Cal OES

GOVERNOR’S OFFICE
OF EMERGENCY SERVICES

CALIFORNIA STATE HAZARD MITIGATION PLAN

Volume 1

Gavin Newsom

Governor

Nancy Ward

Director
California Governor’s
Office of Emergency Services

2023

August 23, 2023

STATEMENT OF PLAN ADOPTION

As Director of the California Governor's Office of Emergency Services (Cal OES) and the Governor's Authorized Representative, I am pleased to formally adopt the 2023 California State Hazard Mitigation Plan (SHMP) for the State of California.

In the five years since the 2018 SHMP was approved and adopted, California has experienced some of the largest and most destructive disasters in the State's recorded history. Disasters are becoming more frequent and resulting in greater impacts, and this trend is expected to increase even further than it has in recent years. With the State's continued population growth combined with prevailing climate projections, California must continue to enhance and invest in mitigation activities and take actions to reduce risks and support resilient communities.

The 2023 SHMP update continues California's commitment to reduce or eliminate the impacts of disasters caused by natural and human-caused hazards. This update also reflects the most comprehensive inclusion to date of the State's climate mitigation and adaptation strategies, and reflects the State of California's equity priorities.

The State is required to review and revise its SHMP for Federal Emergency Management Agency (FEMA) approval to ensure the award eligibility associated with the following funding opportunities:

- Building Resilient Infrastructure and Communities (BRIC) Grants
- Fire Management Assistance Grants (FMAG)
- Flood Mitigation Assistance (FMA) Program
- Hazard Mitigation Grant Program (HMGP)
- HMGP Post Fire
- Pre-Disaster Mitigation Congressionally Directed Spending (LPDM)
- Public Assistance (PA) Permanent Work Categories (Categories C-G)
- Rehabilitation of High Hazard Potential Dam (HHPD) Grant Program
- Safeguarding Tomorrow Revolving Loan Fund Program

Additionally, the State remains eligible for the increased federal cost share for grants awarded under the FMA program.

FEMA has once again designated California as an Enhanced State in recognition of the State's efforts surpassing the Standard requirements. California continues to demonstrate an unwavering commitment to long-term risk reduction and remains a proactive leader in implementing comprehensive, multi-disciplinary statewide mitigation. As an Enhanced State, California receives an additional five percent in HMGP funds after a disaster.

In adopting the 2023 SHMP, the State agrees to comply with all applicable state and federal statutes and regulations as stipulated in the assurances enclosed in the 2023 SHMP and will update the SHMP at least once every five years. Through implementation, monitoring, and meaningful integration across government and private sectors, the SHMP continues to ensure a safer and more resilient California.

Sincerely,

Nancy Ward

NANCY WARD
Director

SPECIAL THANKS

At the heart of the State Hazard Mitigation Plan lies an unwavering commitment to safeguarding the well-being and resilience of California's communities. The strength of this Plan is a testament to the collective efforts of our stakeholders and partners, who have contributed their expertise, time, and steadfast devotion to mitigating the risks our State faces. The list below reflects a small portion of the most active contributors to our efforts. We extend our sincere thanks to all Plan contributors, as their dedication has been instrumental in shaping a safer and more resilient future for California.

California Governor's Office of Emergency Services, Executive Leadership

Christina Curry	Chief Deputy Director
Lisa Mangat	Chief Deputy Director
Ryan Buras	Deputy Director of Recovery

California Governor's Office of Emergency Services, Hazard Mitigation Section

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Scott Gowin	Quality Assurance Administrative Unit Manager
Anna Foley	Hazard Mitigation Analyst
Lisa Rice	Hazard Mitigation Analyst
Ron Miller	Hazard Mitigation Assistance Branch Chief
Robyn Fennig	Hazard Mitigation Planning Division Chief

Hazard and Working Group Champions

Seismic Hazard Group	
Cindy Pridmore	CGS
Flood Hazard Group	
Mike Mierzwa	DWR
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Goals and Objectives Working Group	
Victoria LaMar-Haas	Cal OES
GIS Technical Assistance Working Committee	
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David Harris	CNRA
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Fire Hazard Group	
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Climate Impacts Working Group	
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Abby Browning	Cal OES
Monisha Avery	Cal OES
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EXECUTIVE SUMMARY

The State of California is committed to building resilience for future hazard events in all communities through ongoing risk reduction efforts. Home to almost 12 percent of the U.S. population, California is culturally, ethnically, economically, ecologically, and politically diverse. The State is vulnerable to a wide range of natural and non-natural hazards that have impacted and will continue to impact its people, property, environment, infrastructure, and economy. California has experienced 72 federal disaster declarations since 2018 (as of June 1, 2023) across three types of declarations (major disaster (5), emergency (13), and fire management assistance (54)). The number of declarations includes some duplication due to fire management assistance and Emergency Declarations escalating to Major Disaster Declaration status. Many State and local disasters have also occurred within this time frame. The pace and scale of disasters will continue to increase due to the effects of climate change. The State continues to actively work to address the potential impacts from a wide range of natural and non-natural hazards and to build community resilience.

The Disaster Mitigation Act of 2000 (DMA) amended the Robert T. Stafford Disaster Relief and Emergency Assistance Act to include Section 322, which requires states to have a hazard mitigation plan approved by the Federal Emergency Management Agency (FEMA) to be eligible for federal disaster assistance and hazard mitigation funding. A hazard mitigation plan is a state's plan to reduce damage to life, property, and the environment from future disasters. California maintains an Enhanced Plan, demonstrating the State's commitment to long-term risk reduction and confers additional mitigation funding from FEMA after Presidential Major Disaster Declarations. California's Enhanced Plan illustrates the State's approach to holistic and integrated mitigation efforts and the State's capacity, resources, and capabilities to manage effective mitigation grant programs.

As communities and populations continue to grow and develop amid the ongoing effects of climate change, risks from all the hazards that California faces will increase in the coming decades. This has already been seen with more severe and expansive wildfires and frequent days of extreme heat. To mitigate these risks and inform future decision-making, California is updating its State Hazard Mitigation Plan (SHMP or Plan) to reflect an integrated, multi-level, multi-sector, collaborative approach to risk reduction that builds community resilience and promotes equitable outcomes. The 2023 SHMP identifies hazards informed by science-based projections and the history of disasters in California and lists the State's goals, objectives, strategies, and actions for reducing future risk. Implementing planned, feasible, and cost-effective mitigation measures reduces loss of lives, property, and the environment and streamlines the disaster recovery process.

The FEMA Hazard Mitigation Assistance Guidance defines hazard mitigation as the sustained effort to reduce loss of life and property by lessening or eliminating the impacts of natural disasters, climate hazards, and human-caused threats. It creates safer communities and helps maintain quality of life. Effective hazard mitigation requires an understanding of all risks and a sustained investment in long-term community well-being through the implementation of short- and long-term strategies before the next disaster (FEMA 2023j).

The SHMP provides an overview of California's disaster history and landscape, outlines the efforts of the California Governor's Office of Emergency Services (Cal OES) Hazard Mitigation Section to reduce disaster losses, and describes the strategies used to administer an effective and comprehensive statewide hazard mitigation program. The Plan was developed in conjunction with multi-disciplinary groups of federal, State, Tribal Nation, local, and non-governmental stakeholders, as well as with input from the public. The Plan articulates a science-based risk reduction strategy to support decision-making across State and local government to equitably promote community resiliency. An additional benefit of the SHMP is continued eligibility for federal assistance and enhanced funding to support mitigation activities and repairing or replacing public infrastructure damaged during federally declared disasters.

The updated SHMP demonstrates the State's commitment to reduce or eliminate risk and the impact of disasters to build a more resilient State, reduce losses during future hazard events, and promote faster recovery after disasters. To enhance its content and keep the public engaged in ongoing mitigation measures, the Plan is a living document that will continue to be updated in accordance with the plan maintenance process outlined in Chapter 48.

The 2023 Plan is the fifth update to California's SHMP. The Plan has been streamlined to enhance readability for the public while maintaining appropriate detailed analysis and implementable strategies to support future State risk reduction activities. The SHMP is a technical reference for California's counties, cities, special districts, Tribal Nations, and other local governments as they update their local hazard mitigation plans (LHMPs). The SHMP presents a robust, updated risk assessment correlating California's existing resources with the best available data and climate science. The SHMP will be implemented by the State from the Plan's adoption in 2023 to its next update in 2028.

The 2023 SHMP demonstrates:

- California's commitment to a comprehensive and integrated mitigation program
- Integration with federal, State, Tribal Nation, and local agencies with mitigation capabilities and shared objectives to reduce risks from natural hazards
- Successful implementation of mitigation programs to achieve mitigation goals
- The State's ability to meet FEMA's required grant management performance metrics to maintain an Enhanced State plan

The 2023 Plan is organized to align with FEMA's State Mitigation Planning Policy Guide. The SHMP consists of the following parts:

- Background Information
- Profiles and Risk Assessment for Natural Hazards of Interest
- Profiles for Other Hazards of Interest
- Hazard Mitigation for Local Jurisdictions
- Mitigation Strategy
- Enhanced State Plan Requirements
- Appendices that support Volume 1

CALIFORNIA'S HAZARD HISTORY

The impact of natural disasters on California since 1950 has been significant:

- 365 State Emergency Declarations
- 337 federal disaster declarations (this includes some duplication due to fire management assistance and Emergency Declarations escalating to Major Disaster Declaration status.)
- Over 900 deaths
- $20.7 billion in State-administered costs

Since the 2018 update to the SHMP, the State has experienced 37 State Emergency Declarations and 72 federally declared disasters, resulting in at least 185 deaths and $22.8 billion in State-administered costs. As the climate continues to change, science indicates that the scale, pace, and intensity of disasters will continue to increase, resulting in increased human suffering, loss of infrastructure, damage to the environment, longer disaster recoveries, and escalating disaster costs. Disaster escalation is especially apparent in the State's wildfire activity. The seven largest wildfires in California history have occurred since the 2018 SHMP update. Half of the most destructive wildfires, by number of structures destroyed, have also occurred since the 2018 update. To address these risks, implementing hazard mitigation actions is critical to building community resiliency and protecting California's communities in the coming decades.

HAZARDS INCLUDED IN THE SHMP

The 2023 SHMP includes 34 hazards. Of this total number, 15 natural hazards are fully assessed by describing hazard location, previous occurrences, impact analysis, probability of future events, vulnerability of State assets, how the State is currently mitigating the hazard, and new mitigation opportunities. Historically, California has been most impacted by floods, wildfires, and earthquakes. Due to the impacts of climate change, drought and extreme heat have become significant hazards in the 2023 SHMP update. There are 19 other hazards of interest, including non-natural hazards, which are also profiled.

Natural and other hazards are organized according to the impact rating of each hazard. The impact rating performed for the SHMP is based on the fundamental definition of risk: Probability x Impact = Risk.

Many of the hazards are amplified or accelerated by climate change impacts. Climate change will continue exacerbating the frequency, scale, and intensity of hazards across the State. Each natural hazard assessment describes the changing climate of California, how climate change will impact natural hazards, and how the State is acting to address the challenges. Hazard impacts on equity priority communities are also discussed in all hazard chapters.

Natural Hazards of Concern	Other Hazards of Interest
▪ Earthquake ▪ Riverine, Stream, and Alluvial Flood ▪ Extreme Heat ▪ Extreme Cold or Freeze ▪ Wildfire ▪ Severe Wind, Weather, and Storms ▪ Sea-Level Rise, Coastal Flooding, and Erosion ▪ Landslide, Debris Flow, and Other Mass Movements ▪ Drought ▪ Tsunami ▪ Dam Failure ▪ Levee Failure ▪ Snow Avalanche ▪ Subsidence ▪ Volcano	▪ Urban Structural Fire ▪ Other Potential Causes of Long-term Electrical Outages ▪ Public Safety Power Shutoff (PSPS) ▪ Terrorism ▪ Air Pollution ▪ Energy Shortage ▪ Cyber Threats ▪ Tree Mortality ▪ Invasive and Nuisance Species ▪ Epidemic, Pandemic, Vector-Borne Disease ▪ Civil Disorder ▪ Natural Gas Pipeline Hazards ▪ Hazardous Materials Release ▪ Transportation Accidents Resulting in Explosion ▪ Well Stimulation and Hydraulic Fracturing ▪ Oil Spills ▪ Electromagnetic Pulse (EMP) Attack ▪ Radiological Accidents ▪ Geomagnetic Storm (Space Weather)

HAZARD ASSESSMENT BY COUNTY

California has 58 counties, 482 cities, and over 1,500 special districts that are eligible to develop LHMPs. Numerous multi-jurisdictional LHMPs have been developed, led by counties or groups of cities. Many single-jurisdiction plans have also been prepared by cities and special districts. The following hazards are most commonly ranked as high concern in the county LHMPs:

- Wildfire was identified as a hazard by 57 counties; of those, 45 counties identified it as a hazard of high concern
- Earthquake was identified as a hazard by 57 counties; of those, 46 counties identified it as a hazard of high concern
- Flood was identified as a hazard by 57 counties; of those, 38 counties identified it as a hazard of high concern

MITIGATION ACTIONS AND GOALS

The State has identified a mitigation strategy to reduce or eliminate long-term vulnerabilities from hazards of concern. The strategy, developed through a multi-stakeholder process, sets the State's mitigation priorities and assists local governments in updating LHMPs. The mitigation strategy, which includes 92 mitigation actions, is based on the following goals that reflect State's current priorities:

- **Goal 1**—Significantly reduce risk to life, community lifelines, the environment, property, and infrastructure by planning and implementing whole-community risk reduction and resilience strategies.
- **Goal 2**—Build capacity and capabilities to increase disaster resilience among historically underserved populations, individuals with access and functional needs, and communities disproportionately impacted by disasters and climate change.
- **Goal 3**—Incorporate equity metrics, tools, and strategies into all mitigation planning, policy, funding, outreach, and implementation efforts.
- **Goal 4**—Apply the best available science and authoritative data to design, implement, and prioritize projects that enhance resilience to natural hazards and climate change impacts.
- **Goal 5**—Integrate mitigation principles into laws, regulations, policies, and guidance to support equitable outcomes to benefit the whole community.
- **Goal 6**—Significantly reduce barriers to timely, efficient, and effective hazard mitigation planning and action.

ENHANCED PLAN

California is committed to ongoing and coordinated efforts to reduce risk from all hazards, protect life and property, and create more resilient communities. The 2023 SHMP was prepared as an Enhanced SHMP, demonstrating the highest commitment to risk reduction. Under this designation, the State is a proactive leader in implementing comprehensive, multi-disciplinary statewide mitigation. With this Enhanced SHMP, California leverages partnerships and resources across the whole community to the maximum extent to increase resilience and reduce the risk from future disaster losses. Through robust planning and coordinated mitigation action and investment, the State of California is dedicated to building resilient communities for all.

ADOPTING AND IMPLEMENTING THE PLAN

Upon conditional approval of the finalized 2023 SHMP by FEMA, the Cal OES Director, acting as the Governor's designated official, formally adopts the SHMP. The Director's letter of adoption is forwarded to FEMA to finalize the approval process. The adoption letter and final approval letter are included following this Executive Summary.

Gavin Newsom
Governor

Nancy Ward
Director

August 23, 2023

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The State is required to review and revise its SHMP for Federal Emergency Management Agency (FEMA) approval to ensure the award eligibility associated with the following funding opportunities:

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Additionally, the State remains eligible for the increased federal cost share for grants awarded under the FMA program.

FEMA has once again designated California as an Enhanced State in recognition of the State's efforts surpassing the Standard requirements. California continues to demonstrate an unwavering commitment to long-term risk reduction and remains a proactive leader in implementing comprehensive, multi-disciplinary statewide mitigation. As an Enhanced State, California receives an additional five percent in HMGP funds after a disaster.

In adopting the 2023 SHMP, the State agrees to comply with all applicable state and federal statutes and regulations as stipulated in the assurances enclosed in the 2023 SHMP and will update the SHMP at least once every five years. Through implementation, monitoring, and meaningful integration across government and private sectors, the SHMP continues to ensure a safer and more resilient California.

Sincerely,

Nancy Ward
NANCY WARD
Director

U.S. Department of Homeland Security
FEMA Region 9
1111 Broadway, Suite 1200
Oakland, CA 94607

FEMA

August 30, 2023

Ms. Nancy Ward
Director
California Governor's Office of Emergency Services
3650 Schriever Avenue
Mather, CA 95655

Reference: Approval of the California Hazard Mitigation Plan

Dear Ms. Ward:

The Federal Emergency Management Agency (FEMA) Region 9 approves the updated California State Hazard Mitigation Plan effective August 30, 2023, through August 29, 2028. This plan is approved in accordance with applicable mitigation planning regulations and policy requirements.[1]

In addition, this plan meets the requirements to address wildfire risks and mitigation measures and the requirements to address all dam risks.

An approved state hazard mitigation plan is a condition of receiving certain FEMA non-emergency assistance and mitigation grants from the following programs:

- Public Assistance Categories C-G (PA C-G)
- Fire Management Assistance Grants (FMAG)
- Hazard Mitigation Grant Program (HMGP)
- Hazard Mitigation Grant Program Post-Fire (HMGP-PF)
- Building Resilient Infrastructure and Communities (BRIC)
- Flood Mitigation Assistance (FMA)
- Rehabilitation of High Hazard Potential Dams Program (HHPD)
- Safeguarding Tomorrow Revolving Loan Fund (STORM RLF)
- Pre-Disaster Mitigation (PDM)

Approval of a state hazard mitigation plan does not guarantee funding under any FEMA program. Please refer to the individual FEMA non-emergency assistance and mitigation grant program policy and/or annual Notice of Funding Opportunities for specific application and eligibility requirements for the FEMA programs listed above.

[1] Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act), as amended; the National Flood Insurance Act of 1968, as amended; Title 44 Code of Federal Regulations (CFR) Part 201; and the "Water Infrastructure Improvements for the Nation Act," or the "WIIN Act," on December 16, 2016, which amends the National Dam Safety Program Act (Pub. L. 92-367).

State hazard mitigation plans must be updated and resubmitted to FEMA Region 9 for approval every five years. If the plan is not updated and approved by August 29, 2028, the plan is considered lapsed, and FEMA will not obligate funds until the mitigation plan is approved.

If at any time over the plan approval period FEMA determines that the state is not complying with all applicable federal statutes and regulations in effect during the periods for which it receives funding or is unable to fulfill mitigation commitments, FEMA may take action to correct the noncompliance (44 CFR §201.3[b][5] and §201.4[c][7]).

FEMA recognizes the State of California for the additional effort and commitment to mitigation. Under Section 322 (42 U.S.C. 5165(e)), additional HMGP funds of up to 20% of the total estimated eligible disaster assistance may be provided to states with enhanced hazard mitigation plans. The "enhanced" designation is recognition for states that are leaders in implementing a comprehensive statewide hazard mitigation program that results in safer, more sustainable communities.

FEMA will provide a reminder at least 12 months before the plan expiration date of the consequences of not having an approved state hazard mitigation plan, which is required to apply for and receive funding for FEMA non-emergency assistance and mitigation grant programs. To continue to apply for and receive funding from the programs listed on page 1, the state must submit a draft of the next plan update before the end of the approval period and allow sufficient time for the review and approval process. This includes any revisions, if needed, and formal adoption by the state following the determination by FEMA that the plan has achieved a status of "approvable pending adoption."

We look forward to working with you to discuss the status of the state hazard mitigation program each year over the approval period of this plan. If you have any questions please contact Kathryn Lipiecki, Mitigation Division Director, by phone at (510) 627-7100, or by email at kathryn.lipiecki@fema.dhs.gov.

Sincerely,

ROBERT J FENTON JR Digitally signed by ROBERT J FENTON JR
Date: 2023.09.05 20:06:45 -10'00'

Robert Fenton
Regional Administrator
FEMA Region 9

Enclosure (1)
State of California Plan Review Tool, dated August 30, 2023

cc: Christina Curry, Chief Deputy Director, CalOES
Ryan Buras, Deputy Director, CalOES
Ron Miller, Mitigation Quality Assurance Division Chief, CalOES
Robyn Fennig, Planning Division Chief, CalOES
Kathryn Lipiecki, Mitigation Division Director, FEMA Region 9
Alison Kearns, Planning and Implementation Branch Chief, FEMA Region 9

Part 1—Background Information

Cal OES
GOVERNOR'S OFFICE
OF EMERGENCY SERVICES

1. Introduction

The State of California is committed to protecting its communities through ongoing efforts to reduce risk from future hazard events. California is culturally, ethnically, economically, ecologically, and politically diverse, with almost 12 percent of the U.S. population. If it were a separate nation, California would have the fifth-largest economy in the world as of November 2022. A catastrophic disaster in the State could adversely affect the national and world economies.

The State of California actively works to reduce risks from the many types of hazards that the State experiences. Past hazard events—from floods, fires, and earthquakes to atmospheric, biological, geologic, human-caused, climate-related, and other hazards—have resulted in significant costs to the State's people, property, environment, infrastructure, and economy. As the climate continues to change, the pace and scale of hazard events will increase, resulting in more losses to California communities. Reducing these hazard risks requires integrated, collaborative, and equitable strategies to build statewide community resilience.

Hazard mitigation is the sustained effort to reduce loss of life and property by lessening or eliminating the impacts of natural disasters, climate hazards, and human-caused threats. It creates safer communities and helps maintain quality of life. It differs from climate mitigation, which strives to reduce greenhouse gases (GHGs). Still, it is essential to consider climate mitigation in hazard mitigation efforts to ensure that mitigation actions do not unintentionally worsen the effects of climate change.

Effective hazard mitigation requires an understanding of all risks and a sustained investment in long-term community well-being through the implementation of short- and long-term strategies before the next disaster (FEMA 2015). The 2023 State Hazard Mitigation Plan (SHMP or Plan) presents a robust risk assessment of the hazards that present the greatest threat to California's communities and outlines a collaboratively developed, science-based strategy to reduce these risks. California's mitigation strategy emphasizes equitable, whole community risk reduction that protects natural and cultural resources and promotes resilient social and economic systems.

1.1. STATE HAZARD MITIGATION PLAN OVERVIEW

1.1.1. History of the California SHMP

On September 28, 2004, the State of California's first approved SHMP went into effect. As required by Section 322 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988 (the Stafford Act; 44 Code of Federal Regulations 201.3(c), 201.4(d), and 201.5(c)), California reviews and updates this Plan on a five-year cycle. The Federal Emergency Management Agency (FEMA) approved, and California adopted the most recent SHMP in 2018 (Cal OES 2018a). The 2023 Plan is the fifth update to the SHMP.

1.1.2. Purpose of the 2023 SHMP

The State of California is required to have a FEMA-approved hazard mitigation plan to be eligible for certain types of federal assistance under the Stafford Act. The SHMP provides a road map to reduce death, injury, environmental damage, and property losses caused by natural hazards. It identifies hazards based on the history of disasters within California and lists goals, objectives, strategies, and actions for reducing future losses. Implementing planned, technically feasible, and cost-effective mitigation measures helps reduce damage to life, property, and the environment and streamlines the disaster recovery process. Hazard mitigation is most effective when based on an inclusive, comprehensive, long-term plan that is developed before a disaster strikes.

States with Enhanced Plans must demonstrate commitment to a comprehensive statewide mitigation program and capabilities to administer FEMA grant programs. A state that meets the Enhanced Plan requirements will receive additional post-disaster mitigation funds compared to states with Standard Plans. The 2023 SHMP satisfies all requirements of an Enhanced Plan.

The 2023 SHMP was developed to prioritize actionability and usability and to highlight emerging and critical issues, such as climate impacts and equity.

It is a comprehensive update of the 2018 SHMP and performs the following functions:

- Presents a robust risk assessment for California's most prominent hazards
- Describes goals, objectives, and actions for future mitigation efforts
- Documents statewide hazard mitigation systems implemented to reduce risk
- Highlights new hazard mitigation initiatives since the 2018 SHMP
- Describes mitigation processes and success stories
- Facilitates integration of local, State, Tribal Nation, and non-governmental hazard mitigation activities into a comprehensive statewide effort
- Complies with applicable federal statutes and regulations authorizing federal grant funding
- Maintains State eligibility to participate in all FEMA funding programs
- Maintains California's Enhanced status by demonstrating California's commitment to a comprehensive mitigation program and capabilities to administer the additional funding conferred by this status
- Outlines a process to amend the SHMP whenever necessary to reflect changes in State or federal laws and statutes as required in Title 44 of the Code of Federal Regulations (CFR) (44 CFR 201.4(c)(7) and (d), and 201.5(c))

Guiding Risk-Informed Decision-Making

As the State's primary hazard mitigation guidance document, the SHMP provides an updated and comprehensive description of California's historical and current hazards, a robust risk analysis for current hazards, and mitigation strategies, goals, and objectives to guide risk-informed decision-making. A statewide, collaborative planning process provided the opportunity to identify, select, and prioritize mitigation strategies that address vulnerabilities identified in the Plan's comprehensive Risk Assessment.

The SHMP provides critical information and guidance to local governments about risks from natural hazards and State capabilities, priorities, and action plans. It addresses risks to the built and natural environment and to community lifelines and considers future conditions, demographics, land use, and disparities in underserved communities to inform equity priority actions. The SHMP also considers the effects of climate change on hazards, hazard impacts, and long-term mitigation strategies.

Community Lifelines

Community lifelines are the most fundamental services available to a community. When stabilized, they enable all other aspects of society to function. They include the following (FEMA 2021e):

- Safety and Security
- Food, Water, and Shelter
- Health and Medical
- Energy
- Communications
- Transportation
- Hazardous Materials

Establishing Eligibility for FEMA Assistance

States must have an approved Standard state mitigation plan meeting the requirements in 44 CFR 201.4 as a condition of receiving the Stafford Act assistance and FEMA mitigation grants listed in Table 1-1. FEMA requires that states update their mitigation plans every five years and submit them for review and approval. States must ensure that each update reflects changes in development, progress in statewide mitigation efforts, and modifications to priorities.

Table 1-1. Non-Emergency Stafford Act Assistance Programs

Program	Description
Public Assistance (PA) Categories C-G	Post-disaster reimbursement of response and recovery costs
Fire Management Assistance Grants (FMAG)	Mitigation, management, and control of fires on publicly or privately owned forests or grasslands that threaten destruction that would constitute a major disaster
Building Resilient Infrastructure and Communities (BRIC)	Pre-disaster funding for proactive mitigation and community resilience projects and plans
Hazard Mitigation Grant Program (HMGP)	Post-disaster funding for mitigation and community resilience projects and plans
HMGP-Post Fire	Assistance to help communities implement hazard mitigation measures after wildfire disasters
Flood Mitigation Assistance (FMA)	Pre-disaster funding for flood hazard mitigation and community resilience activities that benefit properties insured under the National Flood Insurance Program (NFIP)
Rehabilitation of High Hazard Potential Dams (HHPDs)	Technical, planning, design, and construction assistance in the form of grants for the rehabilitation of eligible dams

Source: (FEMA 2023f)

Assisting Local Governments

Local jurisdictions can use the SHMP as a reference and guidance document when developing their own hazard mitigation plans to satisfy FEMA requirements. The SHMP provides critical guidance to local jurisdictions about California's risks from natural hazards and the State's capabilities, priorities, and mitigation actions. Local jurisdictions can also use this SHMP to guide their risk assessment and mitigation strategies, as the hazards and risks assessed in this SHMP also affect local jurisdictions. This SHMP discusses risk impacts on the built environment, community lifelines, future conditions, demographics, population, land use, and existing disparities in underserved communities. The SHMP also discusses the effects of climate change on hazards and strategies to address potential impacts.

1.1.3. State Authorities and Responsibilities for Hazard Mitigation Planning

California's statewide hazard mitigation effort is led by the California Governor's Office of Emergency Services (Cal OES), whose charge is protecting lives and property, building capabilities, and supporting local communities for a more resilient California. California's State Emergency Plan (SEP) assigns mitigation duties to Cal OES and other State agencies under various emergency support functions. The Emergency Management Activities section of the 2017 SEP requires the following of the lead agency for each emergency support function:

- Identify stakeholders and engage them in the development and maintenance of the emergency support function
- Complete a vulnerability assessment and prioritize actions to reduce vulnerabilities within the scope of the emergency support function
- Collaborate to pool emergency support function resources to prevent hazards and reduce vulnerability (leveraging funding, resources, and people)
- Develop strategies and processes to prevent or reduce the impact of emergency events and reduce the need for response activities
- Support the SHMP

In 1991, Governor's Executive Order W-9-91 authorized the Cal OES Director to assign emergency support functions to State agencies through standing administrative orders (Executive Department, State of California 1991). The current administrative order includes the following requirements related to hazard mitigation for agencies across State government:

- Identify, document, and, when practical, implement activities that could reduce or lessen the impact of an emergency or hazard
- In alignment with the SHMP, establish hazard mitigation as an integral element in operations and program delivery as appropriate
- Participate in the development, annual maintenance, and implementation of the SHMP
- During a federal declaration of a major disaster, participate in the hazard mitigation planning process and in project identification and prioritization
- Provide subject matter expertise and technical assistance to Cal OES in support of developing complex mitigation actions, including technical feasibility and cost/benefit, and in support of post-wildfire watershed and debris flow mitigation
- Track and report to Cal OES on changes to natural hazard risk exposure, emerging vulnerabilities, and newly available mapping and data sources

The Governor first included hazard mitigation in emergency management standing orders in an update letter sent to agency secretaries on September 12, 2000.

The Cal OES Hazard Mitigation Section is responsible for supporting State and local mitigation planning, grant administration, and technical assistance. The Hazard Mitigation Planning Division, housed within the Hazard Mitigation Section, develops and maintains the SHMP and supports the development and review of local hazard mitigation plans (LHMPs). This division consists of the State Mitigation Planning Unit (SMP Unit) and Local Mitigation Planning Unit (LMP Unit).

Cal OES responsibilities in preparing and implementing the SHMP include the following:

- Ensuring that the SHMP meets FEMA Standard and Enhanced Hazard Mitigation Plan Requirements, is approved by FEMA, and is adopted by the State of California
- Coordinating the continued development, implementation, and maintenance of the SHMP with stakeholders, strategic working groups, and federal, State, Tribal Nation, local, and non-governmental agencies
- Providing ample opportunities for stakeholder involvement in the SHMP update

- Administering FEMA Hazard Mitigation Assistance (HMA) programs, including the Hazard Mitigation Grant Program (HMGP), Building Resilient Infrastructure and Communities (BRIC) grants, and Flood Mitigation Assistance (FMA) grants
- Supporting integration of local, regional, and Tribal Nation hazard mitigation efforts with the SHMP

1.1.4. Federal Guidance for State Hazard Mitigation Planning

In 2000, the Disaster Mitigation Act of 2000 (DMA) was enacted to amend the Stafford Act to provide a framework for hazard mitigation planning. The requirements for meeting federal standards for hazard mitigation planning are established in 44 CFR Part 201. FEMA publishes further guidance to assist state, local, Tribal Nation, and territorial governments in preparing a hazard mitigation plan. In 2022, FEMA updated its *State Mitigation Planning Policy Guide*, effective April 2023 (FEMA 2022r).

The updated guidance serves as the official interpretation of 44 CFR Part 201 and provides additional clarity and guidance on hazard mitigation planning requirements. Notable updates to the guidance include spotlighting the importance of integrating considerations for climate change impacts and equity. California began integrating climate change into the SHMP in 2007 and equity beginning in 2018. The updated guidance calls for assessing climate change impacts in terms of hazard impacts, vulnerability, extent, and location. Impacts on equity priority communities are assessed for each hazard.

Hazard mitigation plans developed to meet federal standards must document the planning process, identify hazards, assess risk, assess state capabilities, document local planning coordination and capability building, develop a mitigation strategy, and establish an approach for plan maintenance and updates.

The planning process must include stakeholders from emergency management, economic development, land use and development, housing, health and social services, infrastructure, and natural and cultural resources. Additional stakeholders providing services associated with FEMA's community lifelines should also be engaged. The hazard identification and risk assessment provide the basis for plan development; the risk assessment establishes hazards impacting the planning area and associated vulnerabilities. Identifying state capabilities aids in determining what existing resources there are to address and mitigate vulnerabilities. This is further accomplished by documenting the resources available to local communities to ensure the state has a comprehensive, statewide approach to mitigation in terms of overarching goals, utilization of data, and ensuring technical assistance is available to develop local plans. The mitigation strategy is the long-term roadmap for implementing activities to reduce risk. It establishes the goals of the plan and prioritizes actions for risk reduction.

The 2023 SHMP complies with FEMA's updated guidance and exemplifies climate change and equity integration. Central elements are described below.

Planning for Equitable Outcomes

California's disasters have significantly impacted the health and economic security of its diverse communities across the State. Cal OES recognizes that long-standing institutional and systemic barriers continue to deliver disparate outcomes by which systems of inequity based on race, ethnicity, gender, sexuality, disability, socio-economic status, and other forms of discrimination intersect to create and maintain disadvantages for some and privileges for others. Californians who live in historically underserved and under-invested communities are more likely to be hit harder by and bear a disproportionate burden of the impact of disasters than other communities.

