enhancements: Based on the review of this report by the Plan Maintenance element, the following recommendations will be noted for future updates or revisions to the plan:

- ______________________________
- ______________________________
- ______________________________
- ______________________________
- ______________________________
- ______________________________

Public review notice: *The contents of this report are considered to be public knowledge and have been prepared for total public disclosure. Copies of the report have been provided to the governing boards of all planning partners and to local media outlets. The report is posted on the Santa Clara County Hazard Mitigation Plan website. Any questions or comments regarding the contents of this report should be directed to:*

Insert Contact Info Here

Appendix C. Plan Adoption Resolutions from Planning Partners

C. PLAN ADOPTION RESOLUTIONS FROM PLANNING PARTNERS

To Be Provided When Available