Equity is essential to reducing risk to the whole community, including those who face barriers to accessing information, assistance, and resources to recover from disasters. Cal OES defines equity to mean that all people are justly and fairly included in society and that everyone is able to participate, prosper, and achieve their full potential. Whereas equality means providing the same to all, equity means recognizing that not all people start from the same place and acknowledging and adjusting for imbalances. The ongoing process requires identifying and overcoming intentional and unintentional barriers arising from bias or systemic structures.

The concept of equity recognizes that everyone enjoys different advantages and faces different challenges and that everyone should be treated justly and fairly, according to their circumstances, socio-historical experiences, and structurally imposed barriers. This builds upon FEMA's definition of equity as "the consistent and systematic fair, just, and impartial treatment of all individuals, including individuals who belong to underserved communities of color, persons who belong to communities that may face discrimination based on sex, sexual orientation, and gender identity (including members of the LGBTQ+ community); persons with disabilities, persons who may face discrimination based on their religion, national origin and persons with Limited English Proficiency, and persons who live in rural areas that have been systematically denied a full opportunity to participate in aspects of economic, social, and civic life" (FEMA 2022r).

Critical Cal OES Equity Partners

Office of Access and Functional Needs— Recognizing the disproportionate impact disasters have on individuals with access and functional needs (AFN) (e.g., people with disabilities, older adults, children, limited English proficiency, and transportation disadvantaged), California's Governor established the Office of Access and Functional Needs (OAFN) within Cal OES in 2008. OAFN is tasked with a two-fold mission: Identifying the needs of all Californians before, during, and after disasters and working with emergency managers and whole community stakeholders to integrate those needs throughout every facet of the State's emergency management system. To meet its mission, OAFN adopts a multi-pronged approach to inclusion and integration, which includes providing technical assistance, guidance, facilitation, partnership outreach, training, and other support services to emergency managers, disability stakeholders, and service providers responsible for planning for, preparing for, responding to, and recovering from all hazards.

Office of Diversity, Equity, and Inclusion—As part of its continued commitment to making emergency management equity-centered, Cal OES formally created the Office of Diversity, Equity, and Inclusion (ODEI) in 2022 to elevate and expand current equity and access programs and embed equity and engagement principles throughout Cal OES's actions, policies, programs, and procedures, both internally and externally. ODEI works to ensure that principles of equity, justice, inclusion, transparency, and accountability govern all aspects of emergency services. ODEI prioritizes actions promoting equity, fostering community resilience, and putting diversity into purposeful and meaningful action. The office knows it is impossible to be equitable without being inclusive of diverse voices. Thus, it continues to build a culture of belonging, respect, and connection by actively inviting the contribution and participation of all people. At Cal OES, diversity is an asset, one which is essential for a more resilient California.

Office of Tribal Coordination—The role of the Office of Tribal Coordination is to improve and maintain communication and collaboration between the Cal OES and all Native American Tribal Nations in California. The office aims to create effective collaboration and provide relevant information that allows for informed decision-making so that all parties can share the goal of reaching an informed decision together. The Office of Tribal Coordination shares resource information, including grants, training opportunities, and key initiatives, provides consultation and technical assistance and addresses inquiries from our Tribal Nation partners. Its priorities are to educate internal and external agencies and partners, to become informed about the cultural settings of California Native Americans, to understand and relay Tribal Nations' priorities for emergency management and homeland security issues, to provide cultural awareness and sensitivity, and to improve Cal OES's understanding of all Native American Tribal Nations and related issues in California.

Equity-Related Definitions

To include equity in a plan, individuals and communities facing greater barriers must first be identified. Many definitions exist related to equitable planning. In this SHMP, "**social vulnerability**" is generally called "**equity priority.**" Social vulnerability is commonly used, but California recognizes that the purpose of an equity focus is to prioritize closing inequitable gaps through proactive action. Additionally, "socially vulnerable" may convey a negative connotation to those unfamiliar with the concept. This is similar to using the term "disaster victim" versus "disaster survivor." The former implies a focus on the impacts an individual has endured; the latter calls attention to the individual's power and resilience in the face of a disaster. "Equity priority" conveys a more positive connotation and better expresses the goal of these considerations; it focuses on empowering communities rather than on the barriers and challenges they face. However, the SHMP still uses "social vulnerability" when referring to a specific tool or resource, such as the Social Vulnerability Index (Section 0). The Equity Working Group for this SHMP identified the following relevant definitions for use in this Plan:

- The term "**equity priority**" was identified by stakeholders in the Equity Working Group (see Appendix D), which discussed how to define equity and integrate it into the SHMP. It was important to stakeholders that social vulnerability be discussed to ensure the term included the various factors that may contribute to vulnerability. It also highlighted the State's commitment to be proactive and intentional and aid individuals and communities in need.
- **Social Vulnerability** refers to social factors that influence the susceptibility of various groups to harm and govern their ability to respond. It can also be the product of plan inequalities— those characteristics of communities and the built environment, such as urbanization, growth rates, and economic vitality, that make the people who live or work there vulnerable to disaster (Cutter, Boruff and Shirley 2003).
- **Equity Priority Communities** are those that bear a disproportionate burden of emergency hazards because of a history of being systemically marginalized due to structural inequities relating to race, ethnicity, gender, sexuality, access and functional needs, language, documentation status, native or indigenous origins, mental health, age, socio-economic status, country of origin, religion, disability, etc. The term "equity priority communities," identified by stakeholders in the Equity Working Group, is the umbrella term used in the Plan to include all other communities.
- **Access or Functional Needs Communities** refer to individuals and groups who have access or functional needs, such as, but not limited to, people without vehicles, people with disabilities, older adults, and people with limited English proficiency, as defined by California Government Code 8593.3.

Equity-Related Definitions (Continued)

- **Underserved Communities** refer to populations and geographic communities sharing characteristics that have been systematically denied a full opportunity to participate in aspects of economic, social, or civic life (Executive Order 13985).
- **Underrepresented Communities** refer to populations or groups lacking historical or current representation in decision-making or aspects of economic, social, or civic life.
- **Historically Marginalized Communities** refer to groups and communities that experience discrimination and exclusion because of unequal power relationships across economic, political, social, and cultural dimensions (National Collaborating Centre for Determinants of Health n.d.).
- **Environmental Justice** is the fair treatment and meaningful involvement of all people—regardless of race, color, national origin, or income—in the development, implementation, and enforcement of environmental laws, regulations, and policies (EPA 2023).
- **Diversity** refers to physical, social, and psychological differences between people and groups with multiple subjectivities, perspectives, experiences, backgrounds, and socially constructed differences.
- **Inclusion** means building a culture of belonging, respect, and connection by actively inviting the contribution and participation of all people.

Often, populations and communities are categorized based on shared characteristics that create barriers to accessing resources, leading to increased vulnerability. An individual or community may face barriers or have characteristics that apply to multiple populations and communities. Appendix B describes the many communities that need to be considered in integrating equity as a priority for hazard mitigation.

Cal OES has had a strong history of adopting integrated approaches to managing disasters and is a global leader in inclusive planning. Identifying concentrations of priority and underserved populations can assist emergency managers and the whole community in preparedness, response, recovery, and mitigation actions. Inclusive planning to help identified populations may be accomplished through partnerships and relationships with whole community leaders as representatives of these populations. The State must ensure that considerations for higher-risk populations, such as those with disabilities or financial challenges, are included in the decision-making process when identifying projects to mitigate risk and carrying out disaster management processes.

Centering equity in the mitigation plan helps ensure an inclusive planning process that benefits the whole community and directs information and resources to those disproportionately impacted by disasters. Intentional inclusive planning ensures that everyone has access and the opportunity to meaningfully participate and contribute to successful hazard mitigation.

Equity considerations are woven throughout the 2023 SHMP. The hazard Risk Assessments all consider the risk to equity priority communities, and the goals, objectives, and outcomes of the 2023 SHMP were developed through the lens of inclusion and equity. The State intends to prioritize the principles of social justice, equity, and inclusion in the planning and administration of all hazard mitigation programs and actions statewide.

Planning for Climate Change

When planning for climate change, the terms "climate adaptation," "sustainability," and "resilience" are frequently used interchangeably and associated with mitigation. "Climate adaptation" describes the actions taken to prepare for and adjust to current and projected impacts of climate change (EPA 2022). For this SHMP, "sustainability" includes the preservation of resources—physical, social, economic, environmental, historical, and cultural—for the benefit of future generations. One path to sustainability is through investment in strong disaster mitigation. "Resilience" is defined as the ability of a system to absorb shock and maintain its structure and functions with a minimum of loss. A resilient system can resume pre-event functionality in a relatively short time. A community is resilient when it maintains continuity and recovers quickly despite experiencing disaster events. Combined with these efforts, it is also important to ensure that these measures do not inadvertently cause unintended consequences and further contribute to GHG emissions. Addressing adaptation, sustainability, and resilience in the SHMP allows communities to identify ways they might be harmed by future conditions—including those unique to their communities—and provides a tool for finding solutions to those risks.

Climate adaptation efforts may be undertaken separately or in addition to the hazard mitigation planning process. Hazard mitigation and climate adaptation are complementary efforts with the same goal: long-term risk reduction for people and increased safety for communities. Adapting to the expected impacts of climate change is a form of hazard mitigation. A climate change-informed risk assessment and mitigation strategy provide the greatest potential for long-term risk reduction and increased resilience.

Integrating resilience into the SHMP addresses two factors:

- The connection and dependencies among multiple geographic levels—cities, counties, regions, Tribal Nations, and the State
- The capacity of the city, county, Tribal Nation, or State to change and adapt during recovery to meet challenges posed by changed conditions

Resilience can be built through mitigation or coordinated development, and implementation of other disaster management functions such as preparedness, response, and recovery (Topping, et al. 2010).

An integrated approach to climate change and resilience involves adapting to future climate conditions and reducing GHG emissions. Climate adaptation activities can have several benefits, such as increased public health and safety, greater economic stability, reduced healthcare and infrastructure costs, increased housing resilience, improved air and water quality, and better stormwater management (Cal OES 2020). Climate adaptation strategies can also lead to the sustainability of resources.

The best available science overwhelmingly confirms that climate change will continue to increase the frequency, duration, and intensity of natural hazards such as floods, wildfires, extreme heat, drought, storms, heavy precipitation, and sea-level rise. A changing climate increasingly impacts communities, and many of these climate trends will continue and amplify for decades. Climate change heightens risks to California communities and residents and challenges conventional hazard mitigation approaches. It poses a unique threat to the nation's most at-risk populations by exacerbating the effects of disasters on marginalized and historically underserved communities, which already experience the greatest impacts from natural hazards.

Tools such as Cal-Adapt will be critical for assessing vulnerability to climate impacts. Cal-Adapt provides a way to explore peer-reviewed data that portrays how climate change might affect California at the State and local levels. This data is available through downloads, visualizations, and the Cal-Adapt application programming interface (API) for research, outreach, and adaptation planning needs. Cal-Adapt is a collaboration between State agencies, universities, and private-sector researchers.

Cal OES has also developed the Climate Adaptation Planning Guide (APG) as a tool that local governments and organizations can use to integrate best practices into their adaptation planning efforts. First published in 2012 and updated in 2020, the APG includes an improved step-by-step process communities can use to plan for climate change. The updated APG reflects the latest best practices, especially considering the many updates to California's plans, programs, science, regulations, and policies.

Climate Adaptation and Mitigation

Climate change adaptation describes measures that seek to assist communities in adjusting to the actual or expected climate and its effects (IPCC 2014). Mitigating natural hazards is a key component of climate change adaptation that focuses specifically on hazard risk reduction. Climate adaptation and hazard mitigation focus on long-term threats to human life, property, economic continuity, ecological integrity, and community function.

Effective hazard mitigation requires accurate, science-based, and data-driven prediction of the likelihood of hazard events. Historically, predictions are based on statistical projections from records of past events. This approach assumes that the probability of hazard events remains unchanged over time. Thus, averages based on the past frequencies of hazards are used to estimate future frequencies. For example, if a river has flooded an average of once every five years for the past 100 years, it can be expected to continue to flood an average of once every five years.

For hazards that are affected by climate conditions, the assumption that future behavior will be equivalent to past behavior is no longer valid. As flooding is generally associated with precipitation frequency and intensity, for example, the frequency of flooding will not remain constant if broad precipitation patterns continue to change over time. Specifically, as hydrology changes, storms currently considered to be the 1% annual chance flood might strike more often, leaving many communities at greater risk. The risks of flood, landslide, severe storms, extreme heat, drought, and wildfire are all affected by climate patterns.

For this reason, understanding climate change is pertinent to mitigating natural hazards. Hazard risk assessments must be based on the best available data incorporating future climate conditions. Information about changing climate patterns provides insight into the reliability of future hazard projections used in mitigation analysis.

Source: (FEMA 2023h)

The 2023 SHMP incorporates climate change considerations throughout the Risk Assessments and in developing mitigation goals and actions. The Risk Assessments in this Plan are based on the best available data that incorporates future conditions and an increase in the pace, intensity, and scale of future hazard events. Climate adaptation is a key theme in the goals and objectives outlined in this Plan.

1.2. HOW THIS PLAN WAS PREPARED

S1 – 44 CFR 201.4(b) and (c)(1): Does the plan describe the planning process used to develop the plan?
Section 1.2 addresses this requirement, including how the Plan was prepared, schedule or timeframe, specific milestones and activities, agencies and other stakeholders who were involved, and the efforts to integrate that process into additional state planning efforts.

The planning process lays the foundation for developing an effective plan, maintaining, updating, integrating, and improving it, and tracking and evaluating progress on the recommended mitigation efforts. A successful planning process involves consultation with a cross-section of stakeholders, including those impacted by the plan and those with authority to implement specific actions, reaching a consensus on desired outcomes, and resolving problems. It results in widespread support for directing financial, technical, and human resources to the plan's recommended courses of action.

The Cal OES SMP Unit managed the planning process for the 2023 SHMP. The Unit's activities included convening and supporting expert working groups; providing subject-matter expertise in hazard mitigation, planning, and FEMA requirements; researching and writing plan content; and making daily operational decisions. The SMP Unit coordinated the process with the support of consultant firm Tetra Tech.

Cal OES began the 2023 SHMP update in August 2021 to incorporate a broader range of stakeholders into the planning process. The Plan was made available for public review and comment on February 7, 2023. Comments were addressed, and a first draft was submitted to FEMA Region 9. The final draft was submitted to FEMA for review on June 9, 2023. FEMA issued an Approved Pending Adoption (APA) letter on July 24, 2023. California adopted the FEMA-approved SHMP on August 23, 2023. The signed adoption letter and final approval letter are included following the Executive Summary of this Plan.

The hazard mitigation planning process consisted of four major tasks, as further described in the sections below:

- Organizing the process and resources

- Assessing risk and capabilities
- Developing a mitigation strategy
- Adopting and implementing the Plan

1.2.1. Organizing the Process and Resources

S2 – 44 CFR 201.4(b) and (c)(1): Does the plan describe how the state coordinated with other agencies and stakeholders?
Section 1.2.1 satisfies this requirement by documenting coordination with agencies and stakeholders and how their input was utilized to inform the Plan update.

Cal OES initiated the 2023 SHMP update by conducting an internal review of the 2018 SHMP's content, format, and opportunities for enhancement. Cal OES also compared this information against FEMA's new guidance once it was released to determine necessary edits. Cal OES established expert working groups organized around different hazards and themes, known as the Hazard and Working Groups, by examining California's disaster landscape since the 2018 SHMP and the overarching themes to be highlighted in the 2023 Plan.

Hazard and Working Group Activities

Since the 2023 SHMP Kickoff in August 2021, the Hazard and Working Groups and group leadership met 102 times, accounting for over 100 hours of active, collaborative planning. Appendix D lists meetings and dates. The Hazard and Working Groups will remain active following approval of the 2023 SHMP to facilitate its implementation and monitoring and to streamline the planning process for the 2028 SHMP.

FEMA's National Mitigation Framework (FEMA 2020a) emphasizes the value of collaboration among sectors to ensure that mitigation capabilities continually develop, and that comprehensive mitigation includes strategies for all community systems. Cal OES facilitated numerous meetings throughout the planning process to ensure a robust Risk Assessment based on the best available validated data, an extensive review of capabilities and mitigation progress, and a comprehensive updated mitigation strategy. The following sections describe engagement outreach activities and the resulting input from participating planning partners.

Activities to Engage with Stakeholders

The 2023 SHMP planning process engaged a wide range of whole community stakeholders and subject matter experts. As the lead agency, Cal OES collaborated with partners across State government, local and Tribal Nation jurisdictions, federal agencies, and non-governmental organizations (NGOs).

The "public" for this SHMP update was defined in three categories:

- State agencies and subject matter experts
- Local jurisdictions
- The general public

Agency Engagement

HHPD1 – 33 USC 467f-2: Did Element S2 (planning process) describe how the state dam safety agency, other agencies, and stakeholders participated in the planning process and contributed expertise, data, studies, information, etc., relative to high hazard potential dams?
Text under the "Agency Engagement" part of Section 1.2.1 describes how state agencies were engaged during this Plan update process, including those agencies associated with Dam Safety and program administration.

The SMP Unit collected significant input across Cal OES directorates and other State agencies and departments, such as the California Department of Forestry and Fire Protection (CAL FIRE), the California Governor's Office of Planning and Research (OPR), the California Department of Water Resources (DWR), the DWR Division of Safety of Dams (DSOD), the California Geological Survey (CGS), and the California Department of Housing and Community Development (HCD).

Engagement with agencies that own and operate the State-owned facilities that are the basis of the Risk Assessment occurred through various working groups, which met bi-monthly. Four Hazard Groups and four Working Groups were established to assist in developing this SHMP update. Each group was co-led by the SMP Unit, and one or two subject-matter experts referred to as "champions," as listed in Table 1-2. All groups met regularly between August 2021 and September 2022 to discuss the content and themes of the Plan.

Table 1-2. Hazard Group and Working Group Champions

Hazard Group/ Working Group	Champion Name	Title	Agency
Seismic Hazards	Cindy Pridmore	Engineering Geologist	California Department of Conservation (DOC)
Flood Hazards	Mike Mierzwa	Technical and Policy Advisor	DWR
	Remy Gill	Engineer, Water Resources	DWR
Fire Hazards	Edith Hannigan	Executive Officer	California Board of Forestry and Fire Protection (BOF)
Other Hazards	No designated champion		
Geographic Information System (GIS) Technical Assistance Working Group	Michael Crews	Information Security Officer	Cal OES
	David Harris	Enterprise Data Services	California Natural Resources Agency (CNRA)
	Eric Howard	Geospatial Data Scientist	Cal OES
Goals and Objectives Working Group	Victoria LaMar-Haas	Program Manager, LMP Unit	Cal OES
Climate Impacts Working Group	JR DeLaRosa	Climate and Science Advisor	Cal OES
	Neil Matouka	Program Manager, Fifth Climate Change Assessment	OPR
Equity Working Group	L. Vance Taylor	Chief of the Cal OES Office of Access and Functional Needs	Cal OES
	Abby Browning	Chief of the Cal OES Office of Private Sector/Non-governmental Organization Coordination	Cal OES
	Monisha Avery	Chief of the Cal OES Office of Diversity, Equity, and Inclusion	Cal OES
	Priscilla LoForte	Diversity, Equity, and Inclusion Specialist	Cal OES

By collaborating with the Hazard Groups and Working Groups, Cal OES engaged with various sectors throughout the planning process. Sector areas included emergency management, economic development, land use and development, housing, health and social services, infrastructure, and natural and cultural resources. Their participation provided these sectors with opportunities to offer plan input.

Appendix D lists key stakeholders engaged in the update process, provides rosters of each Hazard Group and Working Group, and presents details on coordination with agencies and stakeholders (e.g., distribution of capability assessment tables, interactive exercises at leadership meetings, meetings to discuss and collect Risk Assessment data and methodology).

Local Jurisdiction Engagement

County and operational area emergency managers were invited to participate in a webinar hosted by Cal OES on September 13, 2022. This webinar explained the SHMP planning process, the 2023 Plan update, and recent FEMA mitigation state-level guidance updates. The webinar concluded with a discussion of opportunities for continued SHMP involvement.

Following this webinar, Cal OES scheduled and delivered local listening sessions. The purpose of these listening sessions was to further develop working relationships between Cal OES and local jurisdictions and to determine how to maximize the usefulness of the 2023 SHMP for counties developing their hazard mitigation plans. Representatives from all 58 California counties were invited. Sessions were kept small, and attendees were grouped by common attributes to the extent possible. These attributes included hazards, geography, hazard history, planning experience, and planning challenges and strengths. Some key themes from these sessions included:

- Additional support and assistance to bolster the capability and capacity of local planning entities
- Challenges to accessing funding to prepare and implement local plans
- Aligning feedback from Cal OES and FEMA with plan guidance and requirements, as well as State legislative requirements
- Better explanations of minimum requirements for plans and plan updates
- Techniques and best practices for engaging stakeholders and the public to create or update local plans
- Identifying mitigation actions to include in plans and implementing those actions and the overall plans

These listening sessions were held from October 27, 2022, to November 9, 2022. Representatives from 32 counties attended.

Public Outreach

Residents of the State were engaged through a public-facing website that was continually updated throughout the process. The public comment period took place from February 7 to March 24, 2023. During this time, the draft Plan was posted online, and the Cal OES SMP Unit socialized the public comment opportunity on various social media outlets, including Twitter, Facebook, Instagram, and LinkedIn, and through extensive listserv emails and speaking engagements. During this public comment period, Cal OES received comments from 38 separate entities, including State agencies and departments, federal agencies, local governments, Tribal Nations, NGOs, and independent citizens of California. Cal OES received over 1,000 comments from these entities.

Plans for Ongoing Engagement

Hazard mitigation planning is an ongoing process, and Cal OES is committed to increasing coordination and collaboration in future hazard mitigation planning and grant activities. Cal OES will further integrate agencies/departments and stakeholders as documented in the mitigation action plan (see Chapter 47) and plan maintenance strategy (see Chapter 48).

Support Received From Participating Agencies and Stakeholders

The content of the SHMP is the culmination of information provided by numerous stakeholders from local, Tribal Nation, State, and federal government agencies, public and private business organizations, and individual citizens. The following sections describe the contributions of each type of participating partner.

Hazard Groups and Working Groups

The Hazard Groups and Working Groups provided guidance and subject matter expertise for the Plan. The Hazard Groups focused on specific hazard profiles and mitigation actions. The Working Groups evaluated overarching themes integrated throughout the 2023 SHMP.

Subject-Matter Experts

Many hazard subject-matter experts in California participated in the 2023 SHMP Hazard Groups and Working Groups by providing spatial data, guiding the vulnerability assessment methodology, reviewing the draft Risk Assessment, and providing critical text updates to various hazard profiles. These subject-matter experts were consulted from the beginning stages of the planning process. Cal OES also engaged subject matter experts, including the Cal OES Statewide AFN Community

Advisory Committee, on critical themes such as equity and climate change through the Working Groups.

State Agencies

The 2023 SHMP reflects specific mitigation actions and activities from programs administered by other agencies and departments throughout the State. State agencies provided subject matter experts to participate in the Hazard and Working Groups, and partner agencies were consulted in developing the goals and objectives and the mitigation actions assigned to their agency.

Counties, Operational Areas, and Tribal Nation Governments

Local governments provided input on the content of the Plan to support local mitigation planning and capacity-building efforts through the county and operational area webinar and the listening sessions with local jurisdictions.

Through the Cal OES Tribal Coordination Office, Cal OES also leveraged relationships with Tribal Nation associations to gather input on the 2023 SHMP planning process. This input included how to best incorporate Tribal Nation populations into the SHMP while maintaining their sovereignty regarding mitigation planning.

Public and Private Business Organizations and Individual Citizens

The SHMP was made available to this audience via the public-noticed, 45-day public comment period that commenced on February 7, 2023, and concluded on March 24, 2023. During this timeframe, the SHMP was available for review and comment through a publicly accessible website providing a web-based platform to submit comments. Various public and private businesses and individual citizens used this opportunity to give feedback and comments on the SHMP draft.

1.2.2. Assessing Risk and Capabilities

Hazard Groups and Working Groups were consulted to determine how to organize and assess hazards in the 2023 update. The 2018 SHMP organized hazards by type (earthquake/geologic, flood, fire, and other). Based on input from the 2023 SHMP Hazard Groups and Working Groups, Cal OES elected to present hazards in order of impact rating for this update. Natural hazards of interest are grouped first, followed by other hazards of interest.

Subject matter experts were consulted to determine which phenomena should be assessed as stand-alone hazards and which ones represent cascading impacts of a standalone hazard. For example, post-fire debris flow is an impact of wildfire, while urban structural fire is a standalone hazard.

Cal OES worked with Hazard Groups and Working Groups to identify key information for integration into the Plan, including the best available data on climate change and equity priority communities. The Hazard Groups guided the development and methodologies for the hazard Risk Assessments.

1.2.3. Developing a Mitigation Strategy

Goals and Objectives

The 2023 SHMP describes the State's commitment to reducing or eliminating impacts of natural and human-caused disasters by preparing and implementing comprehensive hazard mitigation strategies, plans, and actions. This commitment is reflected in the SHMP goals and objectives discussed in Chapter 44, which were reviewed and updated by the Goals and Objectives Working Group for this update.

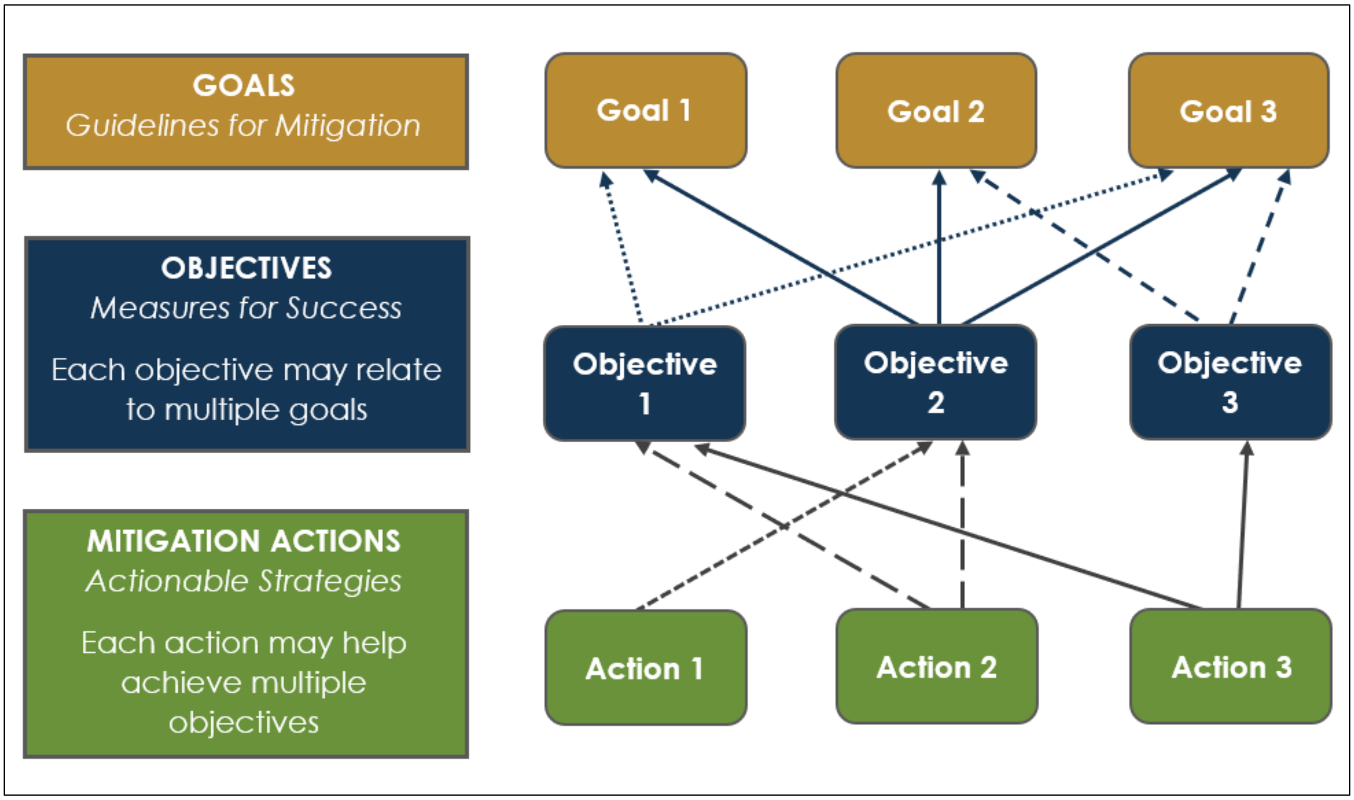
The Goals and Objectives Working Group was responsible for reviewing the 2018 SHMP goals and objectives and updating them to reflect priorities for the 2023 update. The 2023 SHMP adopted a new strategy for goals and objectives, as shown in Figure 1-1. This strategy allows multiple objectives to apply under multiple goals. It provides an opportunity to establish more comprehensive objectives that the State can use to set priorities for actions identified in the Plan. All stakeholders were invited to review and refine the goals and objectives.

Mitigation Actions

Once goals and objectives were confirmed, an action plan was developed and prioritized. The first step in action planning was to reconcile all actions recommended in the 2018 SHMP. The reconciliation process, discussed in Chapter 45, identified which actions would be carried over to the 2023 SHMP.

Actions carried over from the previous SHMP were vetted through the Hazard Groups and Working Groups, which also identified any new actions to be added to the Plan based on the groups' expertise and understanding of hazard impacts in California. After identifying the actions, each was assigned a priority based on metrics that emphasized State priorities and concerns, as discussed in Chapter 47.

Figure 1-1. Goal-Setting Approach



Opportunities for Mitigation Activities

Developing new mitigation actions for this SHMP considered options from catalogs of potential mitigation opportunities. Each risk assessment chapter of this SHMP provides a catalog outlining potential actions for mitigating the hazard addressed in that chapter. These potential actions are categorized in two ways:

- By who would carry out the action:
  - Community-scale (a group of individuals, caregivers, guardians, households, and families; while a single individual may undertake preparedness measures, the SHMP recognizes that community-scale actions may require an entire neighborhood or community to take part in implementing the action)
  - Organizational scale (businesses and organizations, including non-profits and community-based organizations)
  - Government-scale (any government agency that has permit authorities and police powers within a defined planning area)

Opportunities for Mitigation Activities (continued)

- By how the action mitigates hazard risks:
  - Manipulate the hazard (actions to prevent hazard events from occurring)
  - Reduce exposure and vulnerability (actions to safeguard people, property, and the environment from the impacts of the hazard)
  - Build local capacity (actions to improve abilities to mitigate and respond to hazard events)

Nature-Based Solutions

California's climate adaptation strategy highlights using nature-based solutions to promote environmental and community resilience. Nature-based solutions are long-term sustainable planning, design, environmental management, and engineering practices that weave natural features or processes into the built environment to build more resilient communities. Projects incorporating nature-based solutions can achieve multiple benefits and contribute to climate change mitigation, climate adaptation, and hazard mitigation goals (FEMA 2021d). Additionally, nature-based solutions provide health, well-being, and environmental justice benefits.

Historically, most hazard mitigation projects have employed "gray" or "hard" infrastructure solutions in engineering projects that use concrete and steel. For example, seawalls are a gray infrastructure solution to protect shorelines from wave action and coastal erosion, thereby reducing coastal flooding. Preferred building materials in wildfire-prone areas have transitioned from wood to stone, steel, or composites. These approaches have effectively provided site-specific hazard mitigation and are important risk reduction tools in certain circumstances. However, they can result in negative consequences. For example, seawalls can lead to the loss of beaches, and many gray solutions result in high GHG emissions. Projects that utilize nature-based solutions can, in some cases, achieve similar risk reduction benefits while providing social, economic, and environmental benefits. Nature-based solutions often employ "green infrastructure"—intentional or strategic preservation, enhancement, or restoration of a natural or semi-natural system to provide a desired benefit. Green infrastructure can simultaneously reduce risk, protect or enhance the environment, create wildfire habitats, reduce GHGs, and provide recreational opportunities (The Nature Conservancy n.d.).

In addition to the environmental benefits, green infrastructure provides health and wellbeing benefits. Communities can suffer significantly from natural hazards if they are under-invested in, under-targeted for, or excluded from community investment in green infrastructure and other nature-based solutions. Frontline communities are "neighborhoods or populations of people who are directly affected by climate change [and other natural hazards] and inequity in society at higher rates than people who have more power in society. They are on the frontlines of the problem" (NAACP 2018). These communities are at greater risk as structural and institutional inequities often create additional barriers that prevent these populations from being adequately prepared to withstand and recover from a disaster or emergency. Investing in natural systems can improve air quality, reduce impacts from extreme heat, serve as storage for rainwater and flooding, and provide recreational and exercise opportunities for the whole community (Kingsley 2019).

California's hazard mitigation strategy prioritizes using nature-based solutions to reduce hazard risk while enhancing the environment. Nature-based solutions such as the following can mitigate risk for most hazard types, especially those exacerbated by climate change:

- Floodplain restoration is an effective way to reduce riverine flooding by providing natural storage for floodwaters while reducing erosion, enhancing water quality, and creating habitat (FEMA 2021d)
- The restoration or creation of coastal dunes, marshes, and other coastal habitats can serve as a barrier between the ocean and inland areas, reducing coastal erosion and flooding
- Forest restoration, ecologically informed vegetation management, and prescribed fire and fire-resilient community design are examples of nature-based solutions that can reduce wildfire risk
- In urban areas, green infrastructure such as urban tree canopies, rain gardens, and green roofs can assist in stormwater management and reduce the impacts of extreme heat events and drought events

Hazard mitigation projects employing nature-based solutions are key for promoting resilient communities and advancing climate adaptation goals. FEMA is increasingly recognizing the importance of nature-based solutions to reduce hazard risk. For example, the FEMA BRIC program provides additional scoring criteria to promote and encourage the utilization of nature-based solutions. FEMA has produced guidance and other resources to assist communities with planning and implementing nature-based solutions.

1.2.4. Emergency Management Accreditation Program

The Emergency Management Accreditation Program (EMAP) provides emergency management programs an opportunity to be evaluated and recognized for compliance with standards certified by the American National Standard Institute and recognized by the industry and for compliance with EMAP's mission to build safer communities through standards of excellence. EMAP demonstrates accountability and focuses attention on areas and issues where resources are needed to heighten preparedness efforts for any disaster that may affect communities.

Applicants must demonstrate through self-assessment, documentation, and peer assessment verification that their programs meet the Emergency Management Standard. An emergency management program uses the accreditation to prove the capabilities of its disaster preparedness and response systems. Accreditation is valid for five years. The program must maintain compliance and be reassessed to maintain accredited status.

The EMAP process accredits an overall emergency management program, of which hazard mitigation is one component. Many EMAP standards for hazard mitigation planning fall outside of what FEMA requires for state hazard mitigation plans. This SHMP has been developed to comply with EMAP standards and criteria fully. The Core Plan emphasizes elements required by FEMA to better support local planning in the State. Since EMAP is a voluntary program, its components that deviate from FEMA requirements are packaged in Appendix C to this Plan.

1.3. ADOPTING AND IMPLEMENTING THE PLAN

Adoption of the 2023 SHMP is implemented on behalf of the State government by the Cal OES Director. The adopted SHMP communicates the State's priorities and facilitates communication and collaboration among jurisdictions and stakeholders.

Upon conditional approval of the finalized 2023 SHMP by FEMA, the Cal OES Director, acting as the Governor's designated official, formally adopts the SHMP, as required by 44 CFR Section 201.4(c)(6). The Director's letter of adoption is immediately forwarded to FEMA to finalize the approval process. The adoption letter and final approval letter are included following the Executive Summary of this Plan.

1.4. THE UPDATED PLAN—WHAT IS DIFFERENT?

The updated Plan differs from the 2018 SHMP in a variety of ways due to program requirements and Plan enhancements. Key differences may be summarized as follows:

- The 2023 SHMP uses plain language that emphasizes readability for the general reader
- The Plan format has been changed for a simplified Core Plan supported by a technical volume presenting multiple appendices
- The number of fully assessed hazards of concern has been expanded from 13 to 15
- Another 19 hazards of interest, including non-natural hazards, are profiled
- The planning process was conducted through a series of working groups consisting of subject-matter experts covering focus topics for the plan
- Goals and objectives have been revised using an approach that emphasizes multi-objective actions
- The SHMP uses a hazard impact scoring methodology that categorizes risk as high, medium, or low based on the projected impacts of each hazard
- The SHMP includes a catalog of best management practices for local hazard mitigation planning
- The SHMP applies a new methodology for prioritizing actions
- The Risk Assessment for the SHMP has been expanded to include a quantitative analysis that looks at the vulnerability of equity priority communities

Appendix E indicates the significant changes between the two Plans as they relate to federal requirements for state hazard mitigation plans.

1.5. HOW TO NAVIGATE THE PLAN

California's SHMP has been designed to use plain language and provide an engaging experience for readers by making critical information easily identifiable and ensuring increased accessibility. Additionally, the SHMP is a resource for local governments to inform their planning efforts. The Plan consists of two volumes:

- Volume 1 is the Core Plan, highlighting essential information on hazards and risks in California and the proposed strategy for actions to mitigate the risks. Volume 1 also includes a glossary defining the terms and acronyms used in this SHMP and a list of references cited in the Core Plan as authoritative sources of information.
- Volume 2 consists of technical appendices. Development of the 2023 SHMP yielded an extensive collection of documents and data that support the findings presented in the Core Plan. The appendices present these detailed results for readers who have a use for technical information about hazard mitigation in California.

Throughout Volume 1, requirements for FEMA's Standard state hazard mitigation planning, Enhanced state mitigation planning, and EMAP requirements are identified using the icons below. The information is highlighted to indicate how the requirements are met for each program.

FEMA Standard State Hazard Mitigation Plans 44 CFR Section 201.4:
Utilized to highlight the minimum standards required for a state-level hazard mitigation plan.

FEMA Enhanced State Hazard Mitigation Plans 44 CFR Section 201.5:
Utilized to highlight the heightened standards required for an Enhanced state-level hazard mitigation plan that qualifies to receive additional funding.

Emergency Management Accreditation Program:
Utilized to highlight the required EMAP standards. EMAP accreditation is a voluntary program not required by FEMA for Standard or Enhanced State Planning Requirements. EMAP standards are considered to be above and beyond those required by FEMA.

2. CALIFORNIA'S HAZARDS OF CONCERN

2.1. CALIFORNIA'S HAZARD HISTORY

California is subject to many natural and human-caused hazards. Wildfires are the most frequent disaster, followed by floods. Earthquakes occur less frequently but account for the greatest combined losses (deaths, injuries, and damage costs). Since 1950, California has experienced 702 hazard events, including 345 wildfires, 150 floods, 30 severe storms, and 27 damaging earthquakes. Over 530 of these events also included impacts from mud and landslides. Since 2000, 201 disaster events in California (approximately 9 per year) have cost the State over $19 billion. Most of the disasters have taken place between July and October, with the number of disasters increasing in frequency over the last 20 years (FEMA 2022d); (NCEI 2022a); (Cal OES 2022d).

Over the past seven decades, the frequency of disasters and corresponding losses have grown rapidly. Table 2-1 shows the increase in State emergency proclamations and federal disaster declarations from 1950 through 2022. The table shows casualties and Cal OES-administered disaster costs by decade. These casualties and costs peaked in the 1990s due to the 1994 Northridge Earthquake. Appendix F presents a detailed history of disaster declarations for California.

Table 2-1. Hazard Event Frequency and Losses Since 1950

Year	State Emergency Proclamations	Federal Disaster Declarations	Deaths*	Injuries	Cal OES-Administered Costs
1950-1959	8	3	100	227	$332,283,000
1960-1969	32	12	99	1,224	$706,931,196
1970-1979	60	18	96	2,226	$4,197,670,330
1980-1989	60	23	128	5,243	$3,342,205,537
1990-1999	48	19	224	15,592	$9,245,038,369
2000-2009	63	101	59	885	$1,845,112,390
2010-2019	72	123	184	10	$1,120,667,471
2020-2022	22	38	28	4	____**
TOTAL	**365**	**337**	**918**	**25,411**	**$20,789,908,293**

Source: (FEMA 2022d); (CAL FIRE 2022a); (Cal OES 2022d)

* Cal OES tracks fatality reporting based on voluntary local jurisdiction reporting. Figures are likely undercounted because local jurisdictions are not mandated to report fatality numbers. As of January 2023, California has had roughly 11 million Coronavirus Disease 2019 (COVID-19) cases and over 98,000 COVID-19-related deaths. These numbers are not reflected in this table because of the unique disaster type of COVID-19. The most updated statistics are available on California's COVID-19 website. (https://covid19.ca.gov/state-dashboard/)

** At the time of this Plan update, the administered cost calculations were still being finalized due to the volume of events and the scope of costs associated with the COVID-19 federally declared disaster.

Disaster Declarations

Formal disaster declarations provide a good indication of the historical occurrences of a hazard in a given area. Such declarations may be issued by State, local, or federal government agencies. This SHMP reviews the following types of declarations for past hazard events:

- **Federal (or Presidential) Major Disaster Declaration** **(DR)—**For a natural event that the President believes has caused damage of such severity that it is beyond the combined capabilities of state and local governments to respond. Provides a wide range of federal assistance programs for individuals and public infrastructure (FEMA 2023i).
- **Federal (or Presidential) Emergency Declaration** **(EM)—**For an event when the President determines federal assistance is needed to supplement state and local emergency services efforts or lessen the catastrophe threat. The total assistance for a single event may not exceed $5 million (FEMA 2023i).
- **Federal Fire Management Assistance Declaration** **(FM)—**Establishes eligibility for Fire Management Assistance Grants (FMAGs) from FEMA for mitigating, managing, and controlling fires that threaten to be major disasters. This declaration type replaced the fire suppression declaration in 2003 (FEMA 2023).

Disaster Declarations (Continued)

- **Federal Fire Suppression Authorization (FS)—**Funding under FEMA's Fire Suppression Assistance Program and this declaration type were replaced with FMAGs after 2002 (FEMA 2021g).
- **U.S. Department of Agriculture (USDA) Disaster Designation—**Designates counties as disaster areas to make EM loans available to producers suffering losses in those counties and contiguous counties (USDA n.d.-a).
- **California State of Emergency Proclamation—**Issued by the Governor in cases of disaster or extreme peril to the safety of persons and property that are likely to be beyond the control of any single county or city and require the combined forces of a mutual aid region or regions to combat (Cal OES 2023b).
- **California Disaster Assistance Act (CDAA)—**Authorizes the Director of Cal OES to administer a disaster assistance program providing State financial assistance for disaster-related costs incurred by local governments. Funding becomes available when the Director concurs with a local emergency proclamation requesting State disaster assistance. Funds may be used to repair, restore, or replace public real property damaged by a disaster. The program may assist with cost-sharing required under federal public assistance programs in response to disaster events (Cal OES 2023b).
- **U.S. Small Business Administration (SBA) Physical Disaster Loan**—Provides loans up to $2 million for businesses and private non-profit organizations to repair or replace damaged or destroyed real estate, machinery and equipment, inventory, and other business assets. Funds may also be used to help businesses and homeowners with the cost of improvements to protect, prevent, or minimize the same type of disaster damage from occurring in the future (SBA 2022).
- **SBA Home and Personal Property Loan**—Covers disaster losses not fully covered by insurance or other sources. Disaster loans up to $200,000 are available to homeowners to repair or replace damaged or destroyed real estate. Homeowners and renters are eligible for up to $40,000 to repair or replace damaged or destroyed personal property (SBA 2023).
- **USDA Secretarial Disaster Designation**—Establishes eligibility for farm operators in primary counties and contiguous counties to be considered for certain assistance from the Farm Service Agency, provided eligibility requirements are met. This assistance includes Farm Service Agency emergency loans. Emergency loans help producers who suffer qualifying farm-related losses directly caused by the disaster in a county declared or designated as a primary disaster or quarantine area (USDA 2022).

2.2. HAZARDS OF CONCERN

California's physical location, geographic features, population, and assets make the State susceptible to a wide variety of hazards. These hazards include geologic, flood, fire, meteorologic, biologic, energy-related, and human-caused threats. The 2023 SHMP includes 34 hazards across these categories, as shown below.

Some assessed hazards are critical to include to ensure eligibility for federal funding. Others are profiled to establish a comprehensive view of risk in the State. The hazards identified in the SHMP were selected through a collaborative process with the Hazard Working Groups to ensure widespread and regionally specific hazards are assessed in the SHMP. Additionally, some hazards must be included in the SHMP by State legislation, including electromagnetic pulse (EMP) attack, geomagnetic storm, and other potential causes of long-term electrical outrages.

"Mineral hazards" also have been identified as a hazard of interest in California. However, based on FEMA criteria, these are not typical hazards for local or state mitigation plans. Therefore, this hazard is not profiled or assessed within the same context as the hazards listed above. To address these hazards, an overview of potential impacts from mineral hazards is provided in Appendix R of Volume 2.

Geological Hazards

- Earthquake
- Landslide
- Subsidence
- Tsunami and Seiche
- Volcano

Flood Hazards

- Dam Failure
- Levee Failure
- Riverine, Stream, and Alluvial
- Sea Level Rise, Coastal Flooding & Erosion

Fire Hazards

- Wildfire
- Urban Structural Fire

Meteorologic Hazards

- Drought
- Extreme Cold/Freeze
- Extreme Heat
- Severe Wind, Weather, Storms
- Snow Avalanche

Biological Hazards

- Epidemic / Pandemic
- Invasive & Nuisance Species
- Tree Mortality

Other Hazards

- Energy Shortage
- Geomagnetic Storm
- Long-Term Electrical Outage
- Public Safety Power Shutoff

Human-Caused Hazards

- Air Pollution
- Civil Disorder
- Cyber Threats
- Electromagnetic Pulse Attack
- Hazardous Materials Release
- Natural Gas Pipelines
- Oil Spills
- Radiological Accidents
- Terrorism
- Transportation Accidents
- Well Stimulation

2.3. COMMONLY RECOGNIZED NATURAL HAZARDS OMITTED

At the national level, hurricanes and tropical cyclones are significant natural hazards. However, due to their statistical historical improbability of impacting California, they are not assessed in this Plan.

2.4. THE ROLE OF CLIMATE CHANGE

S4 – 44 CFR 201.4(c)(2)(i): Does the risk assessment provide an overview of the probabilities of future hazard events?
The SHMP assesses 34 hazards of interest in Parts 2 and 3 of the Plan. All 34 hazard profiles have a section dedicated to an overview of the probabilities of future hazard events. The assessment of future probability includes consideration of the potential impacts of climate change on hazard risk.

"California is one of the most 'climate-challenged' regions of North America; its historical climate is extremely variable, and climate change is making extreme conditions more frequent and severe. California's temperatures are already warming, heat waves are more frequent, and precipitation continues to be highly variable."

Source: (State of California 2018)

2.4.1. Climate Change and Hazard Mitigation

Climate change will continue exacerbating the frequency, scale, and intensity of hazards across California. Many communities have experienced substantial damage from climate-related hazards, and 20 counties identify climate change as a hazard in LHMPs. Climate patterns are shifting, resulting in more extreme and variable weather conditions across the State, with more extreme precipitation events, declining snowpack, more frequent and severe heat waves, and drought conditions (CNRA; CEC; OPR 2022). Climate change has impacted the State's natural areas and forests, increasing the frequency of catastrophic wildfires. 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. Global sea level has risen approximately 9 inches, on average, in the last 140 years (NASA 2022a). This has already put some coastal homes, beaches, roads, bridges, and wildlife at risk.

Areas across the State have experienced negative impacts on air and water quality and energy reliability from wildfires and extreme heat. Drought conditions have stressed water supplies and affected large industry sectors such as agriculture. There are no parts of California that escape climate impacts, although the scale, severity, and population vulnerability vary across the State.

Adapting to the changing climate will require an approach to hazard mitigation that prioritizes long-term community resilience practices. Such practices aim to reduce harm for those who experience greater risk and burden of harm due to historical and current marginalization and under-investment, thus resulting in greater resilience across the whole community. The hazard mitigation actions necessary to achieve this goal constantly evolve as conditions change, and the participation of all levels of government, non-profit organizations, the private sector, and the public enhances all actions. In addition, it is important to ensure that the mitigation actions implemented do not contribute to GHG emissions, which exacerbate climate change impacts.

As defined by the Intergovernmental Panel on Climate Change, climate adaptation actions are adjustments in natural or human systems that respond to climatic conditions and moderate harm (IPCC 2022). Both hazard mitigation and climate adaptation actions ultimately move toward the same goal of long-term risk reduction. Integration of hazard mitigation and climate adaptation planning is particularly applicable to natural hazards influenced by climate change, such as coastal flooding and sea-level rise, extreme heat, wildfire, and drought.

2.4.2. Projected Impacts

The scientific consensus is that climate change will continue to increase the frequency, duration, and intensity of many natural hazards. According to California's Fourth Climate Change Assessment, the State will experience the following climate impacts (CNRA; CEC; OPR 2022):

- Annual average daily high temperatures are expected to rise by 2.7 °F by 2040, 5.8 °F by 2070, and 8.8 °F by 2100 compared to observed and modeled historical conditions. These changes are statewide averages
- Heat waves are projected to become longer, more intense, and more frequent

- Warming temperatures are expected to increase soil moisture loss and lead to drier conditions. Summer dryness may become prolonged, with soil drying beginning earlier in the spring and lasting longer into the fall and winter
- Droughts are likely to become more frequent and persistent through 2100
- The strength of the most intense precipitation and storm events affecting California is expected to increase
- Snowpack levels are projected to decline significantly by 2100 due to reduced snowfall and faster snowmelt
- Marine layer clouds are projected to decrease
- Extreme wildfires (i.e., fires larger than 24,710 acres) would occur 50 percent more frequently. The maximum area burned statewide may increase by 178 percent by the end of the century
- Sea-level rise is expected to continue to increase beach, cliff, and bluff erosion

California's Fifth Climate Change Assessment will be released after this SHMP is published; the impacts listed above will change in the updated assessment. These hazards will threaten public health, safety, and well-being, damage infrastructure and property, and degrade natural resources (CNRA; CEC; OPR 2022).

2.5. LOCAL HAZARDS OF CONCERN

S6 – 44 CFR 201.4(c)(2)(ii) and 201.4(c)(2)(iii): Does the risk assessment include an overview and analysis of jurisdictions' vulnerability to the identified hazards and the potential losses? Does the risk assessment include an overview and analysis of the potential losses to the identified vulnerable structures based on estimates in the local risk assessments as well as the state risk assessment?

Section 2.5 includes a review and discussion on which hazards have been identified to have high impacts on all 58 counties within the State. This was based on a review of LHMPs within each of the 58 counties in the State.

California has 58 counties, 482 cities, and over 1,500 special purpose districts that are eligible to develop an LHMP. Many counties have led the development of multi-jurisdictional LHMPs, in addition to the single-jurisdiction plans led by cities and special districts.

The information and data gathered through local planning efforts are valuable as the State implements mitigation strategies and actions and develops funding priorities. Planning efforts between the State and local jurisdictions should be consistent. The State Plan integrates local assessments and data emphasizing the hazards posing the greatest risks.

As shown in Figure 2-1, all of California's counties have been included in State and federal disaster declarations (from 2018 to 2022)—ranging from as few as three declarations in several counties to as many as 18 in Los Angeles County.

Preparation of this SHMP included a comprehensive review of approved county LHMPs to determine the following:

- Hazards assessed by each county
- How each hazard was ranked based on its impacts as defined by each planning process
- Hazard ranking by county
- Exposure statistics for each hazard assessed for analysis in this SHMP

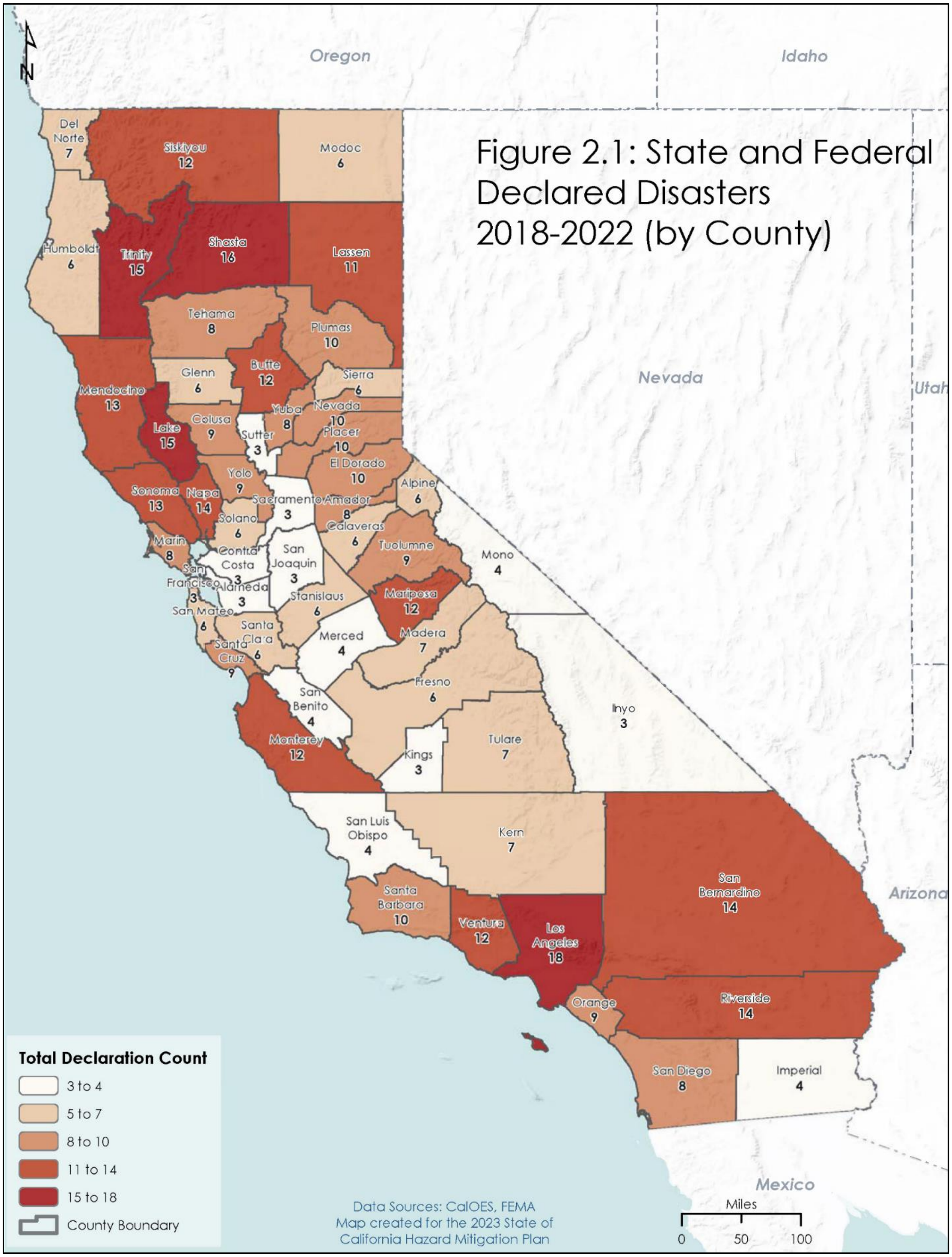
2.5.1. Hazard Risk Assessments

This review identifies high-impact hazards for each of California's 58 counties based on risk assessments that follow a standardized process as required under 44 CFR 60.3. All plans reviewed have been approved by FEMA, so it is assumed that each planning effort met FEMA requirements for extent, location, and impact.

In developing LHMPs, each jurisdiction identified the hazards of greatest concern to its jurisdiction based on factors such as impact, history, probability, and local knowledge. Most plans identify significant "hazards of concern"—rated as high, medium, or low risk—as well as lesser "hazards of interest"—described but not given a full risk assessment and rating.

Different plans use different wording to identify hazards. The SHMP identifies several hazards in addition to the 19 hazards identified in county hazard mitigation plans. The SHMP's hazards of concern include natural and human-caused hazards, which are not required by FEMA for Standard or Enhanced State Planning Requirements. These hazards were identified through coordination with the Hazard Groups and Working Groups, as required through legislation.

Figure 2-1. State and Federal Declared Disasters, 2018 – 2022, by County



Expanding the types of hazards profiled and assessed in the SHMP ensures that the State comprehensively understands potential statewide risk. However, local jurisdictions are not required to include all the hazards of concerns identified in the SHMP.

The hazards of concern from the 58 county hazard mitigation plans in California can be summarized as follows:

- Agricultural Hazards (includes pest infestation for plants and livestock)
- Avalanche
- Climate Change
- Coastal Hazards (includes erosion and sea-level rise)
- Dam Failure
- Dam/Levee Failure
- Drought
- Earthquake
- Flood
- Levee Failure
- Mass Movement (includes landslides, mudslides, and debris flow)
- Other Weather (includes freeze, extreme heat, and extreme cold)
- Seiche Wave
- Severe Weather (includes hail, high winds, winter storms, and fog)
- Subsidence
- Tornado
- Tsunami
- Volcano
- Wildfire

Figure 2-2 indicates the number of counties listing each hazard as a hazard of concern and the number that rate the hazard as a high, medium, or low risk. Table 2-2 lists what each county identified as its high-risk hazards and when FEMA approved each plan.

The highest-ranked hazards in the LHMPs were wildfire, earthquake, and flood, all of which were evaluated in all but one county plan (a different county for each of the three). The counties assessing these hazards ranked them as follows:

- **Wildfire**—48 counties identified it as high risk, and seven counties identified it as medium risk
- **Earthquake**—42 counties identified it as high risk, and twelve counties identified it as medium risk
- **Flood**—38 counties identified it as high risk, and 16 counties identified it as medium risk

Figure 2-2. Identified Hazards From Local Plans

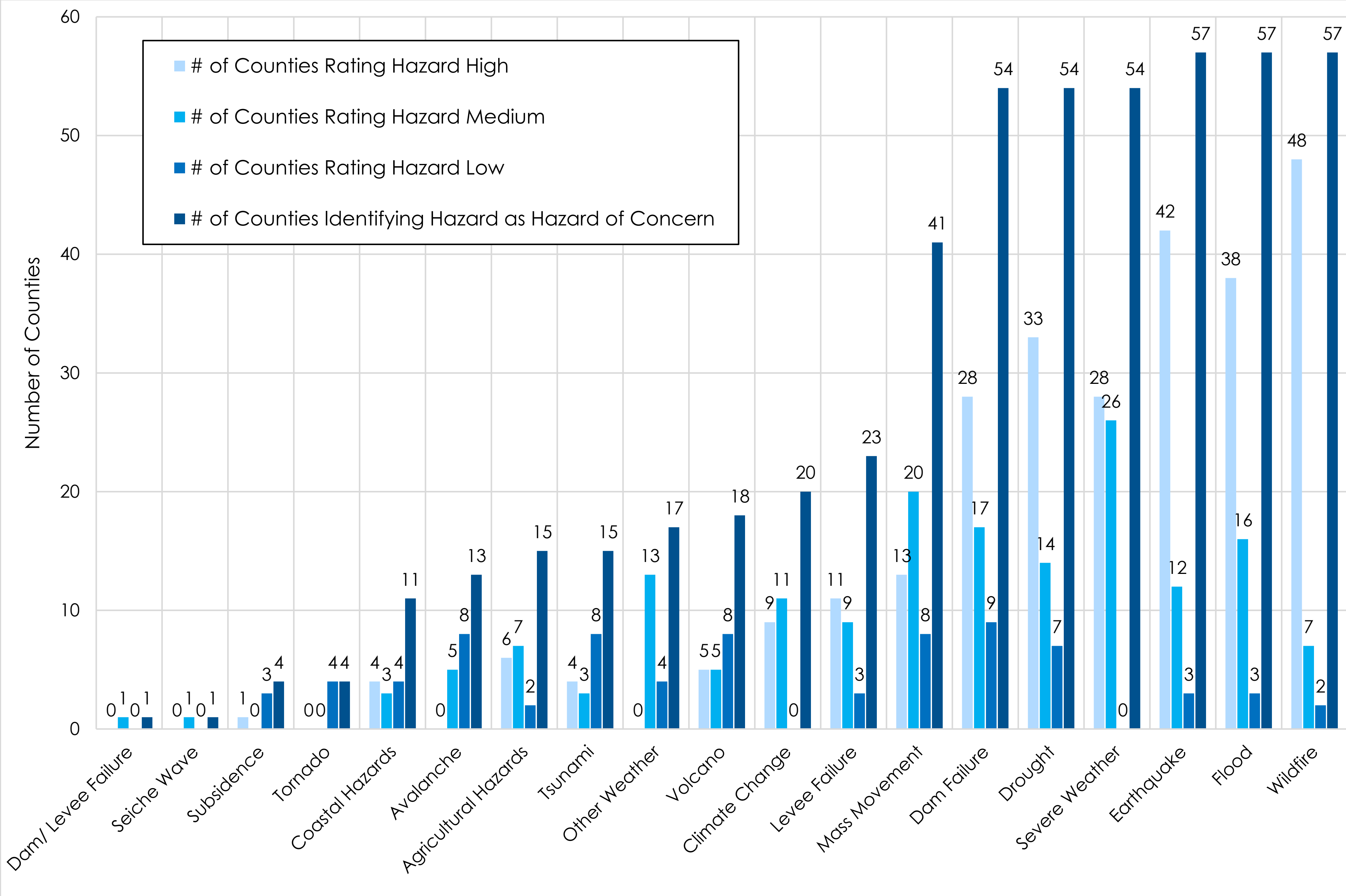


Table 2-2. High Hazards Listed by Counties in California

County	High-Risk Hazards*
Alameda	dam failure, wildfire, earthquake, drought, flood, landslide, tsunami
Alpine	wildfire, severe weather, drought
Amador	earthquake, wildfire, flood, dam failure mass movement, severe weather
Butte	dam failure, wildfire, earthquake, flood, levee failure, mass movement, drought, severe weather
Calaveras	wildfire drought, severe weather
Colusa	flood, drought, dam failure, levee failure, wildfire, agricultural, volcano, climate change
Contra Costa	earthquake, mass movement
Del Norte	earthquake, tsunami
El Dorado	wildfire, flood, severe weather, drought, dam failure, earthquake
Fresno	earthquake, dam failure, wildfire, flood, levee failure
Glenn	wildfire, drought, levee failure, flood
Humboldt	earthquake, wildfire, severe weather
Imperial	earthquake, flood, dam failure, severe weather, volcano
Inyo	wildfire, severe weather, flood, earthquake, drought
Kern	wildfire, severe weather, flood, earthquake, drought
Kings	drought, earthquake, wildfire, dam failure, flood
Lake	drought, earthquake, severe weather, wildfire, volcano, agricultural hazards
Lassen	earthquake, wildfire, flooding, levee failure, drought
Los Angeles	earthquake, wildfire, dam failure, drought, mass movement, climate change
Madera	wildfire, flood, dam failure, agricultural hazards, climate change, drought, earthquake, mass movement, severe weather
Marin	earthquake, dam failure, mass movement, flood, wildfire
Mariposa	wildfire, climate change
Mendocino	earthquake, wildfire, dam failure, flood, drought, severe weather
Merced	severe weather, flood, levee failure, drought
Modoc	drought, earthquake, wildfire, agricultural hazards, dam failure, mass movement, severe weather, volcano
Mono	wildfire, severe weather
Monterey	drought, earthquake, wildfire, severe weather, flood
Napa	wildfire, severe weather, drought, earthquake, flood, climate change, mass movement
Nevada	wildfire, dam failure, flood, agricultural hazards, drought, earthquake, climate change, mass movement, severe weather
Orange	earthquake, dam failure, levee failure
Placer	wildfire, severe weather, flood, drought, dam failure, earthquake, agricultural hazards
Plumas	wildfire, dam failure, earthquake, flood
Riverside	earthquake, wildfire, floods, pandemic, extreme weather
Sacramento	dam failure, flood, wildfire, levee failure

County	High-Risk Hazards*
San Benito	earthquake, severe weather, wildfires
San Bernardino	wildfire, flood, earthquake
San Diego	drought, earthquake, extreme heat, flood, sea-level rise, wildfire, climate change
San Francisco	Earthquake
San Joaquin	floods, dam-related incidents, drought, wildfire
San Luis Obispo	wildfire, mass movement, earthquake flood, dam failure, drought
San Mateo	earthquake, mass movement, coastal hazards
Santa Barbara	wildfire, drought and water shortage, earthquake, extreme heat and freeze
Santa Clara	earthquake, flood, severe weather
Santa Cruz	earthquake, wildfire, drought, flood, tsunami, climate change, coastal erosion, coastal storm, debris flow, landslide, liquefaction
Shasta	flood, wildfire, severe weather, earthquake
Sierra	wildfire, flood, earthquake
Siskiyou	severe weather, wildfire, food
Solano	wildfire, flood, earthquake, drought, extreme weather, slope failure
Sonoma	mass movement, earthquake, wildfire
Stanislaus	drought, extreme temperatures, severe weather
Sutter	levee failure, flood, dam failure, drought and water shortage
Tehama	wildfire
Trinity	drought, flood, severe weather, wildfire, dam failure
Tulare	dam failure, drought and water shortage, flood, wildfire
Tuolumne	wildfire, earthquake
Ventura	dam failure, drought, earthquake, flood, landslide and mass movement, sea-level rise and coastal erosion, severe storms, heat, freeze, tsunami, wildfire
Yolo	dam failure, levee failure, flood, severe weather, volcano, wildfire, earthquake, drought, subsidence, climate change
Yuba	levee failure, flood, wildfire

* Based on the most recently approved LHMP as of April 18, 2023. This table reflects natural hazards only.

In their mitigation planning initiatives, local jurisdictions recognize that a hazard can cause secondary and sometimes tertiary hazard impacts. For example, a destructive wildfire can burn away all the hillside vegetation. When winter weather occurs, the lack of vegetation that usually holds soil and slopes in place may result in a landslide. This possible occurrence has also been identified in State mitigation planning efforts.

Understanding the ranking of hazards at the local level informs the identification and ranking of hazards in the SHMP. Local hazard mitigation plans and the SHMP are integrated to ensure the SHMP serves as a resource for planning data and establishes shared statewide risk reduction goals. Local plans inform the SHMP's Risk Assessment and mitigation priorities by providing insight into how hazards are experienced at the local level and identifying local concerns. Integration of these planning efforts supports the better alignment of mitigation actions and ensures the SHMP, and the local plan may support future mitigation grants.

To achieve this, Cal OES will create a database to track trends in prioritizing hazards, baseline equity data, and local mitigation action measures and strategies to reduce risk and vulnerability in California communities. The Cal OES LMP Unit will use this database to implement the 2023 FEMA Local Hazard Mitigation Planning Policy Guide. As the LMP Unit continues to conduct technical assistance and training sessions on the new guidance, Cal OES staff will highlight best practices in reporting hazard vulnerability data in local risk assessments so that Cal OES may more easily monitor vulnerability and roll up data into future SHMP updates.

Within California, the local identification and ranking of wildfire, flood, and earthquake affirm the State's perspective of these hazards as the "Big Three"— historically the most frequent and impactful hazards affecting the State. Additionally, a hazard may be more regionally focused, such as snow avalanche, and therefore not identified in all local plans. In these instances, the localized hazard is included in the SHMP to provide a comprehensive statewide Risk Assessment and ensure data related to regional hazards is still available to local jurisdictions.

2.5.2. LHMP Mitigation Actions

To further evaluate the hazards of concern addressed by LHMPs, Cal OES reviewed the mitigation actions identified in all the county plans and mapped the actions to the hazards that they address. This review found that over 70 percent of actions in LHMPs in the State address at least one of the flood, earthquake, or wildfire hazards (the "Big Three"). Table 2-3 shows the results of this analysis.

Table 2-3. Mitigation Actions by Hazard in LHMPs

Hazard	Actions Addressing the Hazard		Counties with Actions Addressing the Hazard	
	Number of Actions	% of All Actions Across LHMPs	Number of Counties	% of All Counties
All Hazards/Multi-Hazard	921	40.82%	55	94.83%
Wildfire	367	16.27%	48	82.76%
Earthquake	166	7.36%	43	74.14%
Flood	367	16.27%	41	70.69%
Drought	96	4.26%	30	51.72%
Dam Failure	49	2.17%	26	44.83%
Severe Weather	60	2.66%	23	39.66%
Climate Change	54	2.39%	17	29.31%
Extreme Temperatures	22	0.98%	14	24.14%
Landslide	35	1.55%	12	20.69%
Tsunami	11	0.49%	7	12.07%
Avalanche	13	0.58%	6	10.34%
Agricultural Hazards	9	0.40%	6	10.34%
Slope Failure	8	0.35%	4	6.90%
Levee Failure	32	1.42%	3	5.17%
Soil Hazards	9	0.40%	3	5.17%
Volcano	5	0.22%	3	5.17%
Severe Wind	7	0.31%	3	5.17%
Erosion	4	0.18%	2	3.45%
Subsidence	2	0.09%	2	3.45%
Sea-Level Rise	14	0.62%	2	3.45%
Debris Flow	2	0.09%	1	1.72%
Seiche	1	0.04%	1	1.72%
Fog	1	0.04%	1	1.72%
Tree Mortality	1	0.04%	1	1.72%

3. California State Profile

California is the third-largest U.S. state geographically and the largest by population. With Oregon and Washington, it makes up the western border of the contiguous United States. Known as the Golden State, it is bordered by Oregon to the north, Nevada to the east, Arizona to the southeast, Mexico to the south, and the Pacific Ocean to the west.

The State is filled with valleys, lakes, rivers, mountains, volcanos, beaches, forests, and deserts. California's diverse landscape includes 840 miles of coastline; nine national parks; 279 State parks; three desert regions; giant redwood and sequoia forests unique to the State; mountain ranges creating the important Central Valley; world-famous wine regions; major metropolitan areas in the Bay Area, Los Angeles, and San Diego; and significant agricultural lands predominantly throughout the Central Valley that supply more than half of the fruits, vegetables, and nuts grown in the United States.

California is the most biodiverse state in the continental U.S. and one of the most biodiverse regions in the world (CDFW 2023). The rich biodiversity of the State contributes to the quality of life, environment, and economy of the State. However, that biodiversity is also at risk to the hazards impacting the State. Biodiversity loss can be due to climate change and other disasters. The State has experienced a 20 percent decline in native species, and over 600 additional species are at risk of extinction; in addition, 90 percent of the State's coastal wetlands and inland wetlands have been lost, along with 99 percent of riparian areas and native grasslands (NRDC 2020). Protecting fragile species and landscapes is crucial to effectively utilizing nature to combat impacts from hazards.

Understanding the State's unique characteristics provides a foundation for identifying risks related to the natural hazards—based on California's physical geography—and the State's assets, which may be viewed as targets and increase the risk of human-caused threats. Discussion of the history and governance of California provides details on how the State has historically approached reducing risk and building resilience. The State profile provides a foundational understanding of these factors to assist with understanding the impacts that hazards may have on the State's people, environment, infrastructure, and economy.

Information from the State profile also is used to inform the Risk Assessment. Evaluating development trends, population and demographic changes, and the State's assets and capabilities provides insight into how vulnerability may evolve over a period of time. Identifying geographic areas of increased risk, equity priority communities, and future land use changes guides the development of the mitigation strategy to consider how future changes may increase or decrease vulnerability.

3.1. HISTORY

California's history serves as the background to understanding how risk has evolved. Vulnerability may be increased or decreased based on land use, governance, and allocation and use of resources.

The area now known as California has always been characterized by diversity. California is the original home of numerous Tribal Nations, many of which still reside in the State despite centuries of genocide and occupation. At the time of European colonization, California was one of the most linguistically diverse areas of the world, with 20 percent of all the languages spoken in North America present and with population densities among the highest of any American region north of what is now known as Mexico (Lightfoot and Parrish 2009). Like today, the most populous settlements of Native California tended to be in and around the coastal areas that provided the most plentiful resources, with areas away from the coast becoming less densely populated. However, desert, mountainous, and valley areas were not without settlement (Codding and Jones 2013).

California's Native populations helped create and shape much of the ecosystem diversity by employing various kinds of cultural activities and land management practices based on traditional ecological knowledge, such as prescribed burning, which helped prevent catastrophic wildfires and other ecological consequences (K. Anderson 2013, Lightfoot and Parrish 2009, Risling Baldy 2013, Tushingham, et al. 2019). Colonization by Europeans led to many tumultuous changes that still have sociological and ecological consequences today.

Spain claimed the unceded area in the mid-1760 and divided the region into Alta California and Baja California as provinces of New Spain, now known as Mexico.

Following this, multiple missions, presidios, and pueblos were established in what are now California's major cities, including San Francisco, Los Angeles, San Diego, San Jose, Monterey, Santa Cruz, and others.

Traditional Ecological Knowledge

Traditional ecological knowledge, also called by other names, including indigenous knowledge or native science, refers to the evolving knowledge acquired by indigenous and local peoples over hundreds or thousands of years through direct contact with the environment and generational cultural transmission. This knowledge is specific to a location and includes but is not limited to the relationships between plants, animals, natural phenomena, climate, landscapes, and timing of events that are used for lifeways (e.g., food resources, tools, clothing resources, ceremonial regalia, housing, etc.). The following are possible examples of land management practices based on traditional ecological knowledge:

- Prescribed burning
- Pruning trees, bushes, and other vegetation
- Protection, conservation, and recovery of endangered species
- Analysis of ecosystem change and application of data to facilitate human adaptations

Source: (U.S. Fish and Wildlife Service n.d.)

In the aftermath of their encounters with the Spanish, the Mexicans, and mass immigration and widespread genocide with the beginning of the "Gold Rush" and statehood, the Native American population was cut off from their traditional life, land, and resources, but not without resistance, from some more than others (Burris 2020, State Parks 2022, Office of Governor 2019, Clarke 2016a). These changes led to an increased risk of catastrophic fire due to the prohibition of prescribed burning and, subsequently, flood, drought, famine, and violent conflict. This was due to the consequences of the shifting of the land and its resources from being managed by traditional ecologic knowledge to a land of mining and industrial farming and herding with non-native plants and animals (Lightfoot and Parrish 2009, Office of Governor 2022a, UC 2022, National Park Service 2022).

When California became the 31st U.S. state in 1850, the area experienced a large influx of non-Native populations and businesses, including the construction of the State's first railroad connecting Sacramento to Omaha, Nebraska, completed in 1869. The railroad was built primarily by Chinese immigrant labor forces and other workers from various ethnic and cultural backgrounds (NPS 2022, B. Voss 2005, B. Voss 2015).

As the population grew, so did the need for water. Large infrastructure projects moved water from within the State and outside it—the largest water sources for California are the California Delta system and the Colorado River—and built reservoirs and canals. This allowed for the growth of agriculture in the Central Valley but also created a flood risk from dams.

Today, California is the most populous state in the United States and one of the world's largest producers of agricultural resources. In addition to agriculture, California has one of the most diverse economies in the nation, dealing in technology, entertainment, tourism, manufacturing, health care, construction and development, and professional sports, among other sectors.

The State’s past settlement patterns and economy are still reflected in modern-day land use. Early settlement areas have continued to grow and have high population densities, so a larger percentage of the population may be exposed to hazards. In areas where the population has historically been less dense, and agriculture is the dominant land use, the population's exposure is decreased, but potential impacts on the agricultural economy increase.

The experiences of Native populations of California and other marginalized populations, and the history of European colonization, are central to understanding the State’s complicated and often oppressive past, but it is also the key to developing an inclusive and resilient future.

3.2. GOVERNMENT

California gained statehood through the Compromise of 1850 and was the first declared U.S. state on the west coast (CDPR n.d.). The current capital city is Sacramento, but past capitals included Monterey, San Jose, Vallejo, Benicia, and San Francisco (California State Library n.d.). The State comprises 58 counties and 482 incorporated cities. California also has one city-county, the City and County of San Francisco (CSAC n.d.). California is home to 109 federally recognized Tribal Nations, and several non-federally recognized Tribal Nations.

The multiple levels of government result in varying degrees of responsibility and authority for carrying out hazard mitigation planning and actions. This creates a need for strong inter-jurisdictional coordination and support from the State to ensure success at the city, county, and Tribal Nation levels. Additionally, inter-jurisdictional coordination is often required to address hazards at a meaningful scale rather than strictly based on jurisdictional boundaries.

3.3. GEOGRAPHY AND ENVIRONMENT

California's geography and environment have been shaped by many forces that present hazards today, and the large area and landscape diversity present challenges in developing plans for statewide hazard mitigation. The State's diverse landscape includes a long coastline, lakes, rivers, mountains, volcanos, valleys, desert areas, giant redwood and sequoia forests, vineyards, major metropolitan areas, and major agricultural fields.

3.3.1. Topography and Geology

California's topography and geology vary significantly. Elevations range from Mount Whitney's 14,505 feet above sea level—the tallest peak in the continental United States—to Badwater Basin's 282 feet below sea level—the lowest point in North America—with less than 100 miles between the two landmarks. California has one of the longest coastlines of any U.S. state, and the San Francisco Bay and Sacramento-San Joaquin Delta stretch far inland, making much of the geographic interior of the State near or even below sea level.

Geologic forces are active throughout California, resulting in highly varied topography and geology that are often categorized as distinct regions. The Coastal Ranges, the Great Valley, and the Sierra Nevada mountains cover much of the State, running roughly 400 miles from north to south and each spanning over 50 miles east to west. The Coastal Ranges run along the State's coastline from the Oregon border to Santa Barbara County, separated into two portions by San Francisco Bay. The Great Valley of the Sacramento and San Joaquin Rivers lies to the east, and further east lies the Sierra Nevada mountains. The Klamath Mountains, the Cascade Mountains, and the Modoc Plateau stretch from the northern end of the Great Valley to the Oregon border. Southern California comprises the Transverse and Peninsular Ranges along the coast and the Mojave and Colorado Deserts farther inland.

These topographic and geologic variations are due to geologic forces, including faulting, erosion, and volcanism, which continue today:

- The San Andreas Fault System extends over 800 miles from Mendocino in the northwest to the Salton Sea in the southeast. Additional faults, including the

Hayward Fault, run nearly parallel to the San Andreas Fault in the San Francisco Bay area.

- Rivers transport rainfall and snowmelt across the State and erode land, depositing sediment in alluvial fans at the foot of steep mountains, deltas, or offshore environments where it can be re-deposited in beaches.
- The ocean has shaped California's coastline, eroding the land to create sea cliffs such as in the Lost Coast, Big Sur, and Palos Verdes.
- Landslides and similar flows also erode the land, especially in steeper terrains. Events like wildfires, heavy rains, and earthquakes can trigger these flows.
- California's Pacific coastline borders the Ring of Fire, a string of volcanoes and sites of significant seismic activity. Inland, California has eight potentially active volcanoes.

Topography in California also influences weather. For example, steep mountains enable fast, dry, downslope winds with different local names—most notably Santa Ana winds in Southern California and Diablo Winds in Northern California. The speed and dryness of these types of wind make them an extreme concern for wildfires. Additionally, elevation influences weather patterns and plant type, impacting hazards such as extreme temperatures and wildfires.

These geologic processes that created the current geographic landscape of the State over millions of years also can create disasters in California and present a risk to human life and property today. These geologic processes contribute to the "Big Three" hazards: earthquake, fire, and flood. Due to the physical characteristics of California, some of the risks posed by those and other hazards will always be present. Mitigative measures can be taken to reduce and lessen impacts, but the natural occurrence of contributing factors such as shifting tectonic plates, vast forested areas, and extensive waterways means there will also be residual risks.

3.3.2. Hydrography and Hydrology

Water plays a vital role in California's natural and human landscapes. Natural features provide protection from natural hazards but are also vulnerable to impacts from hazards. Natural systems, such as wetlands and estuaries, provide multiple co-benefits to the environment and people. These natural systems can improve air quality, reduce impacts from extreme heat, serve as storage for rainwater and flooding, provide recreational and exercise opportunities for people, and contribute to creating species habitats (Kingsley 2019).

Potable drinking water in California highlights the nexus of mitigation, critical services, and natural hazards. In addition to in-state resources, California relies on water delivered to the State via built infrastructure, such as canals and aqueducts. California's built water infrastructure is vulnerable to natural and human-made hazards, including earthquakes, wildfires, and terrorism.

The most significant external water source is the Colorado River, which forms the California-Arizona border (Stern 2022). It currently provides up to one-third of the drinking water for Southern California and significant irrigation water for the region (E. Hanak 2018). Under the Law of the River, California is entitled to 4.4 million acre-feet of water from the Colorado River, which arrives through the Colorado River Aqueduct and All-American Canal (Stern 2022). Multiple jurisdictions manage numerous other aqueducts, canals, and ditches to move water around the State. The water infrastructure providing this critical water supply to California's population is vulnerable to impacts from natural disasters. Earthquakes can damage pipes and interrupt potable water services to one-third of the State's population.

Water accumulates in natural lakes and artificially dammed reservoirs, providing recreational opportunities and hazard potential. Major water bodies include the Salton Sea, Lake Tahoe, Clear Lake, Mono Lake, and Owens Lake. Statewide, 240 large reservoirs account for 60 percent of the State's water-storage capacity (A. Escriva-Bou 2019). All water bodies are vulnerable to seiches, which are large tsunami-like waves that can endanger shoreline communities and infrastructure.

Major dams include Shasta Dam, which creates the largest-volume reservoir in California, and Oroville Dam, the tallest dam in the United States. Dams, like other forms of water infrastructure, are susceptible to hazards, including earthquakes and human-caused events. Degradation or overfilling from extreme precipitation or snowmelt can cause devastating flooding.

Groundwater is a vital water resource in California, threatened by the State's prolonged drought. In an average year, groundwater accounts for 38 percent of the State's total water supply. During dry years, groundwater accounts for over 45 percent of the statewide annual supply (DWR n.d.). Many communities rely on groundwater for up to 100 percent of their water supply. Removing groundwater faster than it is recharged can lead to groundwater depletion, which can lead to subsidence that can impact infrastructure at the surface.

3.3.3. Regional Climate

Evaluating current and future climate conditions establishes a baseline for the potential intensity, probability, and magnitude of several natural hazards. As the climate continues to change over the next several decades, the resulting impacts from hazards will also change. The climate of California varies widely, from arid desert to highland and timberline, due to significant variations in latitude, elevation, and proximity to the Pacific Coast (California Department of Fish and Game 2003).

California's most common climate classification is Mediterranean under the Köppen climate classification, characterized by hot, dry summers and cool, wet winters. The Mediterranean classification is most commonly associated with locations between about 30° and 45° latitudes north and south of the equator and on the western sides of continents. Different sub-classifications of the Mediterranean climate exist in California's coastal regions, the Sierra Nevada foothills, and much of the Central Valley. Also common across the State are arid, semi-arid, and steppe climate classifications, which occur in the southern Central Valley and Southern California, except for the coastal mountains. These hotter, drier climates extend north inland beyond the Mojave Desert. The remainder of the State in the northeast is classified as cool continental, except for the Sierra Nevada, which gets even colder and is classified as highland/timberline. All of California's climates present opportunities for severe weather, including extreme heat or cold and high winds. Almost all present conditions for wildfires.

The average annual statewide precipitation is 23 inches, with significant variation from year to year—from as low as 7.9 inches in 2013 to as high as 42.5 inches in 1983. Fifty percent of the annual precipitation occurs from December to February (OEHHA 2019). Much of the year-to-year variability in precipitation has been linked to storms called "atmospheric rivers." Atmospheric rivers carry narrow bands of water vapor up to 1,000 miles long and several hundred miles wide. On average, atmospheric rivers that hit California provide 30 to 50 percent of the State's annual precipitation and 40 percent of the Sierra Nevada snowpack. The absence of atmospheric rivers can contribute to drought conditions, while too many atmospheric rivers can lead to catastrophic flooding, such as the Great Flood of 1862 and the atmospheric river 1,000 storm (ARkStorm) megaflood scenario (Porter 2011). The ARkStorm megaflood scenario models a 1% annual chance storm from an atmospheric river, which would result in $725 billion in damage and widespread flooding, landslides, and extended disruption of critical services (USGS 2018b).

Locally, annual precipitation varies from less than 3 inches in Death Valley to more than 100 inches near the City of Eureka (NCEI n.d.-a). Precipitation tends to be low during summer and highest during winter. Different regions of the State may be more prone to drought or flood due to the variability of precipitation throughout the year.

California's vast and diverse land area contributes to the State's ranging climate. As a result of the varying climate, it is necessary to evaluate current and future risk that will be influenced by changes in climate.

3.4. POPULATION

Population and demographic data provide baseline information about California's residents. This baseline data and information may be used to identify the percentage of the population exposed to a hazard and identify communities prone to higher impacts and vulnerabilities from natural hazards.

3.4.1. Statewide Trends

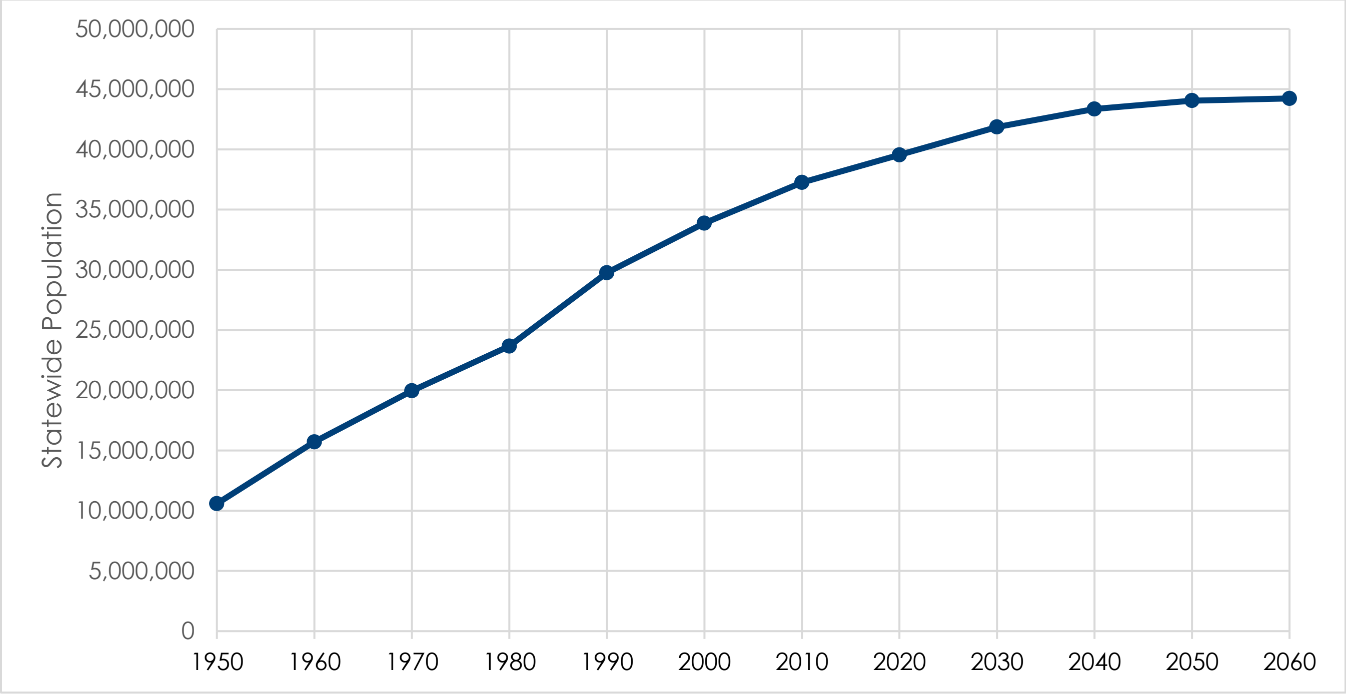
The California Department of Finance (DOF) publishes population estimates annually. Combined with U.S. Census Bureau decennial census data, these estimates show that the State's population has increased significantly in the past seven decades. However, while the population is estimated to continue to grow, it will slow down drastically, as shown in Figure 3-1.

The State's population is dynamic and composed of several subgroups and communities that comprise large percentages of the total statewide population. California saw a 3.32 percent increase in population between 2012 and 2022, but Census data show a decrease in the State's population from 39,648,938 in 2020 to 39,185,605 in 2022.

DOF attributes the population decrease to the following factors (DOF 2022):

> "…Baby Boomers [aging], and fertility declines among younger cohorts, the continuing slowdown in natural increase—births minus deaths—underlies the plateauing of the state's population growth. The addition of COVID-19-related deaths, federal policies restricting immigration, and an increase in domestic out-migration further affected population totals. Overall growth was also affected by continuing federal delays in processing foreign migration: while last year saw positive immigration (43,300), the level was below the average annual rate of 140,000 before the pandemic."

Figure 3-1. Historical Statewide Population



Sources: (DOF 2023a) and (DOF 2023)

Although the population is estimated to stabilize in the coming decades, California's population will continue to represent a significant portion of the total U.S. population.

3.4.2. Regional Trends

The number of people in the State may remain relatively the same, but where people live, work, and visit could continue to change. In addition to reviewing population changes, it will be critical to evaluate development trends to determine where people are in comparison to hazard-prone areas.

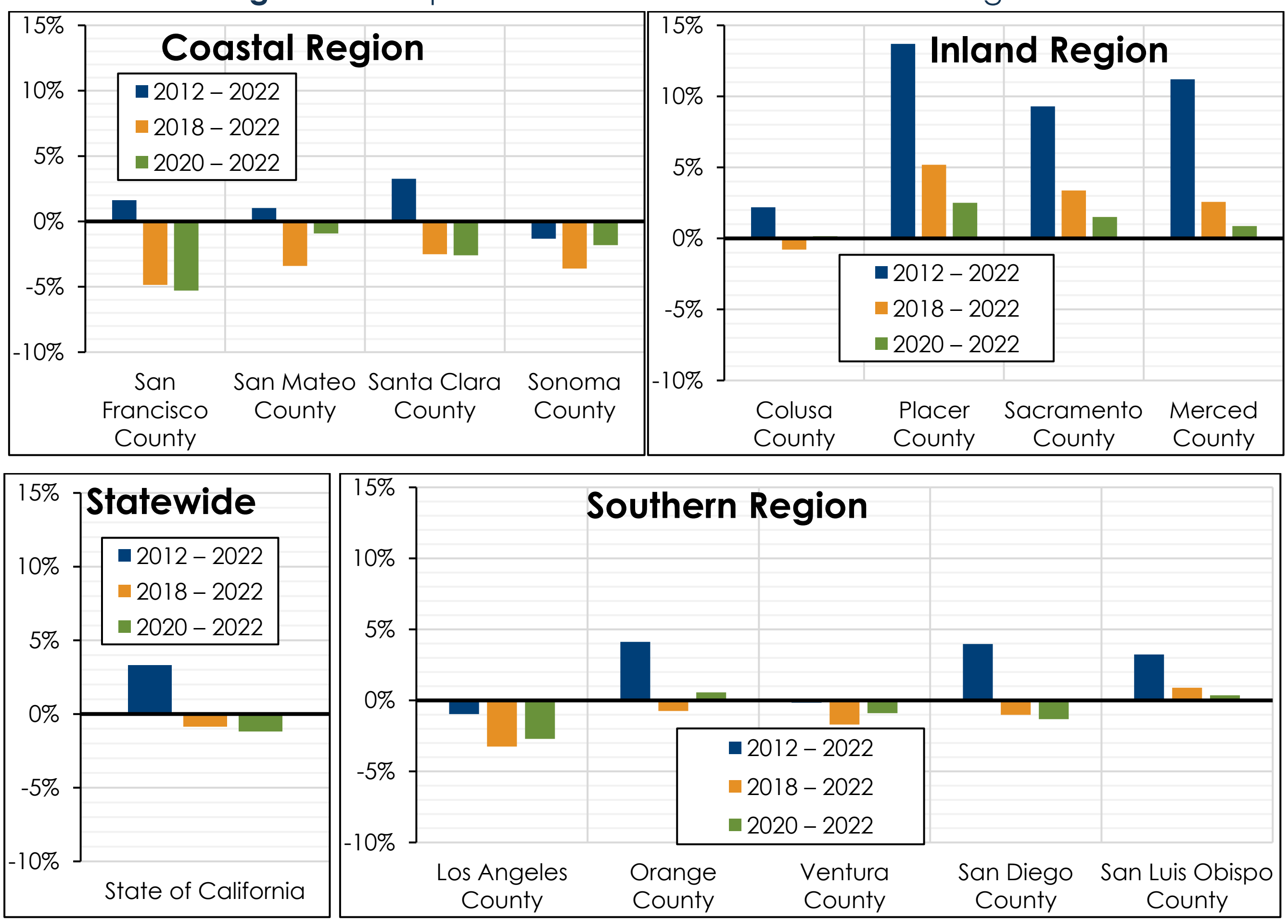
Most counties experienced their highest population count between 2019 and 2020. Between 2021 and 2022, 34 counties saw a decrease in population, while 24 experienced an increase. The Los Angeles metropolitan area (Los Angeles, Orange, and Ventura Counties), San Diego County, and the San Francisco Bay Area (Marin, Sonoma, Napa, Solano, Contra Costa, Alameda, Santa Clara, and San Mateo Counties), have all experienced a population decline. Outside the larger metropolitan areas, counties such as Sacramento, Merced, Colusa, San Luis Obispo, Placer, and others have witnessed population growth. Other counties have remained relatively flat.

Figure 3-2 highlights the population change in selected regions over the following time periods:

- 2012 – 2022: 10 years preceding this Plan update (two Hazard Mitigation Plan cycles)
- 2018 – 2022: time from the 2018 Plan to this Plan
- 2020 – 2022: reflective of recent downward population trend in major areas

Los Angeles continues to be the most populated county, with 10,163,139 people in 2019. San Diego County's population peaked at 3,31,279 in 2019, and Orange County peaked that year at 3,185,378.

Figure 3-2. Population Growth Trends in Cal OES Regions



Source: (DOF 2023)

3.4.3. Equity Priority Populations

California is committed to pursuing equitable outcomes for all populations by delivering hazard mitigation programs and actions. Decision makers must first identify equity priority populations that are underserved or historically marginalized, have access or functional needs, or face additional barriers when preparing for, responding to, or recovering from a disaster. Such information can assist communities in achieving authentic engagement of these populations in the planning process and ensuring that projects and benefits prioritize these populations within communities. This includes identifying populations based on demographic information such as age, disability, income, and race and identifying communities where data may not be as readily available, such as refugee and undocumented populations.

Examples of Equity Priority Communities

- Children (aged five years and under) depend on others to safely access resources during emergencies.
- Older adults (typically 65 and over) are more likely to lack the physical, technological, and economic resources necessary to respond to hazard events.
- Economically disadvantaged populations will likely lack the resources to adequately prepare for and respond to hazards.
- People with physical, developmental, or intellectual disabilities may be less able to receive, process, or respond to emergency information and warnings.
- Individuals with limited English proficiency may have difficulty understanding the information being conveyed to them. Cultural differences can also complicate how information is conveyed to populations with limited English proficiency.

Note: These definitions are established by the Centers for Disease Control and Prevention (CDC); the CDC refers to these populations as socially vulnerable populations.

Available Socioeconomic Data Sets

Several resources provide demographic and socioeconomic data for California. Each has useful data and gaps; the SHMP Equity Working Group determined the most beneficial data for the SHMP. Other data sources may be more applicable based on the particular objectives or planning areas of other initiatives. Below is a non-exhaustive list of datasets reviewed by the Equity Working Group:

- **Center for Disease Control and Prevention (CDC)/Agency for Toxic Substances and Disease Registry Social Vulnerability Index (SVI)—**Identifies areas of vulnerability based on 15 indicators ranging across household composition, minority status, and access to transportation

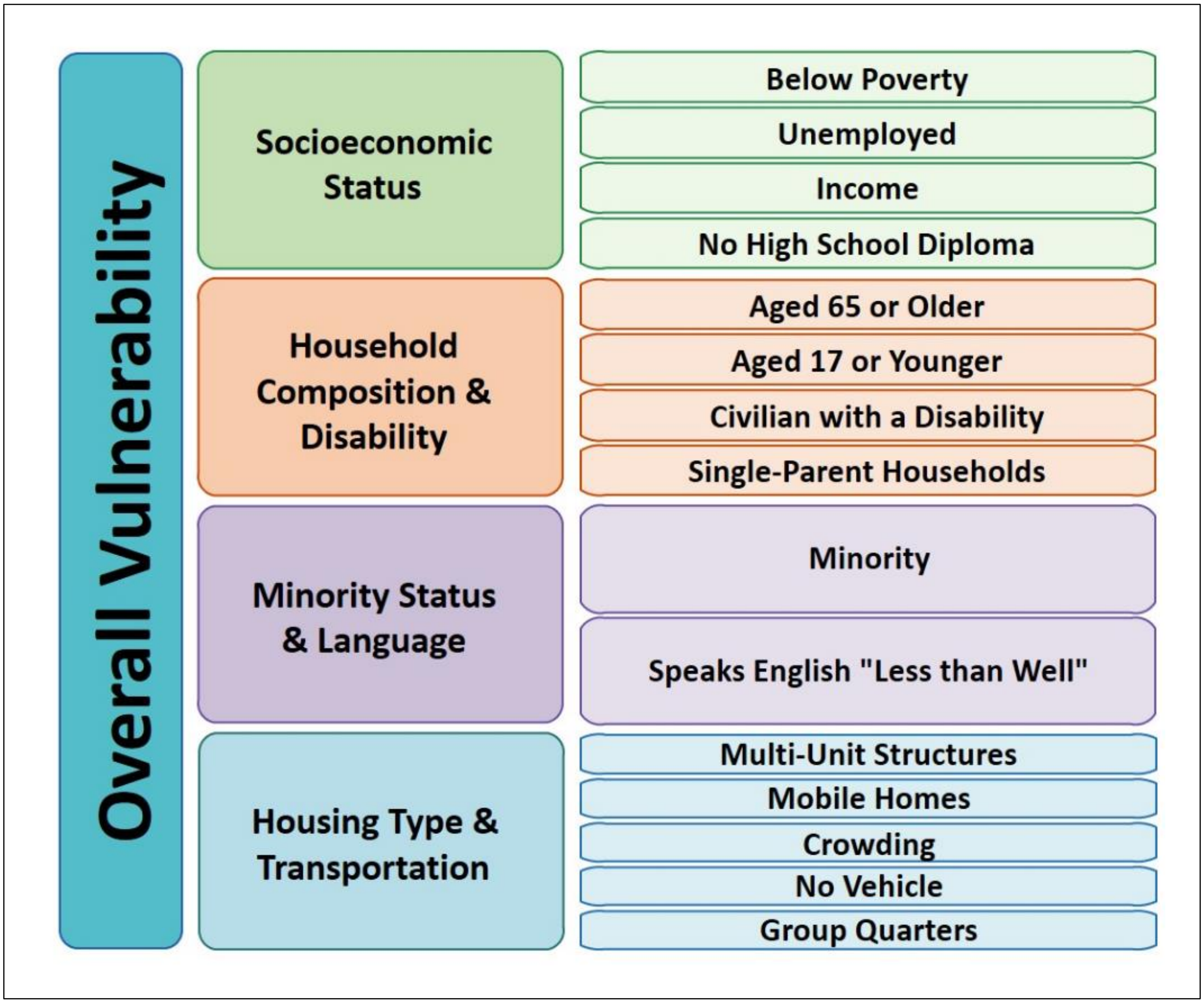
- **Hazards and Vulnerability Resilience Institute Social Vulnerability Index—**Measures the social vulnerability of all U.S. counties to environmental hazards. The index uses 29 socioeconomic variables
- **Hazards and Vulnerability Resilience Institute Base Resilience Indicators for Communities—**Considers six broad categories of community disaster resilience, including social, economic, community capital, institutional, infrastructural, and environmental at the county level
- **U.S. Environmental Protection Agency (EPA) EJScreen—**A national dataset that combines environmental and demographic socioeconomic indicators. The tool uses several indicators, including 12 environmental, seven socioeconomic, 12 environmental justice, and 12 supplemental indices
- **FEMA Resilience Analysis and Planning Tool—**Includes over 100 preloaded layers, including community resilience indicators from peer-reviewed research, the most current census demographic data, infrastructure data, and data on weather, hazards, and risk
- **FEMA National Risk Index (NRI)—**Ranks risk based on 18 natural hazards
- **CalEnviroScreen**—Identifies California communities most affected by pollution, particularly in vulnerable socioeconomic areas
- **Healthy Places Index**—Combines 25 community characteristics, such as access to healthcare, housing, and education, into a single indexed score. The healthier a community, the higher the score

Index Selected for Risk Assessment in This SHMP

For this Plan, the CDC's 2018 SVI was identified by the SHMP Equity Working Group as the most appropriate and authoritative dataset to identify geographic areas where efforts can be prioritized to ensure equitable outcomes from mitigation planning and actions. At the time of this direction and analysis, the 2020 SVI updates had not yet been made public. The planning team adjusted the 2018 data to account for more current population data, as described in Appendix G.

The SVI combines 15 social factors contributing to social vulnerability, as shown in Figure 3-3. Index values are based on a percentile ranging from 0 to 1, with higher values indicating greater vulnerability. Appendix G describes the development of SVI data used in the Risk Assessment for this SHMP.

Figure 3-3. Factors Included in SVI



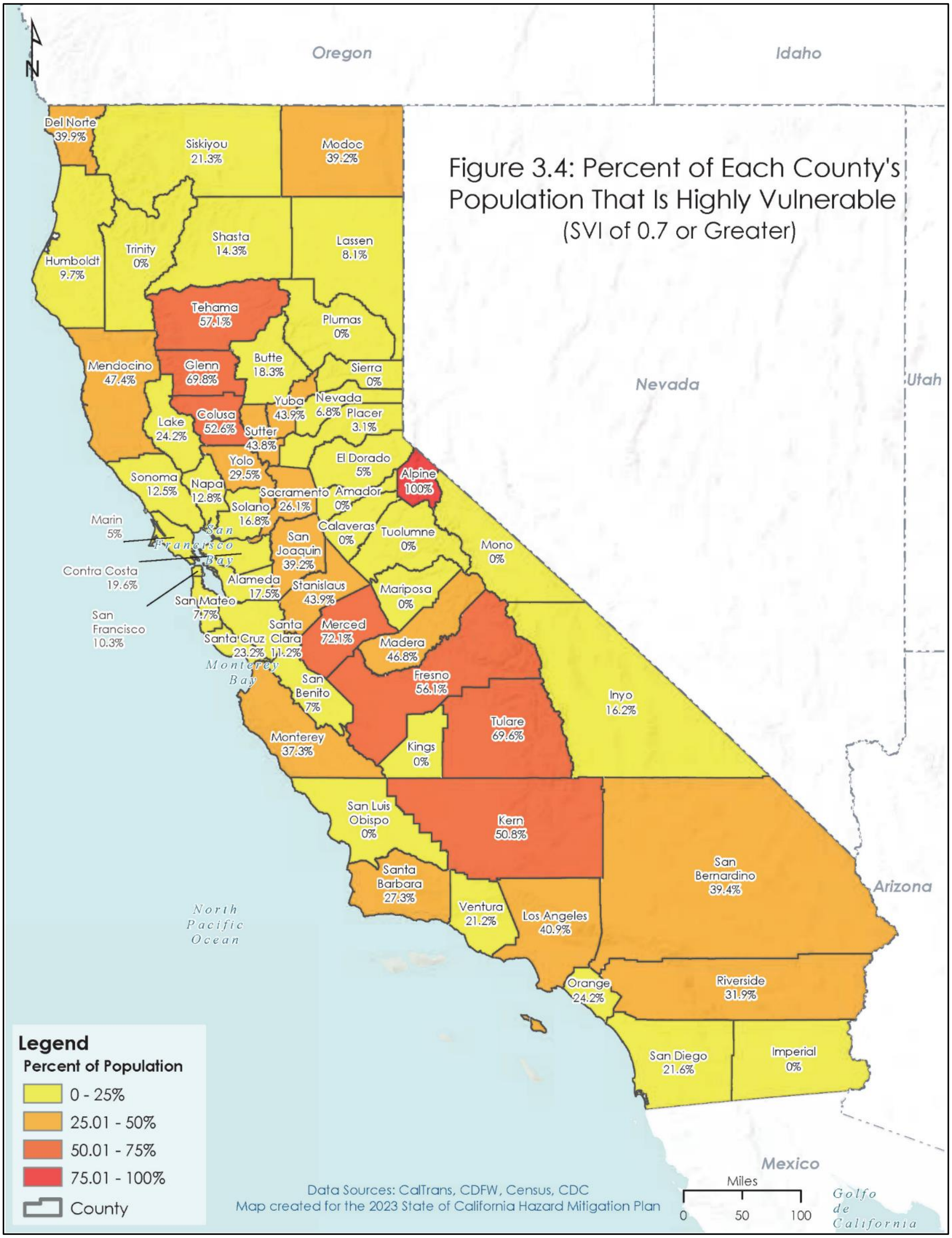
Source: (ATSDR 2022)

For hazard risk analysis in this plan, equity priority communities are defined as areas with an SVI of 0.7 or greater; federal grant programs commonly establish thresholds in the range of 0.60 to 0.75 to prioritize communities with a greater need for funding.

Baseline Equity Priority Communities

Figure 3-4 shows the percentage of the population in each county living in equity priority communities (census tracts with an SVI of 0.7 or greater) as of November 2022. Eleven counties in the State have no equity priority communities. The equity priority population makes up more than 50 percent of the population in eight counties, including 100 percent of the population of Alpine County. Statewide, 30.4 percent of the population lives in an equity priority community.

Figure 3-4. Percent of Each County's Population that is Highly Vulnerable



Since including equity priority communities is a relatively new element in hazard mitigation planning, assessing such communities has not been a regular part of local hazard mitigation planning processes across California. As local plans require updating, consideration for such efforts will be included in the assessment and planning process per updated FEMA Local Planning Requirements. Jurisdictions are not required, however, to follow this Plan's definition of equity or analytical approach.

Although the State uses the CDC's SVI in this Plan, local jurisdictions are encouraged to use the data source that best represents their community. Some communities may have finer scale data than at the census tract level or may determine that other sources are more useful in identifying equity priority areas within their community.

As population changes occur, the percentage of the population within one or more equity priority population categories will fluctuate. Maintaining current demographic data will allow the State to better assess the vulnerability of communities and population categories to develop inclusive mitigation strategies that protect the whole community.

3.5. LAND USE AND DEVELOPMENT

Land strategies impact who is exposed to hazards, and development strategies affect how vulnerable people are to the hazards they experience. Effective land use and development planning can reduce the risk of disasters in the future by reducing development in high-risk areas or by leveraging engineering and mitigation strategies to build homes and infrastructure that are resilient to hazards. Assessing current and projected land use and development patterns is a critical step in the risk assessment process and in developing mitigation strategies that will meet the community's needs in the future.

Identifying where people and development are located compared to hazard-prone areas allows the State to evaluate the exposure of the population, structures, and State assets. When assessing future development, it is important to ensure that new development is implemented in a manner compatible with existing land uses and the natural environment; avoiding unintended consequences is a mitigation strategy to alleviate future burdens on communities.

3.5.1. Statewide Guidance for Land Use

Consistency and compatibility between hazard mitigation and land use initiatives are critical to protecting California's residents, natural resources, businesses, and infrastructure.

OPR formulates long-range goals and policies for land use, population growth and distribution, urban expansion, land development, resource preservation, and other factors affecting statewide development. OPR periodically revises the State General Plan Guidelines for the preparation and content of general plans for cities and counties in California. The guidelines provide information on planning for climate resilience, environmental justice, fire hazards, and equitable and resilient communities (OPR 2020) and were utilized in drafting this SHMP update.

California has very strong building and hazard-related codes and standards related to growth management and requires the integration of hazard mitigation planning with land use planning. This enables the State and local governments to effectively manage risks using the best available data and science on hazard extent and location.

3.5.2. Existing Land Use

A 2018 study by the Terner Center for Housing Innovation at the University of California (UC), Berkley found that most of the land in California is zoned for single-family housing, which limits opportunities to construct multifamily housing (Mawhorter, et al. 2018). This can result in a scarcity of affordable housing and result in economically disadvantaged individuals and families seeking housing that does not provide adequate protection against disasters or housing that is located in hazard-prone areas. Limited housing options become more pronounced during recovery if displaced residents require housing and sheltering.

3.5.3. Development Trends

S7 – 44 CFR 201.4(d): Was the risk assessment revised to reflect changes in development?
Sections 3.5.3, 3.5.4, and 3.5.5 include a review of population change trends as well as a look at building permit volumes since the last plan update in 2018.

In 2010, California's housing density, as shown in Figure 3-5, indicated an accumulation of residents in the three metropolitan areas—the Bay Area, Los Angeles, and San Diego—along with a band across the central portion of the State from Kern County to just north of Sacramento. With recent population changes (see Figure 3-2), development is occurring in some of the more inland counties and moving away from the larger coastal and metropolitan areas of San Diego, Los Angeles, and the Bay Area (see Figure 3-6).

3.5.4. Implications of Growth on Risk

Growth patterns directly affect hazard impacts, risk, and vulnerability. Growth can lead to an increase in the number of people and developed properties exposed to hazards. However, the vulnerability of those exposed does not necessarily increase at the same rate.

Reviewing building permit volumes can help paint a picture of development trends. However, it is difficult to directly correlate permit activity to an increase in hazard risk because, except for development in regulated floodplains, it is not a standard practice for local governments to track building permit activity within designated hazard areas.

According to the Construction Industry Research Board, California's residential housing production from 2018 to 2022 was 15 percent greater than from 2013 to 2017. The increase could likely be tracked to counties that saw increases in population during this timeframe. Table 3-1 shows housing production by year for 2013 to 2022.

Table 3-1. Housing Production in CA for 2013 to 2022

Year	Single-Family Units	Multi-Family Units	Total Units
2013	36,991	48,481	87,485
2014	37,089	48,755	87,858
2015	44,896	53,337	100,248
2016	49,208	51,753	102,977
2017	55,827	59,843	117,687
2018	59,049	58,843	119,910
2019	58,052	53,232	113,303
2020	57,084	43,525	102,629
2021	65,022	53,268	120,311
2022	66,351	55,263	123,636

Source: (Construction Industry Research Board 2022)

Figure 3-5. Development (2020 Housing Density)

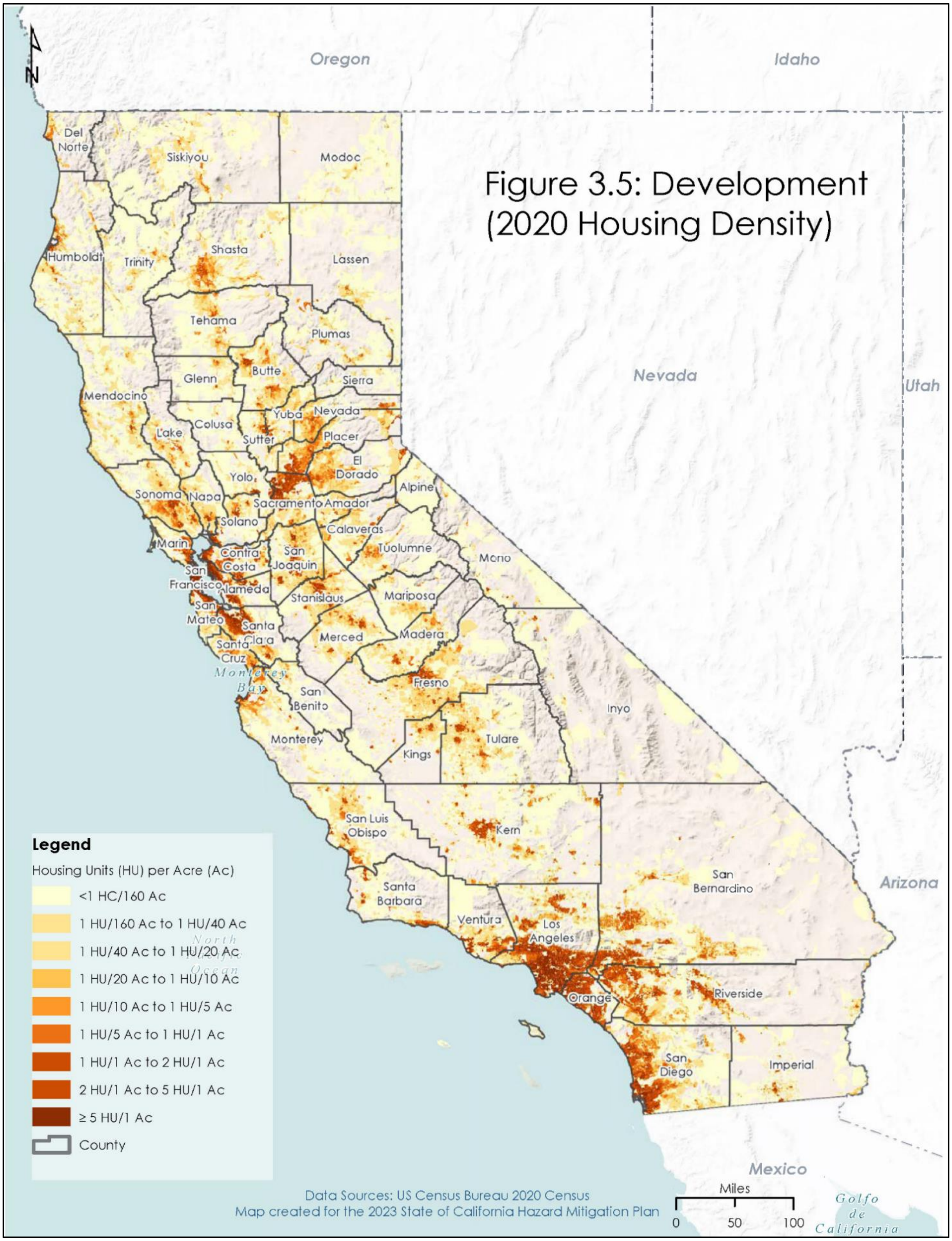
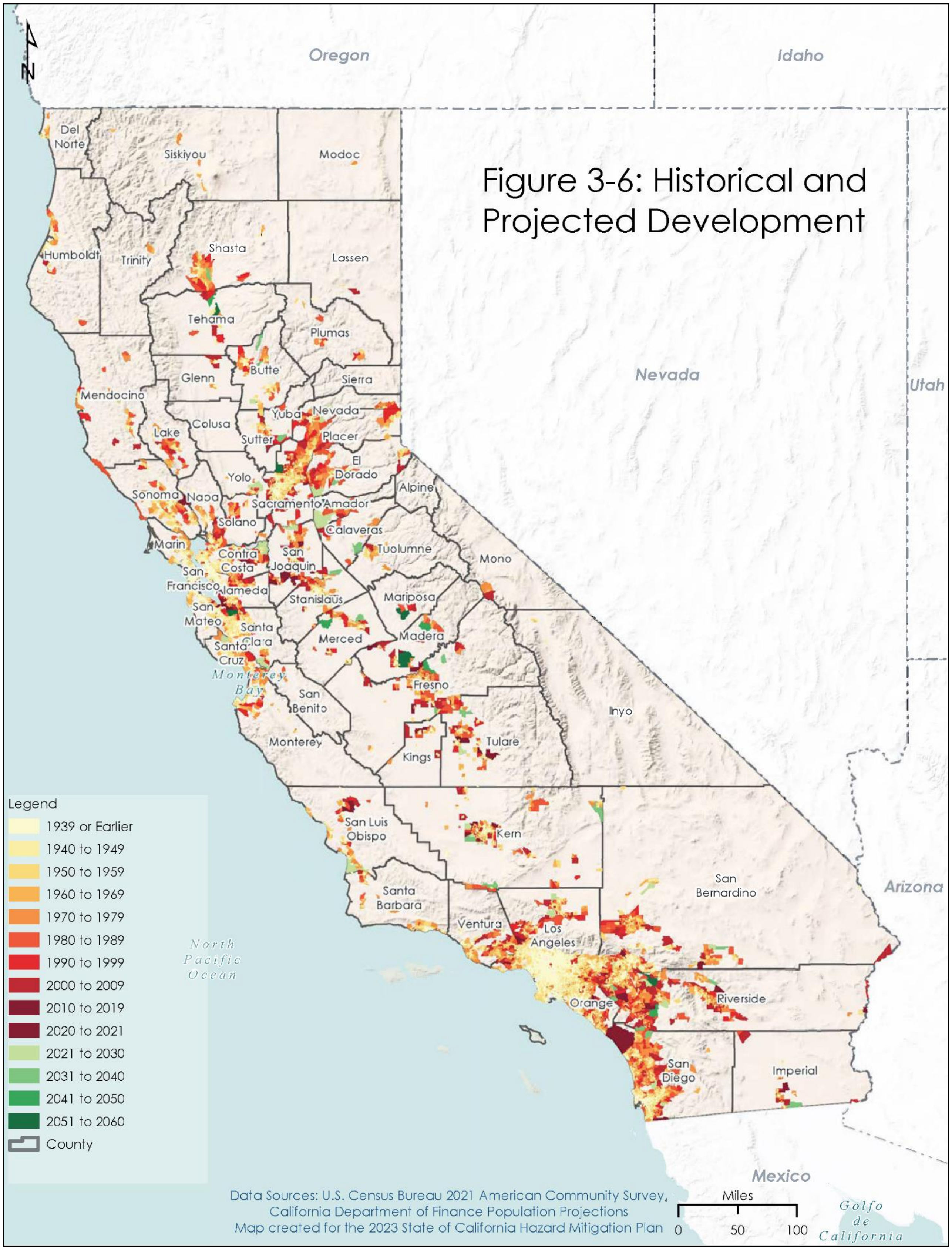


Figure 3-6. Historical and Projected Development



According to HCD, the State faces the following housing challenges:

- **Not enough housing being built**—In the last 10 years, housing production averaged fewer than 80,000 new homes each year, and production continues to be far below the projected need of 180,000 additional homes annually.
- **Increased inequality and lack of opportunities**—Lack of supply and rising costs compound growing inequality and limit advancement opportunities for younger Californians. Much of the new housing growth is expected to be in areas where fewer jobs are available to families that live there.
- **Too much of people's incomes go toward rent**—The majority of Californian renters—more than 3 million households—pay more than 30 percent of their income toward rent. Nearly one-third—more than 1.5 million households—pay more than 50 percent of their income toward rent.
- **Fewer people are becoming homeowners**—Overall homeownership rates are at their lowest since the 1940s.
- **Disproportionate number of Californians experiencing homelessness**—California is home to 12 percent of the nation's population, but 22 percent of the nation's population is experiencing homelessness.
- **Barriers other than cost in finding an affordable place to live**—For California's vulnerable populations, discrimination and inadequate accommodations for people with disabilities are worsening housing costs and creating affordability challenges.

Severe housing pressure makes Californians vulnerable to disaster in numerous ways. Individuals experiencing homelessness are extremely vulnerable to various disasters due to the lack of shelter, difficulties receiving disaster-related communication, and many other factors. High fractions of income going to rent means families have fewer resources available for individual adaptive action. The low building rates mean that when a disaster destroys residences, there are fewer options for where to house survivors. Low homeowner rates mean that people move more frequently, reducing social ties essential for community resiliency.

As described previously, frontline communities often face disasters and impacts from hazards due to historical discrimination and underinvestment. Due to the history and current ramifications of systemic racism in public policy (e.g., racially motivated refusal of loans known as redlining) and the private housing market (racial covenants), current and future housing challenges and related risk of impact from hazards disproportionately impact Black, Indigenous, Latina/e/o, Hawaiian or Pacific Islander, and other communities of color. For example, Black, Indigenous, Latina/e/o, and Pacific Islander Californians are over-represented within populations currently unhoused, in substandard housing, and overburdened by the cost of rent or mortgage while experiencing lower homeownership rates.

As California works to ensure equity, reduce GHG emissions, and reduce the loss of natural areas, many cities are encouraging compact development that reduces sprawl. Urban sprawl means that buildings and people can encroach into areas at high risk for wildfires, flooding, and other hazards while damaging natural resources. However, targeting development to specific areas can put pressure on limited land and compromise ecosystem services, resulting in higher costs. Through careful risk assessment that considers future land use and development patterns, communities can use land use planning as a mitigation strategy to avoid building in high-risk areas or by implementing engineering strategies incorporating nature-based solutions to build more resilient communities.

3.5.5. Future Trends in Development

S7a – 44 CFR Section 201.4(d): Does the plan provide a summary of recent development and potential or projected development in hazard-prone areas based on state and local government risk assessments?
In addition to Section 2.5, Section 3.5.5 outlines a summary of findings about how LHMPs assess changes in development.

California is a strong growth management state that equips its local governments with general plans to address future developments, including safety and housing elements. Regional housing needs assessments are mandated by State law as part of the periodic process of updating local general plan housing elements. Safety elements have similar mandates, including those that promote integration with LHMPs. These initiatives provide a strong footing for local governments to deal with development pressures as they interface known hazard areas. These land use initiatives, and the adoption and enforcement of strong building codes and standards are key ingredients to overall community resilience.

A review of LHMPs within the State, as described in Section 2.5, found that most LHMPs address future development trends for the entire planning area and are not specific to each hazard of concern. It is not a standard practice for municipal governments to track development activity specific to hazard areas, with one exception: development in the Special Flood Hazard Area (SFHA) pursuant to the National Flood Insurance Program (NFIP) requirements. Therefore, specifically providing an overview of potential or projected development in hazard-prone areas is not feasible. This section uses a similar approach to looking at future development by looking at historical trends.

Part 2—Profiles & Risk Assessments for Natural Hazards of Interest

Cal OES
GOVERNOR'S OFFICE
OF EMERGENCY SERVICES

4. WHAT IS AT RISK

S3 – 44 CFR Section 201.4(c)(2)(i): Does the risk assessment include an overview of the type and location of all natural hazards that can affect the state?
Part 2 of this Plan includes the Risk Assessment for the State of California. Each hazard is profiled fully, with specifics about type and location of all natural hazards in the State of California. Section 4.1.3. outlines specific methodology, as well as lists the 15 natural hazards of concern. Natural hazards of concern are presented in order based on Hazard Impact Scores (methodology explained at the end of Section 4.1).

4.1. RISK ASSESSMENT OVERVIEW

4.1.1. What is a Risk Assessment?

Risk is the potential for damage or loss created by the interaction of hazards with people, buildings, infrastructure, and natural and cultural resources. A risk assessment is a process of determining which hazards are of concern and assessing the potential impacts of those hazards statewide. It helps communicate vulnerabilities, develop priorities, and inform decision-making for the hazard mitigation plan and other emergency management efforts.

A risk assessment provides a factual basis for actions recommended in the mitigation strategy. The hazards and associated impacts and vulnerabilities identified in the risk assessment should be the hazards, impacts, and vulnerabilities the mitigation strategy seeks to address. Risk assessments must be based on the best available data and science that incorporate future projections (e.g., climate, land use, demographic, and other potential changes) and equity considerations to ensure that mitigation strategies have the greatest probability of reducing the risks posed by hazards in the most vulnerable areas now and into the future.

4.1.2. How is a Risk Assessment Used in Hazard Mitigation Planning?

Hazard mitigation plans identify the hazards and risks that can impact a community based on historical experience, estimate the potential frequency and magnitude of disasters, and assess potential losses to life, property, and the environment. Risk assessment provides a factual basis for a hazard mitigation strategy. It focuses on areas most in need by evaluating which populations and assets are most vulnerable to the hazards of concern. A risk assessment identifies:

- The hazards to which a community is susceptible
- Which areas and populations are most vulnerable to these hazards
- What these hazards can do to physical, social, environmental, and economic assets
- The resulting cost of damage or cost that can be avoided through mitigation

Risk assessment is a shared responsibility between states, local governments, and the "whole community." While local governments focus on hazards, vulnerabilities, and risks on a local or regional scale, states set the groundwork for those assessments by identifying hazards that impact the state. State plans can further support the local risk assessment process by identifying where hazard events have or could occur. State and local hazard mitigation plans (LHMPs) share the responsibility to communicate risk to the whole community so they can be risk informed.

4.1.3. How the Risk Assessment was Conducted for This Plan

The Risk Assessment for this Plan determined the exposure of identified assets and populations to each hazard of concern and assessed their vulnerability. The assets assessed include State-owned or -leased facilities, critical facilities, and community lifelines. The populations assessed include the general population and the subset of that population identified as "equity priority" communities. The potential for future risk expansion was assessed by looking at buildable lands within each hazard area. Exposure was assessed by overlaying hazard maps with inventories of State-owned or -leased facilities and infrastructure, critical facilities whose loss of function could affect State resilience, and equity priority populations. Vulnerability was evaluated by estimating potential impacts in the event of a hazard incident. Further details on the Risk Assessment methodology used for the 2023 State Hazard Mitigation Plan (SHMP or Plan) are provided in Appendix G.

Hazards of Concern

Standard 4.1.1: The Emergency Management Program identifies the natural and human-caused hazards that potentially impact the jurisdiction using multiple sources. The Emergency Management Program assesses the risk and vulnerability of people, property, the environment, and its own operations from these hazards.
Parts 2 and 3 of the SHMP profile 34 natural, meteorologic, biologic, human-caused, and technological hazards impacting the State of California. These hazards were identified based on California's hazard history statewide and locally, climate change projections, stakeholder input, and technical analysis.

Through coordination with the Hazard Groups, as described in Chapter 1, the State identified 34 hazards of interest that could impact or have impacted the State. They include both natural and non-natural (human-caused) hazards.

- **Natural Hazards of Interests**—These natural hazards, presented in order of impact, are typically assessed by local planning efforts in California and are identified by the Federal Emergency Management Agency (FEMA) as hazards to be addressed in hazard mitigation planning if they are present in the planning area:
  - Earthquake
  - Riverine, stream, and alluvial flood
  - Coastal flood/sea-level rise
  - Extreme heat
  - Extreme cold or freeze
  - Wildfire
  - Severe wind, weather, and storms
  - Landslide, debris flow, and other mass movements
  - Drought
  - Tsunami
  - Dam failure
  - Levee failure
  - Snow avalanche
  - Subsidence
  - Volcano
- **Other Hazards of Interest**—FEMA does not require These human-caused hazards to be assessed in hazard mitigation plans. Local planning efforts in California do not typically assess them. They are listed here in order of impact:

  - Urban structural fire
  - Other electrical outages
  - Public safety power shutoff (PSPS)
  - Terrorism
  - Air pollution
  - Tree mortality
  - Energy shortage
  - Cyber threats
  - Invasive and nuisance species
  - Epidemic, pandemic, vector-borne disease
  - Civil disorder
  - Natural gas pipeline hazards
  - Hazardous materials release
  - Transportation accidents resulting in explosion
  - Well stimulation and hydraulic fracturing
  - Oil spills
  - Electromagnetic pulse (EMP) attack
  - Radiological accidents
  - Geomagnetic Storm (Space Weather)

FEMA does not require hazard mitigation plans to assess human-caused hazards and will not review them as part of its plan approval process. However, considering these hazards is required to achieve Emergency Management Accreditation Program (EMAP) accreditation, a State-identified objective for this SHMP. The State's choice to assess human-caused hazards is not binding on LHMPs. To clearly separate the elements required by FEMA from those required by EMAP, the Risk Assessment has been split into two parts of the SHMP:

- In Part 2, natural hazards of interest are fully assessed pursuant to the requirements S1 to S7 of the FEMA Standard State Hazard Mitigation Plan Review Tool (see Appendix E). These hazard profiles are presented in the order of highest impact based on a hazard impact rating protocol applied for this SHMP (see Appendix H).
- In Part 3, the other hazards of interest are profiled but not assessed in the full context applied to the natural hazards of interest. These profiles qualitatively assess the impacts of each hazard and do not strive to meet all of the requirements of 44 CFR Section 201.4(c)(2)(i). These hazards are important to the State of California, but their nature makes it difficult to fully assess them in a consistent approach that allows comparison of impacts.

This approach sets a precedent for local planning in the State that natural hazards of interest are mandatory and other non-natural hazards of interest are optional, as identified in FEMA guidance for hazard mitigation planning.

Data Sources

The California Governor's Office of Emergency Services (Cal OES) is committed to principles of fairness, transparency, and scientific reasoning and therefore conducts risk assessments using consistent methodologies and high-quality data that is peer reviewed and publicly accessible. Higher-resolution data sources might exist for specific communities, and Cal OES encourages communities to use those if available for risk assessments at the local level. The selection of the best available data for this SHMP update was guided by input from the Hazard Working Groups, partner agencies, and other experts advising the State for the update process. Data sources were selected to apply consistency in evaluating statewide risk and vulnerability for all communities throughout California. Appendix G documents sources and metadata for the data used in the Risk Assessment.

Using the National Risk Index

This SHMP uses FEMA's National Risk Index (NRI) to assess potential hazard-related losses for jurisdictions throughout the State (as called for in FEMA's Standard State Mitigation Planning Requirement S6.a). The NRI assigns numerical risk scores (based on percentiles) and descriptive risk ratings (very low to very high) at the Census tract and county levels. These scores and ratings are based on estimates of annual losses due to 18 types of hazard events, with adjustments to account for social vulnerability (which increases risk) and community resilience (which decreases risk).

The NRI multiplies the expected annual loss by a community risk factor derived from the social vulnerability and community resilience scores. Each community's resulting risk value is compared to all communities nationwide to assign its percentile-based score from zero (lowest risk value) to 100 (highest risk value).

The annual losses estimated in the NRI represent economic losses to buildings and agriculture and human fatalities and injuries. Building values and populations are derived from the Hazus model default inventory. Agriculture values are taken from the U.S. Department of Agriculture (USDA) Census of Agriculture.

The NRI online mapping tool was used to assess local vulnerability to identify the California counties with the highest risk for each NRI hazard included in the SHMP.

Those counties and their NRI scores and ratings are listed in the vulnerability analysis for natural hazards in Part 2 of the SHMP. Figure 4-1 shows the composite NRI ratings for all natural hazards for each county in the State.

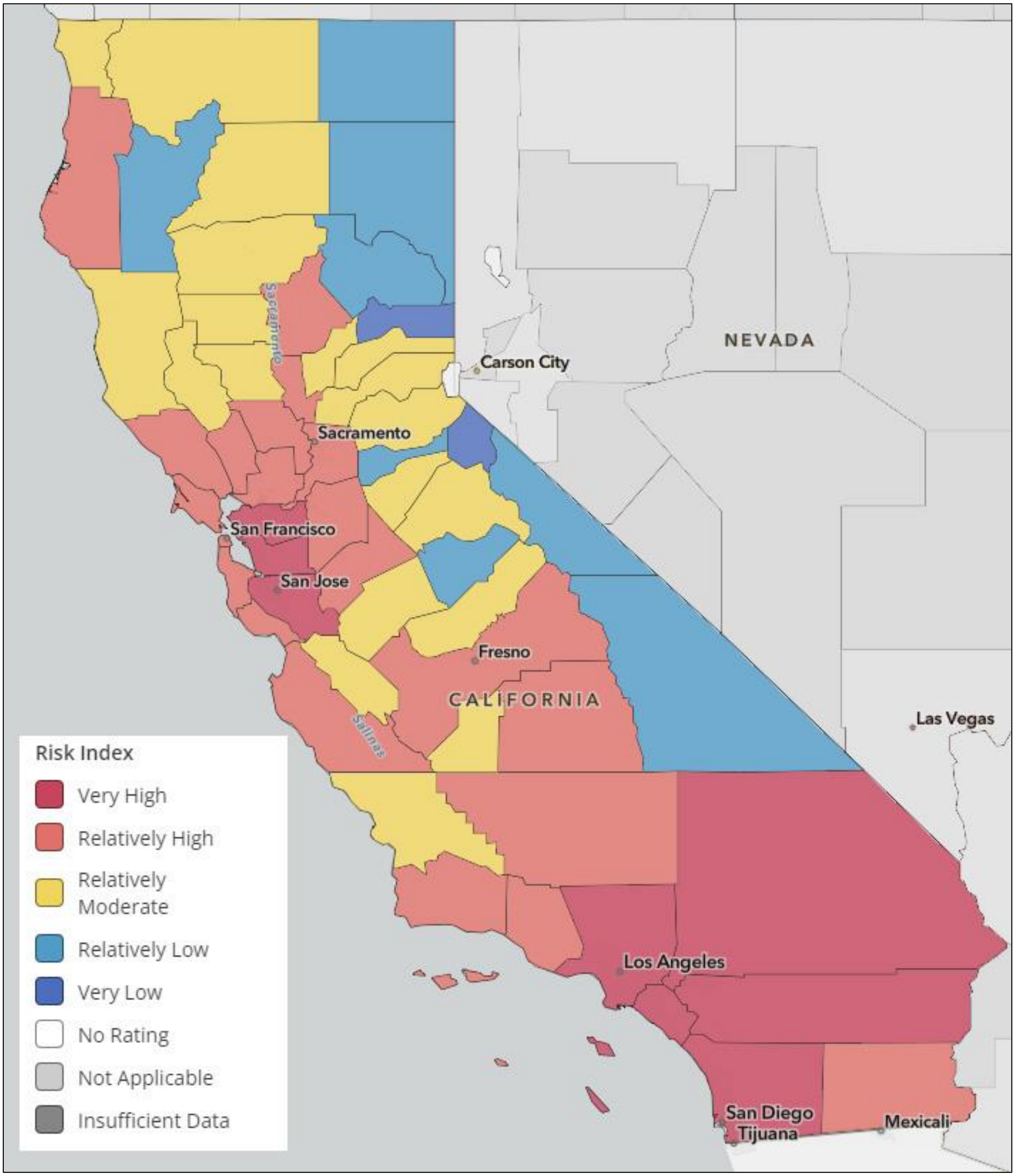
Hazard Impact Scores

To assess the impact of each identified hazard of concern and provide direction to the State for action planning, a hazard impact rating was developed that uses quantitative and qualitative data to assign a score based on the projected impact of each hazard. The scoring looks at the following metrics for each hazard of concern:

- The exposure of State assets
  - State-owned or -leased facilities
  - Community lifelines
- Population exposed
- The percentage of the exposed population identified as living in equity priority communities
- Buildable lands exposed
- Climate change impacts

Quantitative, spatial data was used to generate the impact score for hazards with a clearly defined extent and location, such as flooding. For other hazards, a qualitative approach was applied to generate the score. A hazard impact score is presented at the beginning of each hazard profile chapter in this Plan. Details on the metrics used and scoring for each hazard of concern are provided in Appendix H. The hazards are presented in this SHMP based on the resulting impact ratings, with the highest-impact hazards presented first. These hazard impact ratings have been used to inform the identification of the action plan provided in Chapter 47. The State prioritized hazards that scored either "high" or "medium" for targeted actions to address their impacts. Hazards that ranked "low" are considered to be optional.

Figure 4-1. National Risk Index Composite Risk Scores for California Counties



Source: (FEMA 2023c)

4.2. STATE ASSETS

S5 – 44 CFR 201.4(c)(2)(ii) and 201.4(c)(2)(iii): Does the risk assessment address the vulnerability of State assets located in hazard areas and estimate the potential dollar losses to these assets?
All 34 hazard profiles in Parts 2 and 3 of the SHMP have sections dedicated to the vulnerability of State assets that is inclusive of both an exposure analysis and loss estimation. Section 4.2. describes the assets evaluated.

This Plan defines a "State asset" as a facility, infrastructure, or community lifeline that serves a critical function on behalf of the State of California. A detailed inventory of assets identified two categories: State-owned or -leased facilities; and critical facilities or community lifelines.

4.2.1. State-Owned or -Leased Facilities

State-owned or -leased facilities are critical to the continuity of operations following hazard events. These assets have been inventoried and categorized in a geospatial format so that an exposure analysis can be performed for each hazard of concern. The source for the State-owned or -leased facility data is the California Department of General Services (DGS). Table 4-1 and Table 4-2 summarize this data for State-owned or -leased facilities.

Table 4-1. State-Owned or -Leased Facilities

Type of Facility	Number of Structures	Total Area (sq. ft.)	Replacement Cost Value*		
			Structure	Content	Total
State-Leased Facilities	1,893	N/A	$9,216,928,646	$9,438,197,133	$18,655,125,778
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	3,896	42,442,942	$3,419,731,320	$2,254,012,157	$5,673,743,477
Development Center	247	2,320,939	$305,783,571	$390,885,847	$696,669,418
Hospital	525	6,470,903	$382,822,433	$454,638,764	$837,461,197
Migrant Center	25	1,588,233	$655,289,706	$341,691,270	$996,980,976
Special School	137	959,233	$64,705,505	$63,904,858	$128,610,363
All Other Facilities	19,131	188,844,446	$14,334,593,292	$14,057,592,693	$28,392,185,985
Total State-Owned	***23,961***	***242,626,696***	***$19,162,925,827***	***$17,562,725,589***	***$36,725,651,416***
Total State Facilities	25,854	N/A	$28,379,854,473	$27,000,922,722	$55,380,777,194

* Replacement cost values calculated using the *2022 Square Foot Costs* by RS Means

Table 4-2. State-Owned Infrastructure

Type of Facility	Number or Length
Bridges	13,201
Highway (miles)	30,098
Dams	49
Water Project (miles)	714.5

Note that the inventory does not include building area for State-leased facilities, so no total area for all State facilities is provided; risk assessments throughout this SHMP show the building area of vulnerable assets only for State-owned facilities. Appendix I includes a detailed breakdown of the number and type of assets by county and other data parameters.

The following are notable statistics from the inventory of State-owned assets:

- The average building area of State-owned facilities statewide is 10,125 square feet, and the average replacement cost value is $1.5 million
- The average replacement cost value for State-leased facilities statewide is $9.8 million
- The agencies with the most State-owned or -leased facilities are as follows:
    - The California Department of Parks and Recreation (State Parks) (6,014)
    - The University of California (UC) (4,010)
    - The California Department of Corrections and Rehabilitation (CDCR) (3,993)
    - The California Department of Transportation (Caltrans) (2,224)
    - The California Department of Forestry and Fire Protection (CAL FIRE) (2,059)
- The State agency with the highest total replacement cost value for State-owned or -leased facilities is the California Employment Development Department (EDD)($1.1 billion)

Figure 4-2 shows the distribution of State-owned or -leased facilities. The distribution of State-owned or -leased infrastructure is shown in Figure 4-3 through Figure 4-6.

Figure 4-2. State-Owned and State-Leased Facilities

Figure 4-3. State Highways

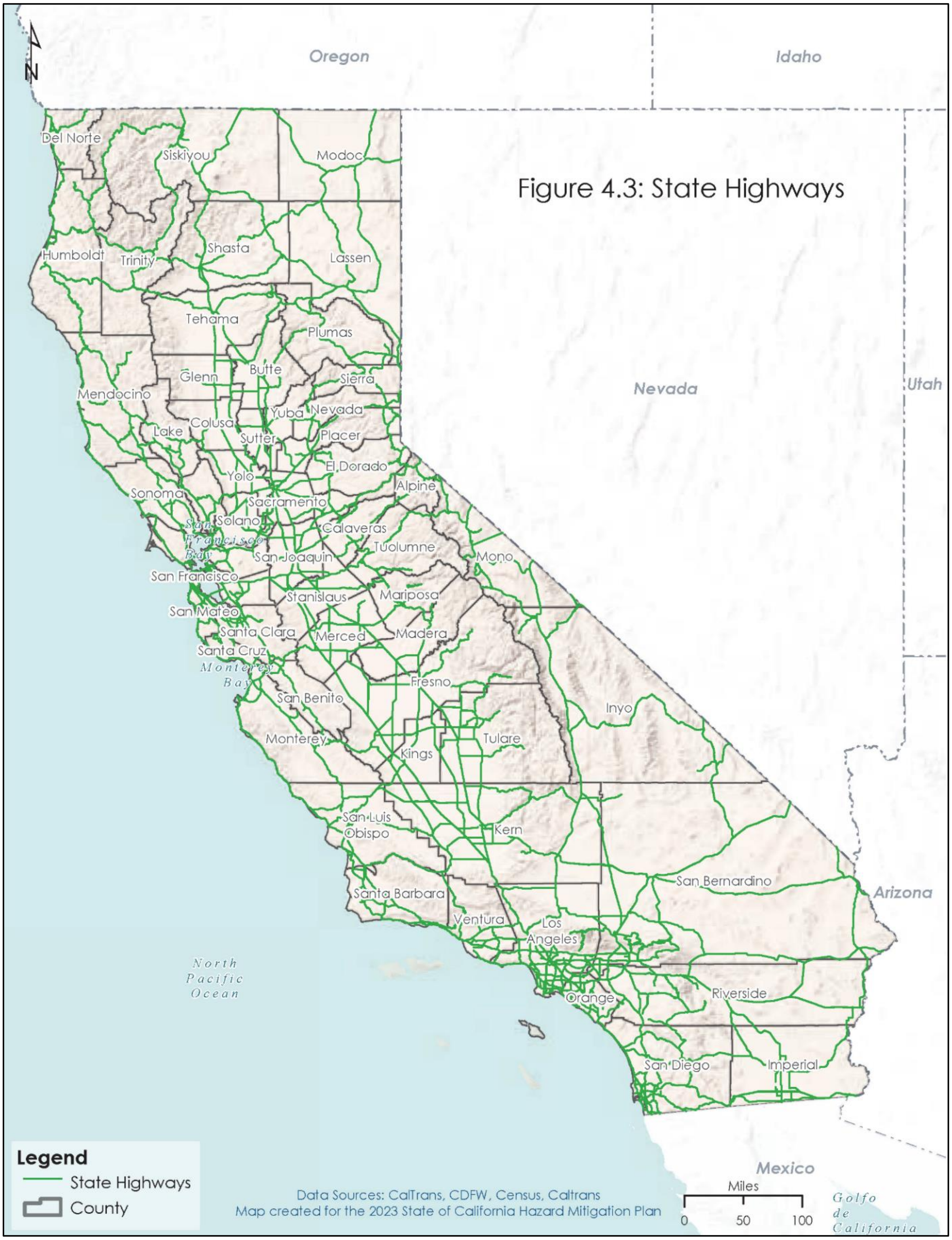


Figure 4-4. State Bridges

Figure 4-5. State Dams

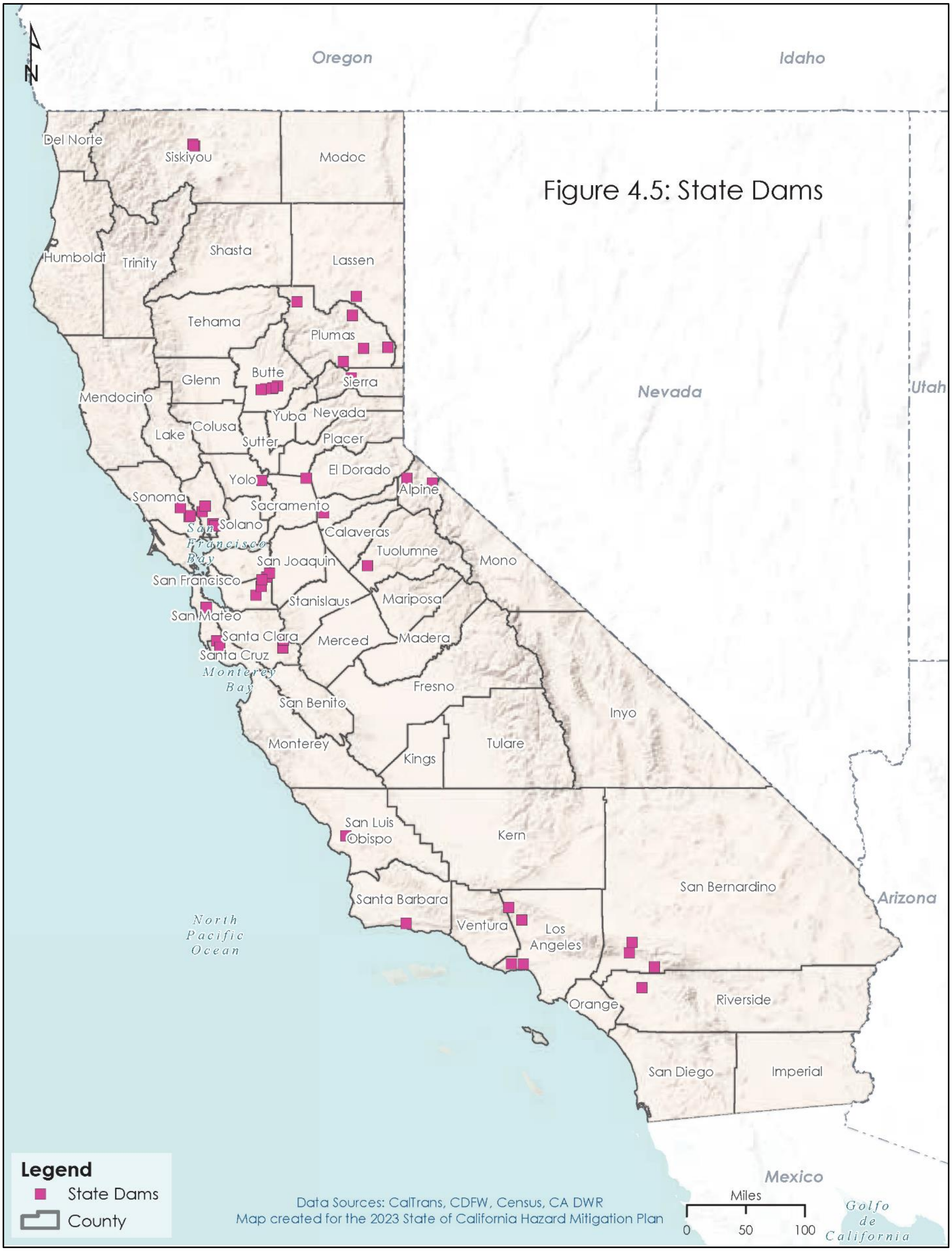
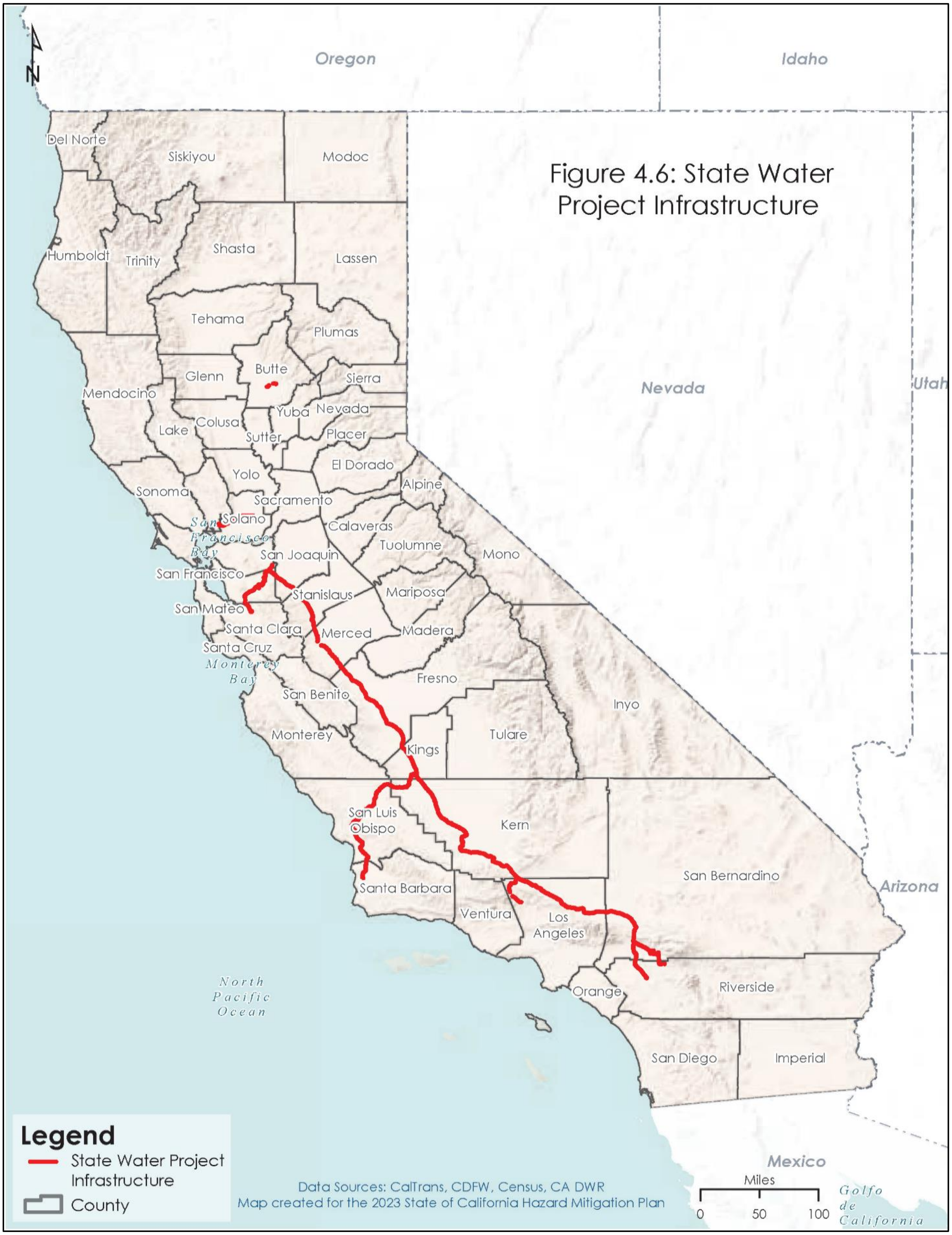


Figure 4-6. State Water Project Infrastructure



4.2.2. Critical Facilities and Community Lifelines

Critical facilities and community lifelines are key assets and resources that assist the State in maintaining the continuity of operations before, during, and after hazard (disaster)events. Lifelines are the most fundamental services in a community that, when stabilized, enable all other aspects of society. FEMA has broken down lifelines into eight categories, as shown in Figure 4-7.

FEMA created the concept of community lifelines to establish a unified nationwide approach to emergency response for these critical assets. However, the concept can be applied beyond questions of response to cover the entire preparedness cycle, including hazard mitigation. Efforts to protect lifelines and build them back stronger and smarter during recovery will benefit overall resilience across the United States.

Impacts on critical facilities and community lifelines can lead to catastrophic and cascading fatal impacts throughout multiple communities. For example, if power is lost for life-sustaining medical devices or refrigeration of essential medications, health-dependent communities, and systems that rely on them may face severe health events. Road or bridge failure could result in an inability to evacuate an impacted area or inaccessibility for emergency medical services. If potable water treatment systems are disrupted, water- and food-borne disease may spread, and access to clean water becomes difficult. If untreated wastewater or other hazardous materials spill, exposure could result in infection, rash, gastrointestinal illness, tetanus, or leptospirosis (CDC 2022d).

For mitigation planning, the most important impact on community lifelines to avoid through mitigation actions is loss of function. Each lifeline can be associated with a critical service needed for the State and local governments to respond and recover from hazard events. Maintaining the continuity of operation of these lifelines is critical for community resilience.

For the inventory of critical facilities and community lifelines, the Cal OES Critical Infrastructure Protection Unit provided data from the State Critical Infrastructure Prioritization Initiative. That initiative establishes an inventory of significant infrastructure prioritized by sector. Table 4-3 summarizes the facility counts for the FEMA Community Lifeline categories.

Figure 4-7. FEMA Community Lifeline Categories

Source: (FEMA 2023a)

Table 4-3. Community Lifeline Counts by Category

Communications	42
Energy	176
Food, Water, Shelter	257
Hazardous Material	56
Health & Medical	47
Safety & Security	46
Transportation	131
Total	**755**

The "food, water, shelter," "energy," and "transportation" categories account for 74 percent of community lifelines in the State. The County with the largest percentage of these facilities was Los Angeles (20.9 percent of the State total), followed by San Diego (9.6 percent), San Bernardino (6.1 percent), and Alameda (5.6 percent). Appendix I provides a detailed breakdown of facility counts by county.

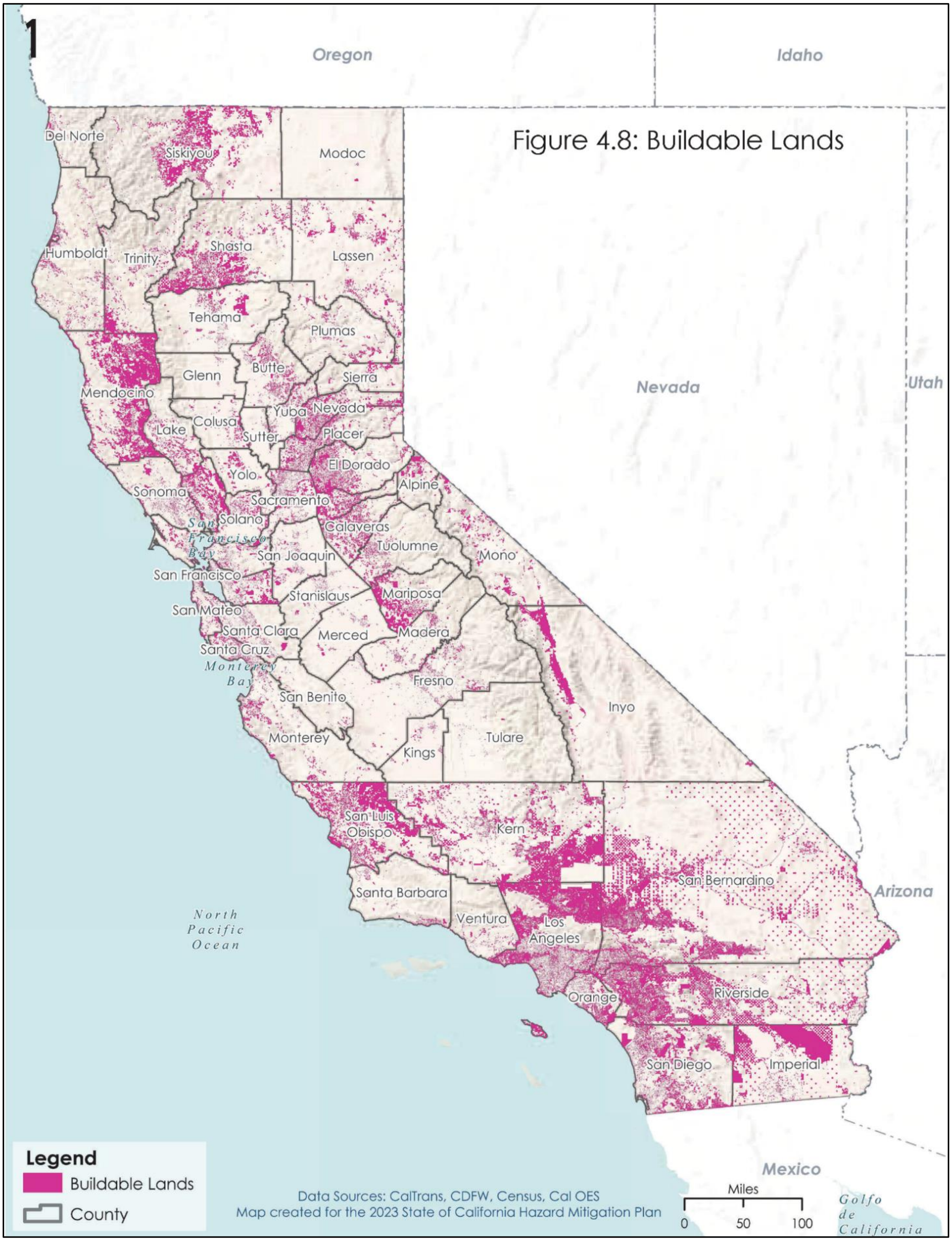
4.3. BUILDABLE LANDS

Buildable Lands are currently vacant lands with land use or zoning designations that would allow them to be developed in the future. Information on such lands is valuable for assessing where future growth could intersect known hazard areas, thus increasing hazard risk. The generation of this data was supported by a software application accessible by Cal OES called LandVision, as described in Appendix G. Figure 4-8 shows the distribution of buildable lands across California. Table 4-4 summarizes total buildable lands by county.

Table 4-4. Buildable Lands by County

County	Acres	County	Acres	County	Acres
Alameda	83,922	**Madera**	41,190	**San Joaquin**	28,214
Alpine	50,861	**Marin**	24,696	**San Luis Obispo**	733,458
Amador	97,686	**Mariposa**	228,533	**San Mateo**	32,801
Butte	88,320	**Mendocino**	855,474	**Santa Barbara**	28,657
Calaveras	124,320	**Merced**	12,030	**Santa Clara**	43,054
Colusa	39,975	**Modoc**	2,853	**Santa Cruz**	40,770
Contra Costa	28,731	**Mono**	130,547	**Shasta**	381,315
Del Norte	10,802	**Monterey**	92,667	**Sierra**	35,361
El Dorado	184,442	**Napa**	169,772	**Siskiyou**	508,754
Fresno	51,792	**Nevada**	146,358	**Solano**	55,831
Glenn	2,085	**Orange**	151,777	**Sonoma**	57,738
Humboldt	78,482	**Placer**	122,653	**Stanislaus**	14,179
Imperial	710,020	**Plumas**	60,257	**Sutter**	2,369
Inyo	246,441	**Riverside**	1,065,179	**Tehama**	84,053
Kern	1,014,386	**Sacramento**	75,501	**Trinity**	116,464
Kings	8,907	**San Benito**	8,877	**Tulare**	6,847
Lake	82,544	**San Bernardino**	1,734,287	**Tuolumne**	70,255
Lassen	180,689	**San Diego**	522,630	**Ventura**	31,804
Los Angeles	911,564	**San Francisco**	4,245	**Yolo**	40,856
Total					**11,788,962**

Figure 4-8. Buildable Lands



4.4. EQUITY PRIORITY COMMUNITIES

In addition to assessing the impacts of hazard events on State assets and lands, the Risk Assessment for this SHMP estimates hazard impacts on equity priority communities. For hazard risk analysis in this Plan, equity priority communities are defined as all locations with a Social Vulnerability Index (SVI) of 0.7 or greater; federal grant programs commonly establish thresholds in the range of 0.60 to 0.75 to prioritize communities with a greater need for funding. Equity priority communities may face additional barriers and challenges that increase vulnerability to hazards. This includes lower quality housing, which increases the risk to floodwater infiltration and mold growth and exposure; limited access to transportation, resulting in delayed evacuation or inability to evacuate; increased mental health impacts from exposure to hazards; and more. Additional details of the barriers and challenges that may lead to increased vulnerability within equity priority communities are discussed in Appendix B. The baseline condition for equity priority communities across the State is presented in Section 0.

Earthquake

Climate Impacts:
Unknown

Equity Impacts:
36.7% of the exposed population (those living on NEHRP D or E soils) identified as residing in equity priority communities

State Facilities Exposed:
$28 billion total replacement cost value for facilities on NEHRP D or E soils; $5.9 billion total replacement cost value for facilities in liquefaction zones (this number represents a minimum value because liquefaction zones are not yet mapped for the entire State); $16.4 billion total replacement cost value for facilities in significant shaking areas

Community Lifelines Exposed:
412 lifelines on NEHRP D or E soils; 149 lifelines in liquefaction zones; 241 lifelines in significant shaking areas

Impact Rating: High (45)

5. EARTHQUAKE

Earthquake has been identified as a high-impact natural hazard of interest based on the hazard impact rating protocol applied for this SHMP. Earthquakes happen frequently in California and can impact all State-owned or -leased facilities, community lifelines, and large percentages of the State's population. The potential impacts of earthquakes will influence future development in the State. Climate change is not expected to affect the frequency of earthquakes.

5.1. HAZARD OVERVIEW

An earthquake occurs when the ground shakes because rock beneath the Earth's surface suddenly breaks and shifts. In California, two of the massive plates that make up the crust of the Earth—the Pacific and North American plates— slide past each other in opposite directions at a rate of about 1.5 inches per year. Friction between the plates causes some parts to stick, then break free in sudden movements. The sudden movements release energy that travels through the ground as waves, causing shaking at the surface in the form of earthquakes (DOC 2022).

California has a long history of damaging earthquakes, and earthquake forecasts indicate a 93 percent chance that one or more major earthquakes (magnitude 7 or greater) will happen in the State in the 30 years following 2014 (USGS 2015).

5.1.1. Ways of Measuring Earthquakes

Magnitude

An earthquake's magnitude is a measurement of the energy radiated by the earthquake. Typically, a particular earthquake recorded at a particular distance is defined as a "standard" earthquake and assigned a magnitude of 1. An earthquake that causes ground motion at a seismic station 10 times larger than the standard earthquake is magnitude 2. An earthquake causing motion 10 times larger than a magnitude 2 is a magnitude 3, and so on. To achieve each tenfold increase in recorded amplitude requires about 32 to 33 times the energy. That means the energy released by an earthquake of magnitude 6 is about 33 times that of the energy released by a magnitude 5 earthquake (Pacific Northwest Seismic Network n.d.).

Magnitude is commonly expressed by ratings on the moment magnitude scale (Mw), the most common scale in use today. This scale is based on the total distance a fault moved and the force required to move it. The scale is as follows:

- Great—Mw > 8
- Major—Mw = 7.0 – 7.9
- Strong—Mw = 6.0 – 6.9
- Moderate—Mw = 5.0 – 5.9
- Light—Mw = 4.0 – 4.9
- Minor—Mw = 3.0 – 3.9
- Micro—Mw < 3

Ground Acceleration

The ground experiences acceleration as it shakes during an earthquake. The peak ground acceleration (PGA) is the largest acceleration that a recording monitoring station at the ground surface records during an earthquake. PGA measures how hard the earth shakes in a given geographic area. It is expressed as a percentage of the acceleration due to gravity (g). Horizontal and vertical PGA varies with soil or rock type. One approach to earthquake hazard assessment involves estimating the annual probability that certain ground accelerations will be exceeded, and then calculating the annual probabilities over a time period of interest using probability models.

Intensity

Intensity is a measure of how strong an earthquake feels at any one location. It can vary widely across the range where an earthquake is experienced. The most commonly used intensity scale is the modified Mercalli intensity scale. Ratings of the scale and the perceived shaking and damage potential for structures are shown in Figure 5-1 and Table 5-1. The range of ground shaking depends on the distance from the earthquake, the rock and soil conditions of the impacted area, and complexities in the structure of the earth's crust that affect how the seismic waves radiate from the earthquake source and propagate to the site.

Figure 5-1. Modified Mercalli Intensity Scale

CIIM Intensity	People's Reaction	Furnishings	Built Environment	Natural Environment
I	Not felt			Changes in level and clarity of well water are occasionally associated with great earthquakes at distances beyond which the earthquakes felt by people.
II	Felt by a few.	Delicately suspended objects may swing.		
III	Felt by several; vibration like passing of truck.	Hanging objects may swing appreciably.		
IV	Felt by many; sensation like heavy body striking building.	Dishes rattle.	Walls creak; window rattle.	
V	Felt by nearly all; frightens a few.	Pictures swing out of place; small objects move; a few objects fall from shelves within the community.	A few instances of cracked plaster and cracked windows with the community.	Trees and bushes shaken noticeably.
VI	Frightens many; people move unsteadily.	Many objects fall from shelves.	A few instances of fallen plaster, broken windows, and damaged chimneys within the community.	Some fall of tree limbs and tops, isolated rockfalls and landslides, and isolated liquefaction.
VII	Frightens most; some lose balance.	Heavy furniture overturned.	Damage negligible in buildings of good design and construction, but considerable in some poorly built or badly designed structures; weak chimneys broken at roof line, fall of unbraced parapets.	Tree damage, rockfalls, landslides, and liquefaction are more severe and widespread wiht increasing intensity.
VIII	Many find it difficult to stand.	Very heavy furniture moves conspicuously.	Damage slight in buildings designed to be earthquake resistant, but severe in some poorly built structures. Widespread fall of chimneys and monuments.	
IX	Some forcibly thrown to the ground.		Damage considerable in some buildings designed to be earthquake resistant; buildings shift off foundations if not bolted to them.	
X			Most ordinary masonry structures collapse; damage moderate to severe in many buildings designed to be earthquake resistant.	

Source: (USGS 2022h)

Table 5-1. Modified Mercalli Intensity and PGA Equivalents

Modified Mercalli Intensity	PGA (% gravitational acceleration)	Perceived Shaking	Potential Damage
I	<0.17	Not Felt	None
II	0.17 – 1.4	Weak	None
III	0.17 – 1.4	Weak	None
IV	1.4 – 3.9	Light	None
V	3.9 – 9.2	Moderate	Very Light
VI	9.2 – 18	Strong	Light
VII	18 – 34	Very Strong	Moderate
VIII	34 – 65	Severe	Moderate to Heavy

Source: (USGS 2022h)

The modified Mercalli intensity scale is generally represented visually using ShakeMaps, which shows the expected ground shaking at any given location produced by an earthquake with a specified magnitude and epicenter. A ShakeMap shows the variation of ground shaking in a region immediately following significant earthquakes.

5.1.2. Mapping the Earthquake Hazard

CGS Seismic Hazards Program Mapping

The California Geological Survey (CGS) Seismic Hazards Program delineates areas prone to multiple earthquake-related hazards:

- Soil liquefaction (when saturated soil loses its strength and stiffness)
- Earthquake-induced landslides
- Surface fault rupture (visible offset of the ground surface due to a rupture along a fault, an underground fracture in the Earth's crust)
- Tsunami inundation

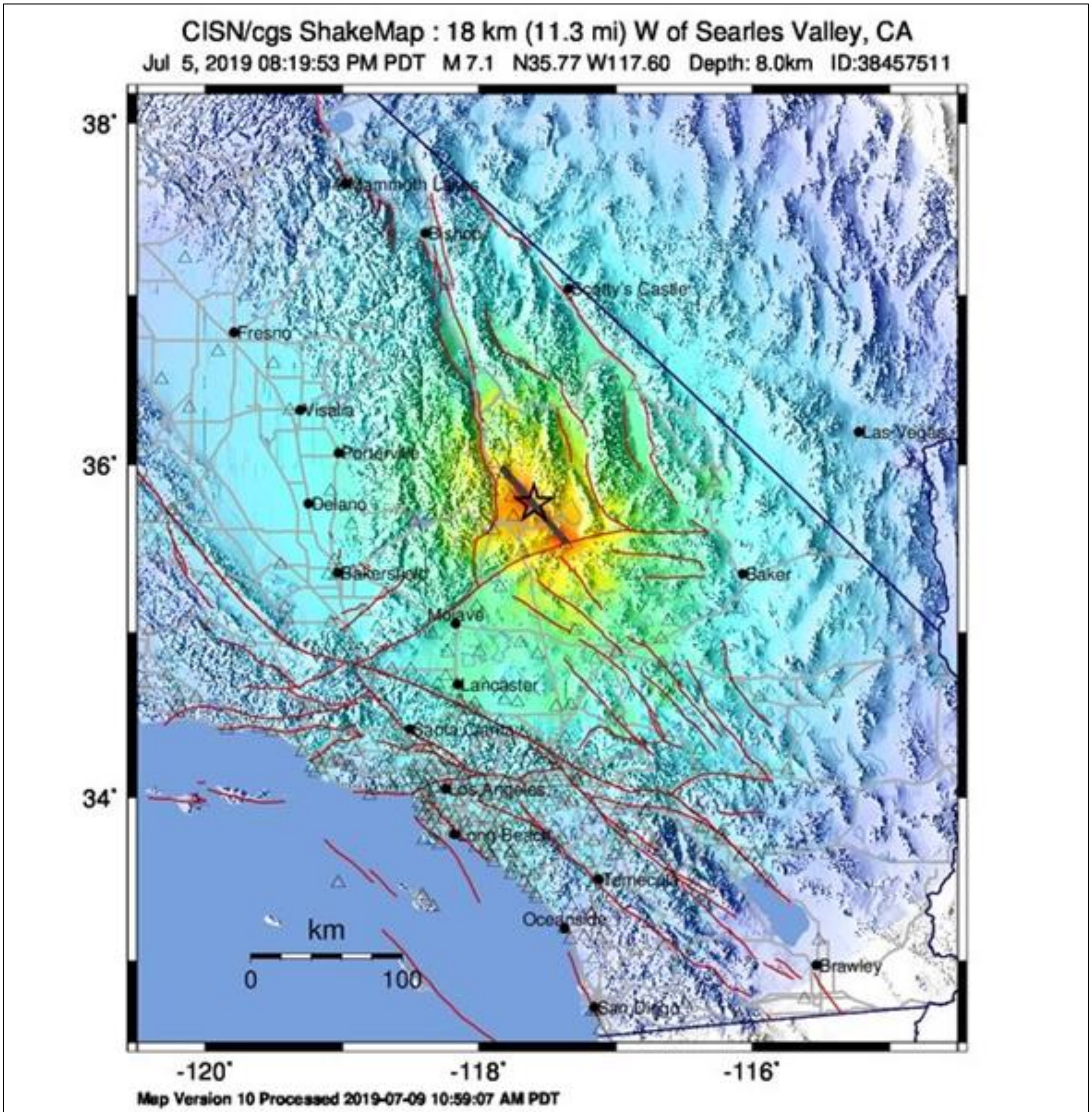
Areas that are prone to these hazards are called seismic hazard zones. Cities and counties are required to use the program's maps in land-use planning and building permitting so that these hazards are identified and mitigated for development projects. The Seismic Hazards Program works with the U.S. Geological Survey (USGS) to produce earthquake maps that are used to develop building codes and estimate earthquake damage and loss (DOC 2019a).

ShakeMaps

The California Integrated Seismic Network is a partnership between CGS, Cal OES, the Seismology Lab at UC Berkeley, the California Institute of Technology's Seismological Laboratory, and the USGS. The Network operates instruments across the State to measure earthquake shaking. It converts the recorded data into maps called ShakeMaps that provide near-real-time pictures of ground motion and shaking intensity following significant earthquakes (CISN n.d.). Figure 5-2 is an example ShakeMap generated for the 2019 M7.1 Ridgecrest Earthquake.

Emergency responders use ShakeMaps to evaluate shaking in areas affected by an earthquake and send resources to areas that most likely sustained heavy damage. ShakeMaps have also been prepared to model the effects of scenario earthquakes. They are the basis for loss estimates following earthquakes in FEMA's Hazus model.

Figure 5-2. ShakeMap for 2019 M7.1 Ridgecrest Earthquake



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.1	0.5	2.4	6.7	13	24	44	83	>156
PEAK VEL.(cm/s)	<0.07	0.4	1.9	5.8	11	22	43	83	>160
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Source: (USGS 2019d)

National Earthquake Hazards Reduction Program Soil Maps

The National Earthquake Hazards Reduction Program (NEHRP) maps soil types that define the potential for significant impact from an earthquake. The soil type determines how an earthquake's energy is amplified as it moves out from the fault. Type A has the least amplification, and Type E has the most. The soil types are generally described as follows:

- Type A—Hard rock
- Type B—Rock
- Type C—Dense soil/soft rock
- Type D—Stiff soil
- Type E—Soft soil
- Type F—Special soils requiring special evaluation

Liquefaction Maps

Liquefaction occurs when loosely packed, water-logged sediments at or near the ground surface lose their strength in response to strong ground shaking. This makes the materials behave like a liquid, damaging building foundations and causing pipes to leak or break and paved surfaces to buckle. Liquefaction beneath buildings and other structures can cause significant damage during earthquakes (USGS 2022d).

Soil liquefaction maps are valuable tools to assess potential damage from earthquakes. Areas susceptible to liquefaction include places where sandy sediments have been deposited by rivers along their course or by wave action along beaches. 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. CGS has only evaluated and mapped about 5 percent of the State for liquefaction hazards. This represents a gap in the capability to assess the risk from earthquakes. Closing that gap has been identified as a high-priority action in this Plan.

Landslide Maps

CGS evaluates earthquake-induced landslide hazard potential by analyzing geologic material strength, slope gradient, and anticipated ground shaking. Resulting landslide hazard maps are useful tools to identify where slopes are more likely to fail during an earthquake. Landslide hazards are discussed in detail in Section 12.

Shaking Potential Mapping

Models of earthquake shaking hazards for a given place consider the potential for all future earthquakes on surrounding faults and their related ground motion affecting that place. Integrating all the potential for ground motion statewide produces maps that show the long-term probabilistic seismic hazard anywhere in the State. Such maps help identify particularly vulnerable areas.

CGS and the USGS have prepared mapping that shows the relative intensity of ground shaking in California from earthquakes (DOC 2022b). The shaking potential is calculated as the level of ground motion that has a 2 percent chance of being exceeded in 50 years. This equates to ground-shaking with about a 2,500-year average repeat time. Where the ground movement defined by the shaking potential has an acceleration that exceeds the acceleration of gravity (1 g), it is considered to be violent to extreme shaking (see Figure 5-2).

The mapping shows relatively long-period (1.0 second) earthquake shaking, which affects tall, relatively flexible buildings, and correlates well with overall earthquake damage. The ground-shaking mapping is used in the earthquake Risk Assessment for this Plan, indicating areas of the State that could experience significant shaking.

California Earthquake Clearinghouse

Following a large and damaging earthquake in California, critical information is rapidly needed to assess ground deformation, damaged buildings, and disrupted utilities and highways. When an earthquake of this extent occurs, the California Earthquake Clearinghouse is authorized to activate and establish a location close to the epicenter (California Public Resources Code, Div. 2, Ch. 2, Sec. 2201(c)). The Clearinghouse is managed jointly by CGS, the Earthquake Engineering Research Institute, Cal OES, the USGS, and the California Seismic Safety Commission (SSC). Its principal function is to promptly gather information from significant seismic events, coordinate the response, and share information with State and federal disaster response managers and the scientific and engineering communities.

Engineers, geologists, seismologists, sociologists, economists, and other professionals who arrive in the affected area share information, findings, and data through the Clearinghouse to maximize its availability. Information is shared through evening briefings and posting of preliminary findings, including data, maps, photos, and reports on the ***Learning from Earthquakes*** Clearinghouse event website hosted by the Earthquake Engineering Research Institute.

With both State and federal managing partners, the Clearinghouse supports the NEHRP directive for state and federal agencies to coordinate the collection of post-earthquake information through a clearinghouse. In addition to emergency response, the Clearinghouse supports pre-event preparedness planning and regional earthquake resilience to promote more rapid recovery.

5.2. HAZARD LOCATION

5.2.1. Fault Locations

California has many faults with the potential to produce damaging earthquakes. In general, faults that slip the fastest over geologic time are more likely to produce earthquakes in the near future (Figure 5-3). More than 70 percent of California's population lives within 30 miles of a known fault where strong ground shaking could occur in the next 30 years (Southern California Earthquake Center 2017).

Faults offshore of California are also capable of producing damaging earthquakes. The Cascadia Subduction Zone—a sizeable offshore fault system extending from Northern California to British Columbia—can produce great earthquakes (magnitudes greater than 8.0) north of Cape Mendocino (Cal OES 2018a). An event on this offshore fault system can increase the tsunami risk.

5.2.2. Areas Susceptible to Earthquake Damage

For the earthquake Risk Assessment in this plan, three data sets were used to map susceptibility to damage from earthquakes. These data sets account for the primary causes of damage from earthquakes:

- **NEHRP Soils Data**—Earthquake vulnerability based on the presence of NEHRP Type D, E, and F soils (see Figure 5-4).
- **Liquefaction Mapping**—Earthquake vulnerability based on liquefaction susceptibility (see Figure 5-5). Liquefaction mapping data currently is not available statewide. However, where this data is available, it can provide increased resolution on the risk associated with earthquakes.
- **Earthquake Shaking Potential**—Earthquake vulnerability based on having more than a 2 percent chance in 50 years of shaking that exceeds 1 g (see Figure 5-6).
- **Earthquake-Induced Landslide Hazard Zones**—Mapping of areas with a higher probability of earthquake-induced landslides, within which specific actions are mandated by California law prior to any development. See Chapter 12.
- Mapping indicates that the entire State is at risk of earthquakes, particularly along the coastline and the San Andreas Fault.

Figure 5-3. Significant Faults in California

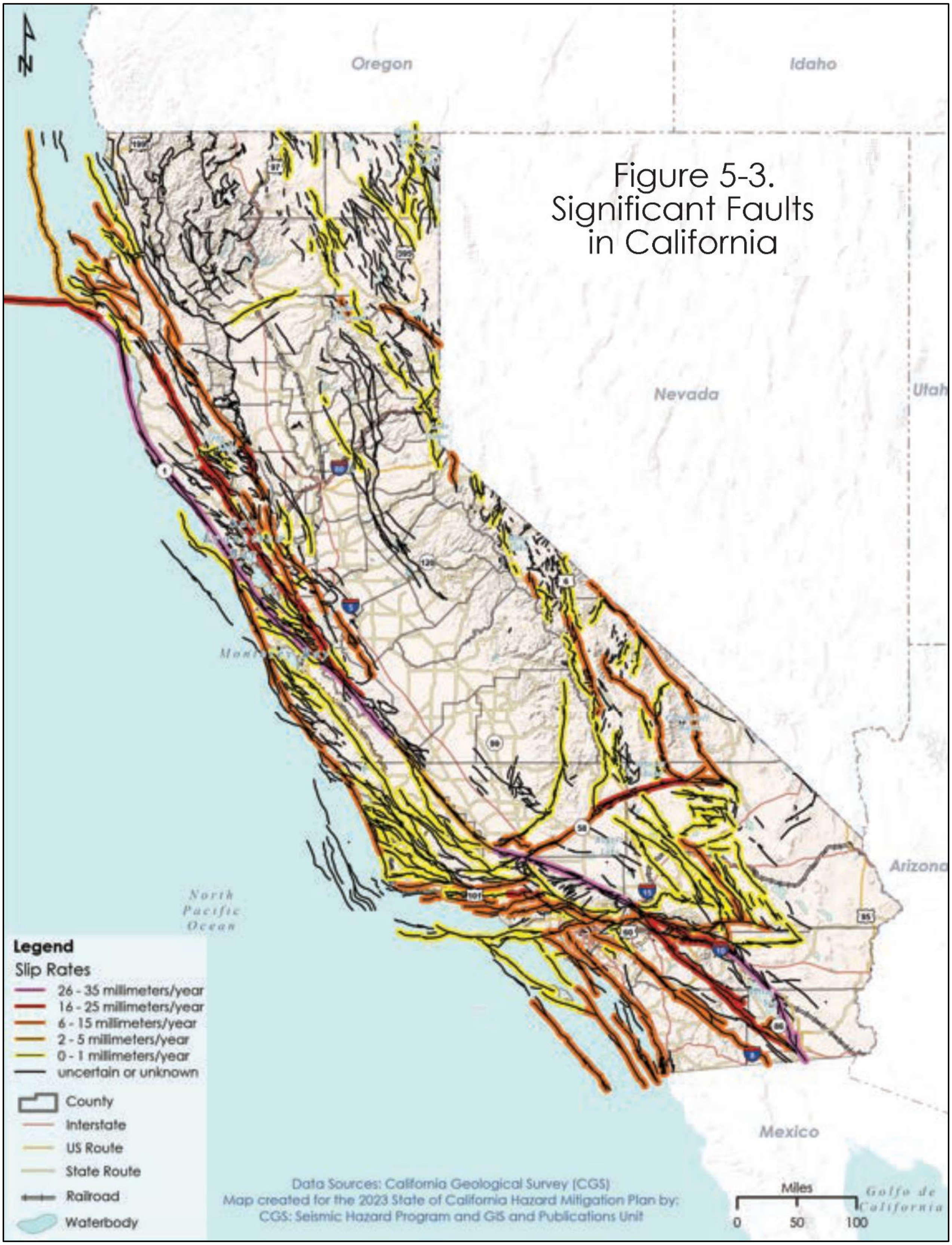


Figure 5-4. NEHRP Type D and E Soils

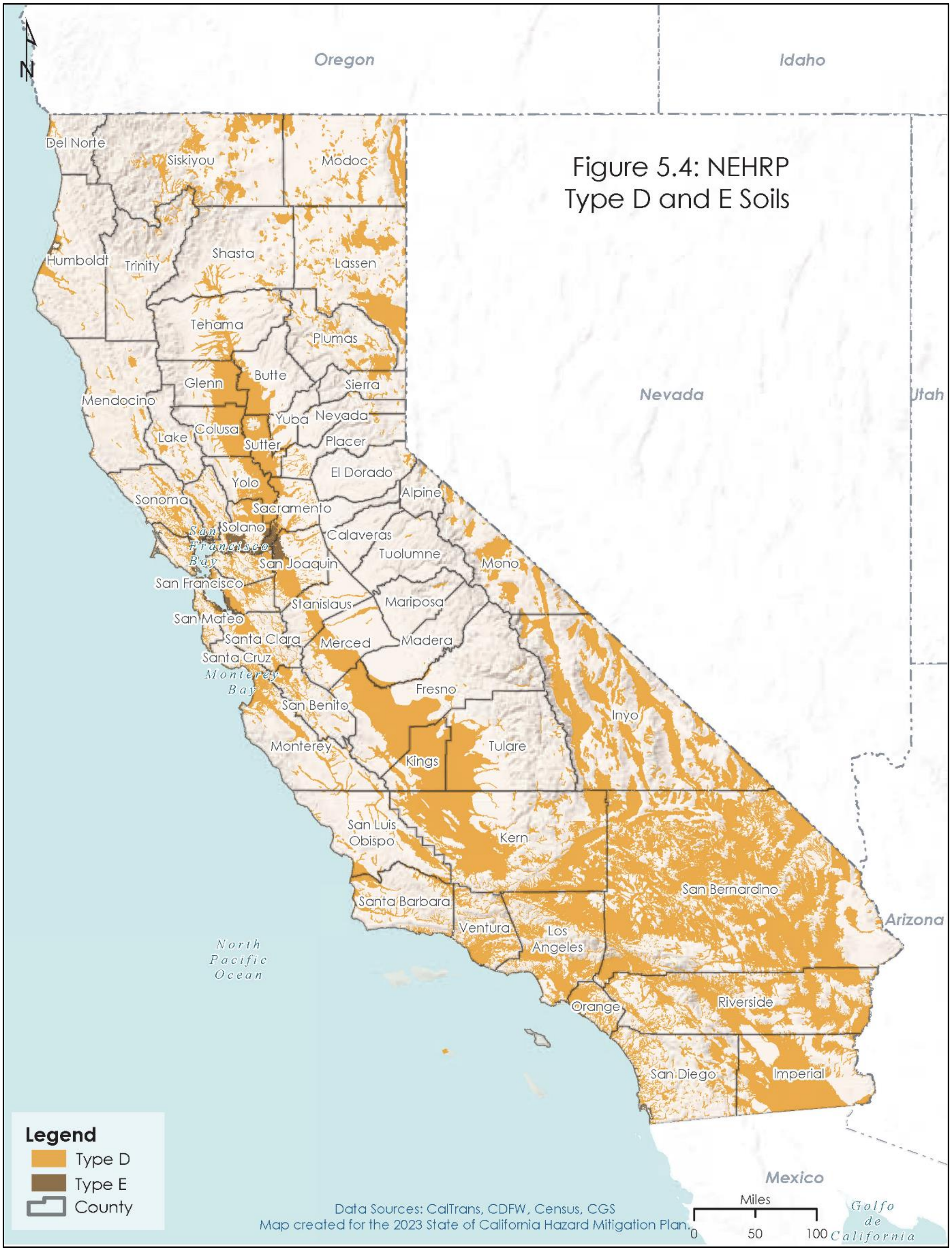


Figure 5-5. Liquefaction Zones

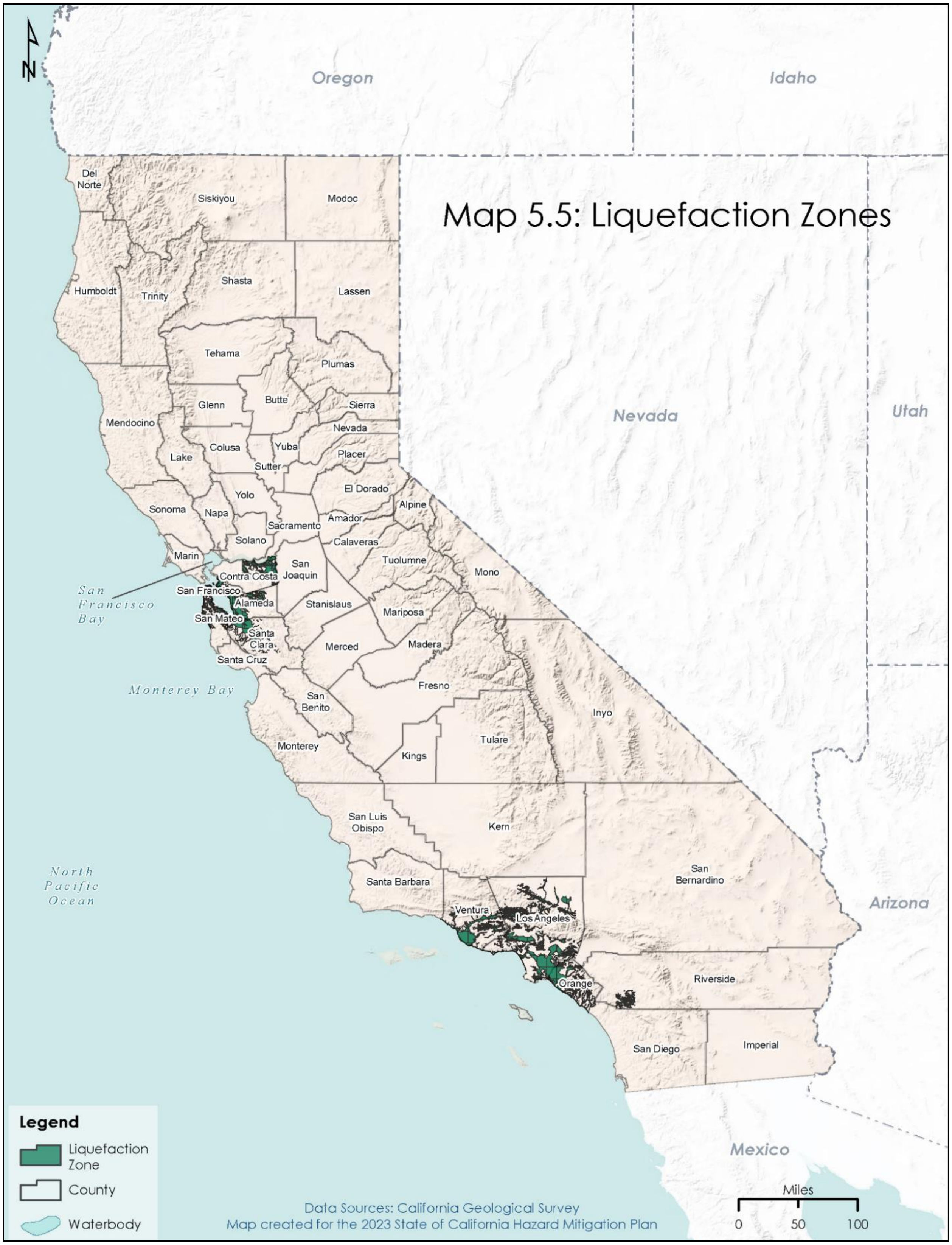
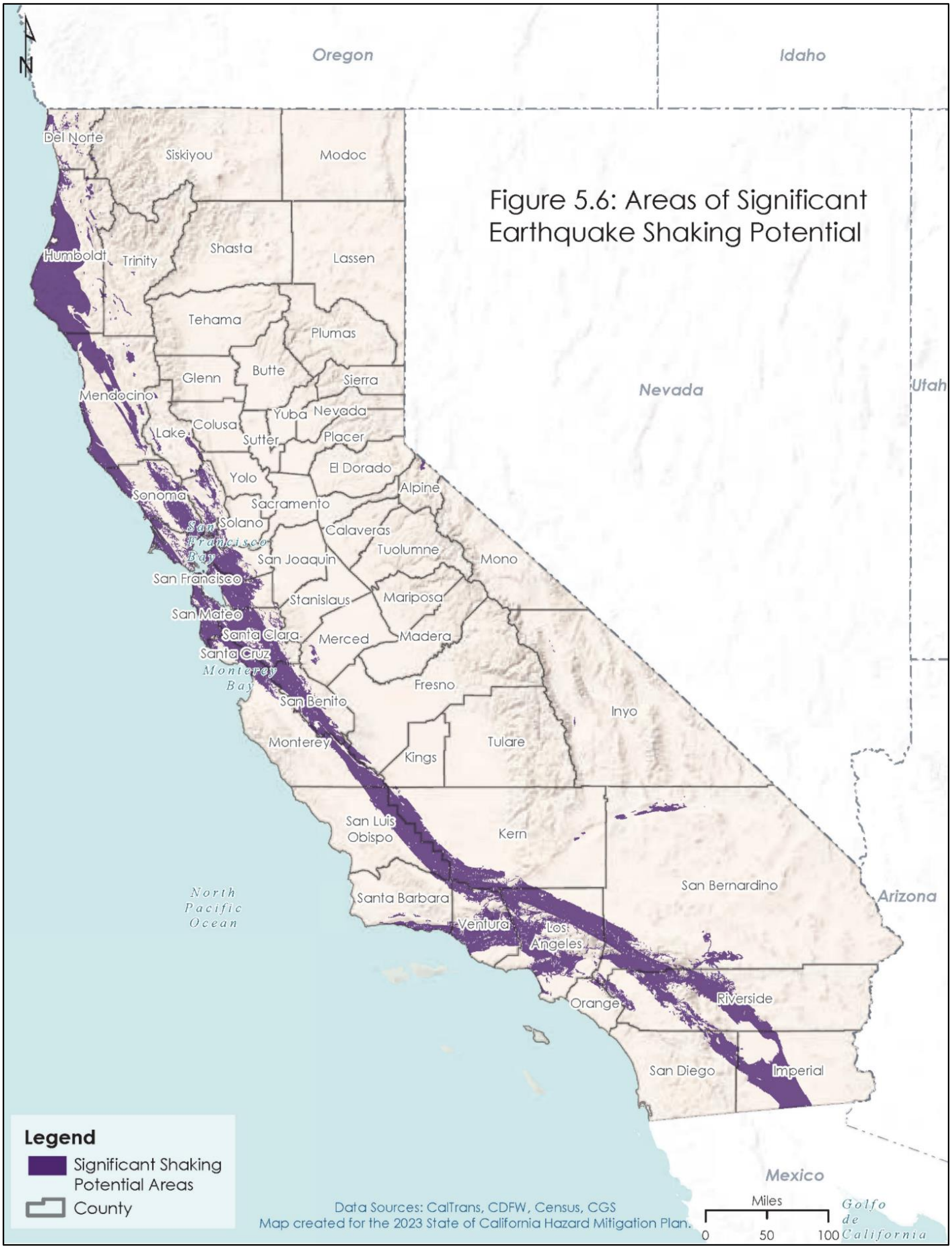


Figure 5-6. Areas of Significant Earthquake-Shaking Potential



5.3. PREVIOUS HAZARD OCCURRENCES

5.3.1. Disaster and Emergency Declarations

The following disaster declarations or emergency proclamations related to earthquakes have been issued for California (see Appendix F for details):

- Federal Major Disaster (DR) or Federal Emergency (EM) declaration, 1953 – 2022: 13 events, classified as earthquake
- California Emergency Proclamations, 1950 – 2022: 23 events, classified as earthquake
- USDA agricultural disaster declarations, 2012 – 2022: none

5.3.2. Event History

The 2018 SHMP discussed specific earthquake events in California through 2018. This SHMP update summarizes earthquake events of magnitude 5 or greater between 2018 and 2023, as listed in Table 5-2.

Table 5-2. Earthquake Events in California With a Magnitude 5 or Greater, 2018 to 2022

Date	Magnitude	Location (recorded epicenter)
April 5, 2018	5.3	19 miles southwest of Santa Cruz Island (E end), CA
June 23, 2019	5.6	4 miles south-southwest of Petrolia, CA
July 4, 2019	6.4	Ridgecrest Earthquake Sequence
July 5, 2019	5.4	10 miles west of Searles Valley, CA
July 6, 2019	7.1	11 miles west of Searles Valley, CA
July 6, 2019	5.5	9 miles east-southeast of Little Lake, CA
July 6, 2019	5.4	12 miles east of Little Lake, CA
March 18, 2020	5.2	9 miles west of Petrolia, CA
April 11, 2020	5.2	19 miles southeast of Bodie, CA
June 4, 2020	5.5	11 miles south of Searles Valley, CA
June 24, 2020	5.8	11 miles south-southeast of Lone Pine, CA
June 5, 2021	5.3	7 miles west of Calipatria, CA
July 8, 2021	6.0	Antelope Valley, CA
July 8, 2021	5.0	20 miles southeast of Markleeville, CA
July 18, 2021	5.1	7 miles west of Petrolia
December 20, 2021	6.2	4 miles north of Petrolia, CA
October 25, 2022	5.1	9 miles east-southeast of East Foothills, CA
December 20, 2022	6.4	9 miles southwest of Ferndale, CA
January 2, 2023	5.4	30 miles south of Eureka and 9 miles southeast of Rio Dell

Sources: (USGS 2023a), (SCEDC 2023)

5.4. PROBABILITY OF FUTURE HAZARD EVENTS

5.4.1. Overall Probability

Probability Based on Previous Events

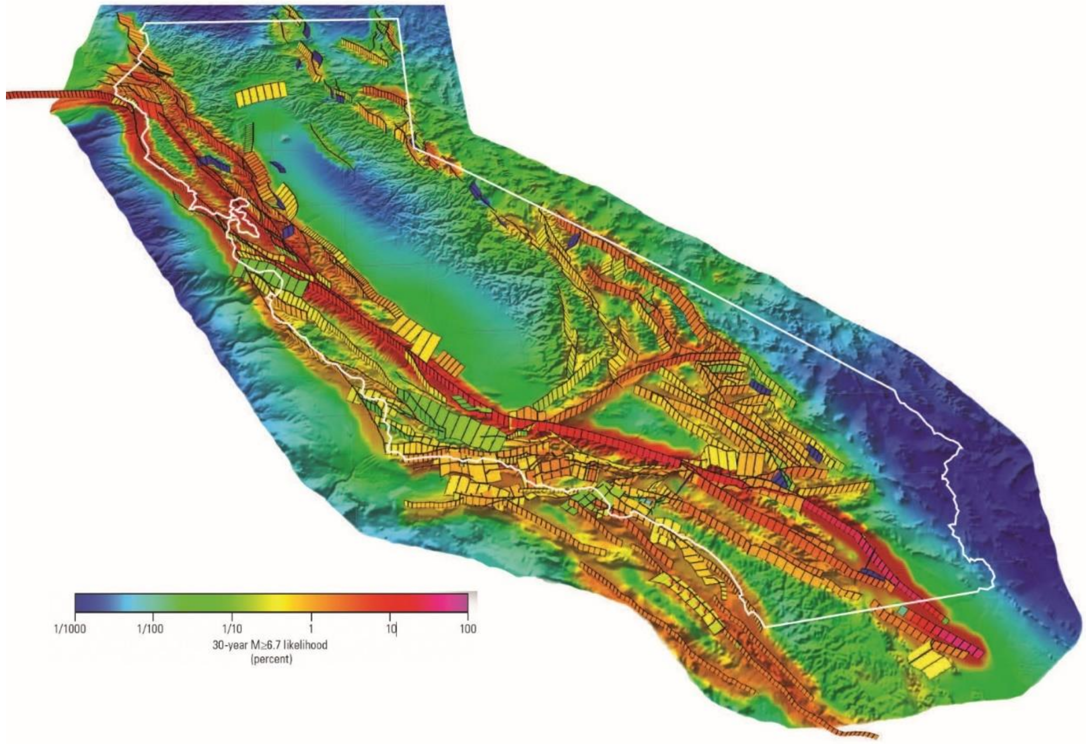
According to the USGS earthquake database, California experienced 285 earthquakes, magnitude 5 and greater, between 1950 and 2021. Based on these statistics, the State can expect at least four earthquakes with a magnitude of 5 or greater each year.

Uniform California Earthquake Rupture Forecast

The sliding movement of rock on either side of a fault is called fault rupture. The fault rupture is responsible for causing the resulting shaking. Scientists have developed an earthquake forecast model for California called the Third Uniform California Earthquake Rupture Forecast (UCERF3) (Field, et al. 2013). The model estimates the magnitude, location, and likelihood of earthquake fault rupture throughout the State. Figure 5-7 shows the model's estimate of the likelihood over the 30 years following 2014 of an earthquake of magnitude 6.7 or greater at locations across the State.

Overall, the results of the UCERF3 modeling confirm previous findings but with some significant changes. For example, compared to the previous forecast model version, the likelihood of moderate-sized earthquakes (magnitude 6.5 to 7.5) is lower, whereas that of larger events is higher. This model serves as a reminder that damaging earthquakes are inevitable in California.

Figure 5-7. Likelihood of a Magnitude 6.7 or Larger Earthquake in the Next 30 Years



Source: (WGCEP 2021)

5.4.2. Climate Change Impacts

The potential direct impacts of climate change on earthquake probability are unknown. Climate change can increase the risk of cascading hazards related to earthquakes, including landslides. Rising air temperatures can facilitate soil breakdown, allowing more water to penetrate soils and affecting erosion rates, sediment control, and the likelihood of landslides. Climate change may also increase the probability of more frequent, intense rainstorms. This can result in more significant erosion, higher sediment transport in rivers and streams, and a higher probability of landslides, primarily from higher water content.

5.5. IMPACT ANALYSIS

5.5.1. Severity

Ground shaking from earthquakes can cause buildings and bridges to collapse; disrupt utility services; and trigger landslides, avalanches, flash floods, fires, and tsunamis. Collapsing buildings and infrastructure during earthquake events produced eight of the 10 costliest disasters In California in the last 100 years (CEA 2020).

State infrastructure (roads, highways, dams, and State water projects) located in areas with liquefaction zones or on NEHRP Soil Types D, E, and F can experience extensive cracking, rip apart, settle, and slough during an earthquake.

As shown in Table 5-2, in just a five-year period, California has experienced numerous earthquakes exceeding magnitude 5, several more exceeding magnitude 6, and one exceeding magnitude 7. The last major rupture in the Cascadia Subduction Zone in 1700 caused what was likely an earthquake in the magnitude 9 range (Oregon Department of Emergency Management n.d.). Figure 5-1 and Table 5-1 describe potential observed effects for ranges of magnitude to associate with the severity of the events cited in Table 5-2.

5.5.2. Warning Time

Researchers are studying potential earthquake warning systems to give critical seconds' notice before damaging levels of shaking arrive. The warning time could allow someone to get under a desk, step away from a hazardous material, or shut down a computer system.

Cal OES's Earthquake Early Warning California (MyShake), developed in partnership with UC Berkeley and USGS ShakeAlert, is the country's first publicly available, statewide warning system that provides seconds or tens of seconds to take cover or other preventive measures before shaking occurs, depending on the location of the event. The system uses data from motion sensors and Global Navigation Satellite System across the State to detect earthquakes before humans can feel them and to notify Californians of an earthquake in advance. Individuals can download the MyShake App on their phones to receive earthquake warnings.

5.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may, in turn, trigger still others. The following are notable cascading impacts associated with earthquakes beyond the hazards associated with ground shaking:

- **Surface Fault Rupture—**When a fault rupture extends to the earth's surface, the displacement can catastrophically damage structures or utilities. Fissuring, settlement, and permanent horizontal and vertical ground shifting often accompany large earthquakes. Such displacement can significantly increase damage and may be a contributing cause of damage. Studies after the 1972 San Fernando Earthquake showed that incidents of moderate to severe damage were significantly elevated near the fault zone. Because of its geographic extent and the tendency for it to be buried, networked infrastructure such as water, power, communication, and transportation infrastructure is particularly vulnerable to surface fault rupture.

- **Fires—**Fires following earthquakes may result from multiple causes, including overturned burning candles, sparking from downed power lines, and broken gas pipelines (Scawthorn and Schiff 2005). Fires following the 1906 San Francisco Earthquake led to more damage than was caused by ground shaking. Significant fires also occurred in San Francisco following the 1989 Loma Prieta Earthquake and in Los Angeles following the 1994 Northridge Earthquake. Fires after earthquakes may severely strain fire departments that must respond to multiple simultaneous ignitions. Impaired communications, water supply, transportation, and other demands such as structural collapses, hazardous materials releases, or medical emergencies affect fire department response. Several computer programs (e.g., Hazus, URAMP, SERA, and RiskLink) are available to assess the fire-following-earthquake vulnerability of a community in future earthquakes (Scawthorn and Schiff 2005).
- **Liquefaction—**Ground settlement during liquefaction can cause damage when the amount of settlement varies significantly across the length of a structure. Liquefaction can occur in susceptible soils below bodies of water. It can severely damage dams, bridges, wharves, piers, and other structures at ports and harbors, as well as underwater utility lines.
- **Landslides—**Landslides caused by earthquakes can be widespread over the area of the highest shaking intensity and at greater distances if hillsides are susceptible. Earthquake-induced landslides can significantly damage structures and transportation and utility lifelines.
- **Tsunami—** Fault rupture and earthquake-induced landslides along the coast and offshore can trigger tsunamis that can cause flooding in low-lying coastal areas.
- **Dam or Levee Failure—**Earthquake ground shaking in and around dams and levees can affect the performance of these structures. The type of foundation

the dam or levee is constructed on (such as peat or alluvium) will influence its performance during a seismic event or under certain static loading conditions.

- **Power Outages—**Earthquakes can cause significant impacts associated with loss of power. Earthquakes of all sizes can damage electrical facilities and power lines, impacting community lifelines that rely on power to maintain their critical functions.
- **Hazardous Materials Release—**Earthquakes can result in collapsed buildings and severed pipelines, leading to the release of hazardous materials, which may include oil spills, the release of gases, and runoff of hazardous materials (Young, Balluz and Malilay 2004).

5.5.4. Environmental Impacts

Environmental problems from earthquakes can be numerous. Earthquake-induced landslides can significantly damage the surrounding habitat. It is also possible for earthquakes to reroute streams, which can change the water quality, possibly damaging habitat and feeding areas. Streams fed by groundwater or springs may dry up because of changes in underlying geology.

Another threat to the environment from earthquakes is the potential release of hazardous materials caused by any of the following:

- The toppling of elevated tanks or overturning of horizontal tanks
- Structural failures
- Dislodging of asbestos
- Sloshing from open-topped containers
- Falling containers or shelves, especially in laboratories
- Storage container failures
- Under- or above-ground pipeline breaks
- Structural fire in industrial facilities following earthquake events

5.5.5. Impacts on Agriculture

California agriculture is large, diverse, and complex, and agricultural impacts from earthquakes can be significant. Earthquakes can cause damage and the loss of infrastructure that supports agricultural production, storage, and transport. Damage to major hubs, including ports, may have more substantial impacts. A 2014 report for SCC found that significant losses are a concern for rural food and agricultural industries and concluded the following:

- Large areas of California agriculture—along the Mexican border, along the central and southern coast, and near the Sacramento-San Joaquin Delta—are especially vulnerable to seismic activity.
- The California produce industry may be more vulnerable to seismic disruptions than any other agricultural sector because of its location and the high levels of perishability.
- The most important dairy production and processing regions, in the Southern San Joaquin Valley, are less prone to seismic events than the coastal counties and Imperial County. Nonetheless, given extreme perishability and animal welfare concerns, dairies need to be aware of seismic risks.

5.5.6. Local Hazard Impacts

LHMP Rankings

All but one of the hazard mitigation plans prepared for California's 58 counties list earthquake as a hazard of concern, and 46 counties rank it as a high-impact hazard:

- Alameda
- Amador
- Butte
- Contra Costa
- Del Norte
- El Dorado
- Fresno
- Humboldt
- Imperial
- Inyo
- Kern
- Kings
- Lake
- Lassen
- Los Angeles
- Madera
- Marin
- Mendocino
- Merced
- Modoc
- Monterey
- Napa
- Nevada
- Orange
- Placer
- Plumas
- Riverside
- Sacramento
- San Benito
- San Bernardino
- San Diego
- San Francisco
- San Luis Obispo
- San Mateo
- Santa Barbara
- Santa Clara
- Santa Cruz
- Shasta
- Sierra
- Solano
- Sonoma
- Stanislaus
- Sutter
- Tuolumne
- Yolo
- Yuba

An additional eight counties identified earthquake as a medium-impact hazard.

LHMP Estimates of Potential Loss

Table 5-3 summarizes potential losses to vulnerable structures based on estimates from the local risk assessments (as called for in FEMA's Standard State Mitigation Planning Requirement S6.b). Due to variances in approaches to assessing risk at the local level as well as the hazards assessed and the age of each assessment reviewed, this data is considered approximate.

Table 5-3. Earthquake Risk Exposure Analysis for LHMP Reviews

Estimated Total Population Exposed	39,538,232*
Estimated Number of Structures at Risk	8,361,028
Estimated Value of Structures at Risk	$319.6 billion

* Assumed to be the entire State population

5.6. VULNERABILITY ANALYSIS

The earthquake vulnerability assessment for State-owned or -leased assets and critical facilities/community lifelines looked at NEHRP soil types D and E, liquefaction zones (where mapping is available; liquefaction zones are not yet mapped for most of the State), and exposure to ground shaking. The assessment determined the exposure to State assets, critical facilities, and community lifelines to these hazard areas.

5.6.1. Exposure of State-Owned or -Leased Facilities

Table 5-4 and Table 5-5 summarize the number and replacement cost value of State assets on NEHRP Type D or E soils, in liquefaction zones (where data are available) and in areas of potential significant shaking.

Figure 5-8, Figure 5-9, and Figure 5-10 summarize the exposed assets as a percentage of total assets statewide. Appendix I provides detailed results by county.

Table 5-4. State-Owned or -Leased Facilities Exposed to the Earthquake Hazard

Type of Facility	Number of Structures	Total Area (sq. ft.)	Replacement Cost Value		
			Structure	Content	Total
State Facilities on NEHRP Soil Types D & E					
State-Leased Facilities	1,037	—	$5,436,392,749	$5,526,604,492	$10,962,997,241
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	2,176	23,629,348	$2,106,526,246	$1,290,776,135	$3,397,302,381
Development Center	0	0	$0	$0	$0
Hospital	2	119,500	$6,114,574	$4,531,982	$10,646,556
Migrant Center	14	818,733	$606,765,693	$311,004,919	$917,770,612
Special School	64	510,744	$10,729,356	$9,928,709	$20,658,065
All Other Facilities	7,155	79,325,222	$6,333,510,634	$6,447,416,272	$12,780,926,905
Total State-Owned	***9,411***	***104,403,547***	***$9,063,646,503***	***$8,063,658,016***	***$17,127,304,519***
Total Facilities	**10,448**	**N/A***	**$14,500,039,252**	**$13,590,262,508**	**$28,090,301,760**
State Facilities in the Mapped Liquefaction Zone (zones are not yet mapped for the entire State)					
State-Leased Facilities	235	—	$1,185,108,167	$1,189,440,868	$2,374,549,035
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	68	482,198	$33,750,554	$26,291,181	$60,041,735
Development Center	0	0	$0	$0	$0
Hospital	1	71,500	$5,669,649	$3,864,595	$9,534,245
Migrant Center	0	0	$0	$0	$0
Special School	64	510,744	$10,729,356	$9,928,709	$20,658,065
All Other Facilities	927	17,569,418	$1,709,473,964	$1,793,595,177	$3,503,069,141
Total State-Owned	***1,060***	***18,633,860***	***$1,759,623,523***	***$1,833,679,663***	***$3,593,303,186***
Total Facilities	**1,295**	**N/A***	**$2,944,731,690**	**$3,023,120,530**	**$5,967,852,220**

Type of Facility	Number of Structures	Total Area (sq. ft.)	Replacement Cost Value		
			Structure	Content	Total
State Facilities in Mapped Areas Exposed to Ground Shaking					
State-Leased Facilities	468	—	$2,357,525,251	$2,376,797,602	$4,734,322,853
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	150	1,707,566	$71,675,721	$54,920,790	$126,596,511
Development Center	0	0	$0	$0	$0
Hospital	308	2,866,825	$95,505,290	$114,662,785	$210,168,075
Migrant Center	3	231,750	$515,052,873	$257,526,437	$772,579,310
Special School	64	510,744	$10,729,356	$9,928,709	$20,658,065
All Other Facilities	4,830	66,335,481	$5,183,127,033	$5,426,765,460	$10,609,892,493
Total State-Owned	***5,355***	***71,652,366***	***$5,876,090,273***	***$5,863,804,181***	***$11,739,894,454***
Total Facilities	**5,823**	**N/A***	**$8,233,615,524**	**$8,240,601,783**	**$16,474,217,306**

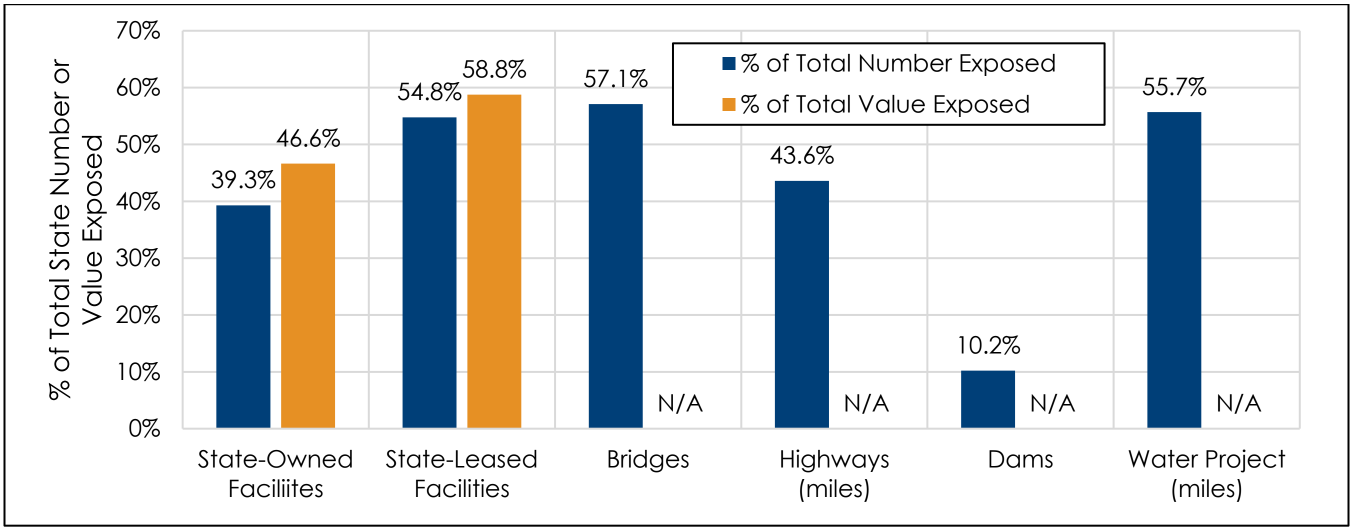
* The inventory of State assets does not include building area for State-leased facilities, so no total area for all State facilities is provided; the building area of vulnerable assets is shown for State-owned facilities only.

Table 5-5. State-Owned Infrastructure Exposed to the Earthquake Hazard

Type of Facility	State-Owned Infrastructure in the Mapped Hazard Area		
	NEHRP Soil Types D & E	Liquefaction Zones*	Exposure to Ground Shaking
Bridges	7,538	2,276	4,642
Highway (miles)	13,120.8	1,601.9	6,364.1
Dams	5	1	9
Water Project (miles)	398.0	7	225.7

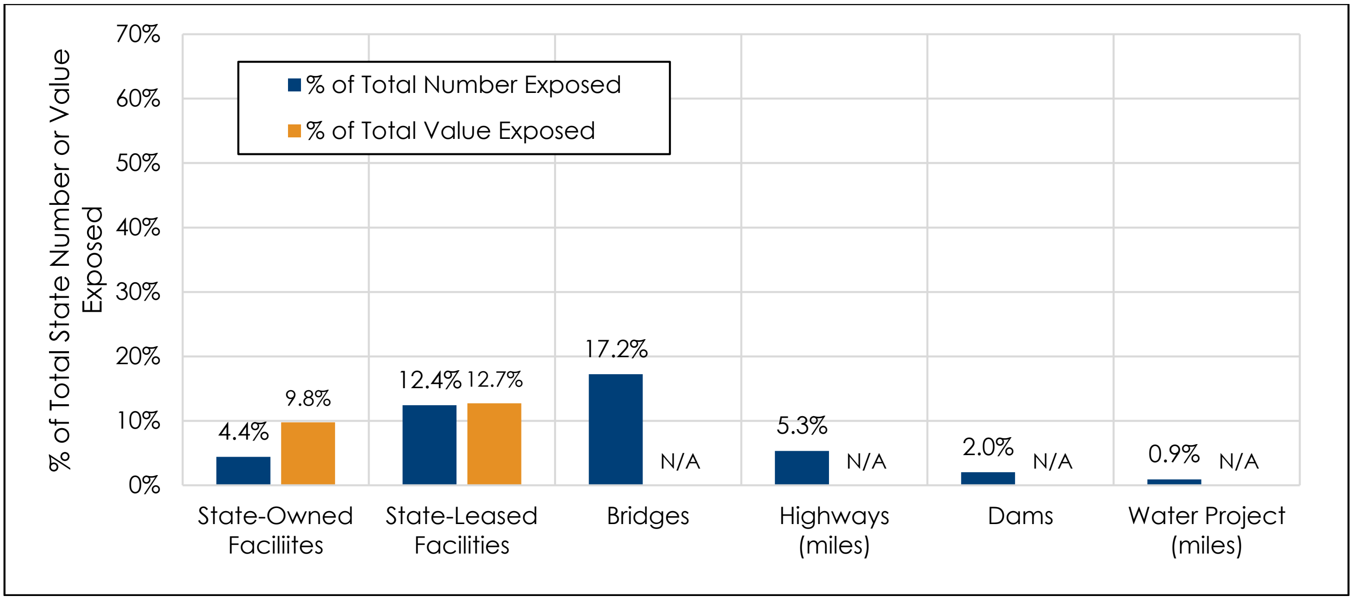
* Liquefaction hazard zones are not yet mapped for the entire State.

Figure 5-8. State Assets on NEHRP Type D or E Soils, as % of Statewide Total



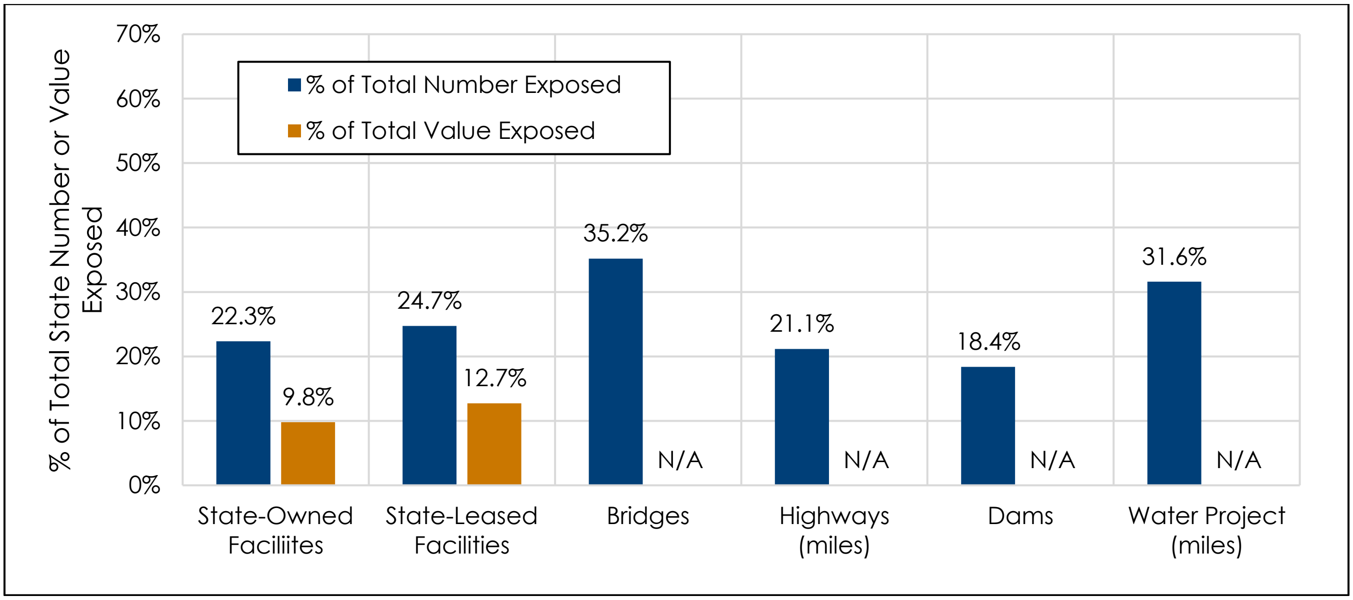
N/A: Values not defined for bridges, highways, dams, and water project

Figure 5-9. State Assets in Mapped Liquefaction Hazard Zones, as % of Statewide Total



N/A: Values not defined for bridges, highways, dams, and water project

Figure 5-10. State Assets in Areas with Significant Ground Shaking Potential, as % of Statewide Total



N/A: Values not defined for bridges, highways, dams, and water project

The following are significant results of the analysis of State-owned or -leased assets in the earthquake hazard areas:

- For State-owned facilities in areas with NEHRP Soil Types D and E, the average area is 1,800,061 square feet, with an average replacement cost value of

$295 million (structure and contents). In mapped liquefaction areas, the average area is 321,273 square feet, with an average replacement cost value of $61.9 million (structure and contents). In areas susceptible to significant ground shaking, the average area is 13,380 square feet, with an average replacement cost value of $2.2 million (structure and contents).

- The average replacement cost value for State-leased facilities (structure and contents) is $189 million on NEHRP Soil Types D and E, $40.9 million in mapped liquefaction zones, and $10.1 million in areas susceptible to significant ground shaking.
- The five State agencies with the most State-owned or -leased facilities in earthquake hazard areas are as follows:
    - **NEHRP Types D and E soils**—CDCR (2,223), State Parks (2,021), UC (1,234), Caltrans (1,073), and California Department of Fish and Wildlife (CDFW) (695).
    - **Mapped Liquefaction zones**—State Parks (280), California State University (CSU) (210), Caltrans (194), California Department of Education (CDE) (79), and CDCR (78).
    - **Significant ground shaking areas**— State Parks (1,924), UC (616), Caltrans (562), CSU (537), and CAL FIRE (463).
- The State agency with the highest total replacement cost for State-owned or -leased facilities in areas of NEHRP Soil Types D and E and areas susceptible to significant ground shaking is CSU, at $3.8 billion.

5.6.2. Exposure of Critical Facilities and Community Lifelines

Functional downtime is the most significant earthquake impact on critical facilities and community lifelines. The severity of this impact is based on the amount of time it takes to restore damaged facilities to operational status. Hazus estimates damage and functional downtime for earthquake scenarios. Local governments are encouraged to use Hazus or similar tools when developing LHMPs.

Transportation routes, including bridges and highways, are vulnerable to earthquakes, especially in NEHRP Soil Types D and E and liquefaction zones. Aging infrastructure and those already in poor condition are most vulnerable.

Interruption of utility infrastructure services may impact vulnerable populations and facilities that need to be in operation during a disaster. Table 5-6 summarizes the total number of critical facilities, by community lifeline, located in earthquake hazard areas statewide. Food, water, and shelter facilities have the largest number located in these hazard areas. Appendix I provides detailed results by county.

Table 5-6. Critical Facilities and Community Lifelines Exposure to Earthquake Hazard Areas

Lifeline Category	Total Number of Facilities	Number of Facilities in Hazard Area			% of Total Facilities		
		NEHRP D & E	Liquefaction *	Significant Ground Shaking	NEHRP D & E	Liquefaction *	Significant Ground Shaking
Communications	42	30	13	24	71.4%	31.0%	57%
Energy	176	92	32	51	52.3%	18.2%	18%
Food, Water, Shelter	257	131	37	73	51.0%	14.4%	28%
Hazardous Material	56	35	12	8	62.5%	21.4%	14%
Health & Medical	47	20	9	23	42.6%	19.1%	49%
Safety & Security	46	20	6	16	43.5%	13.0%	35%
Transportation	131	84	40	46	64.1%	30.5%	35%
Total	**755**	**412**	**149**	**241**	**54.6%**	**19.7%**	**32%**

* Liquefactions zones are not yet mapped for the entire State.

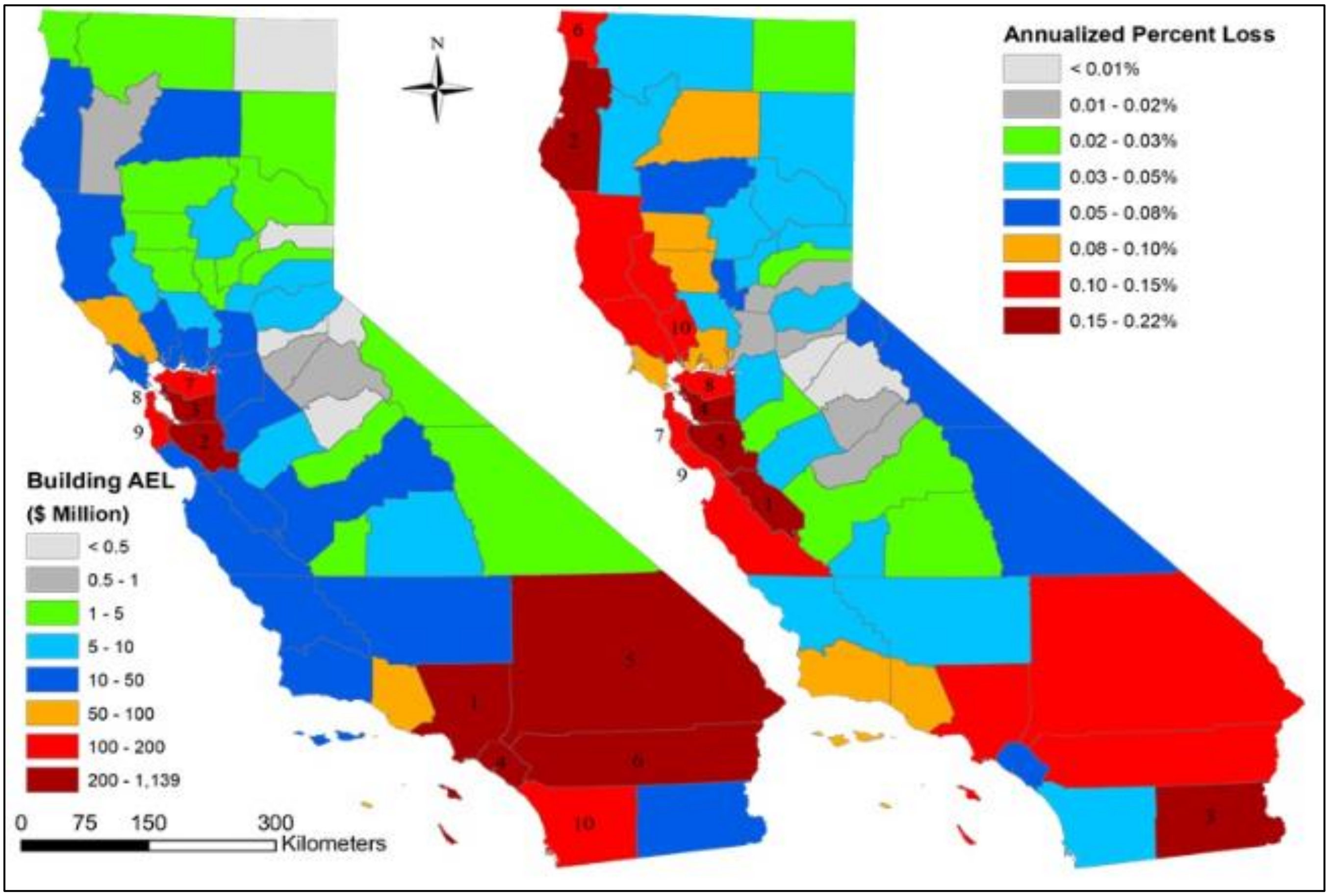
5.6.3. Estimates of Loss

Earthquake loss estimation quantifies seismic risk based on exposure and vulnerability of the built environment. Such studies need to be frequently updated because of the continuing development of the built environment and evolving technology in seismic hazard assessments. CGS has participated in the development of many planning scenarios since 1980. CGS also updates its scenario- and probabilistic-based loss estimations when significant developments occur in ground motion hazard analyses and the built environment (DOC 2019b).

In 2016, CGS calculated the annualized earthquake loss for California. The annualized earthquake loss provides a long-term average yearly loss in a geographic area. It indicates relative regional earthquake risk and facilitates comparison of earthquake risk among different communities. The 2016 analysis estimates the annualized loss to be $3.7 billion for California. This is 11 percent higher than the 2010 estimates due to the combined effects of increased building inventory value and differences in velocity maps (Chen and Wils 2016).

Figure 5-11 shows the building annualized earthquake loss and annualized percent earthquake loss. The five counties with the highest estimated loss are Los Angeles, Santa Clara, Alameda, Orange, and San Bernardino. The five counties with the highest annualized percent earthquake loss are San Benito, Humboldt, Imperial, Alameda, and Santa Clara.

Figure 5-11. Distribution of Annualized Earthquake Losses and Annualized Percent Earthquake Loss



Source: (Chen and Wils 2016)

5.6.4. Buildable Land

Of 11.7 million acres of land available for development statewide, 143,890 acres (1.2 percent) are located in the liquefaction zones that have been mapped so far, 3,714,106 acres (31.5 percent) are located in areas with NEHRP Type D or E soils, and 1,800,765 acres are located in areas susceptible to significant ground shaking. Appendix G provides a detailed assessment of exposed buildable lands by county.

5.6.5. Equity Priority Communities

The risk analysis for earthquakes found the following vulnerability of equity priority communities (a breakdown by county is included in Appendix I):

- 36.7 percent of people living on NEHRP Type D or E soils live in equity priority communities (6,898,652 people)
- 35.6 percent of people living in liquefaction areas that have been mapped live in equity priority communities (2,707,505 people)
- 27.8 percent of people living in areas of significant shaking potential live in equity priority communities (4,083,116 people)

5.6.6. NRI Scores

According to the NRI, all the State's counties have earthquake risk, rated from relatively low to very high. Table 5-7 shows scores for the six counties with the highest rating. See Section 4.1.3 for a description of the components of the NRI.

Table 5-7. NRI Scoring of Counties for Earthquake

County	Expected Annual Loss	Social Vulnerability Rating	Community Resilience Rating	Community Risk Factor	Risk Value	Score
Los Angeles	$3.8 billion	Very High	Very Low	1.36	$5.2 billion	100
Santa Clara	$1.2 billion	Relatively Low	Relatively High	1.34	$1.33 billion	99.97
Alameda	$1.2 billion	Relatively Moderate	Very High	1.13	$1.33 billion	99.94
San Bernardino	$964 million	Very High	Relatively Moderate	1.34	$1.32 billion	99.90
Orange	$926 million	Relatively Moderate	Very Low	1.26	$1.2 billion	99.87
Riverside	$838 million	Very High	Relatively Low	1.34	$1.1 billion	99.84

5.7. MITIGATING THE HAZARD

5.7.1. Existing Measures for Mitigating the Hazard

Earthquake mitigation measures are typically intended to reduce damage and fatalities from earthquakes. Common mitigation measures include:

- Structural mitigation measures to improve the capacity of a building to resist seismic forces
- Nonstructural mitigation measures to restrain, brace, anchor, or otherwise improve the seismic resistance of nonstructural building components
- Replacement of an existing building with substantial seismic deficiencies with a new current code building
- Design and construction of a new facility to be higher than the minimum seismic standards required by building codes

The State of California has invested significantly in seismic mitigation efforts. The State developed a method to mitigate ground failure-related hazards caused by earthquakes. Through the Alquist-Priolo Earthquake Fault Zoning Act of 1972, which addresses hazards associated with surface fault rupture, and the Seismic Hazards Mapping Act of 1990, addressing hazards from soil liquefaction and earthquake-induced landslides, CGS delineates regulatory earthquake zones over the State's most populated areas and most hazardous faults. These earthquake zones promote mitigation activities before or during construction, making new developments resilient to future earthquakes, saving lives, and reducing earthquake recovery costs. In 2018, CGS launched the California Earthquake Hazards Zone Application, also called EQZapp, an online mapping tool that allows anyone to check whether a property is in an earthquake hazard zone (DOC 2019a).

5.7.2. Opportunities for Mitigating the Hazard

In addition to the mitigation actions described above, Table 5-8 provides a range of potential alternatives for mitigating the earthquake hazard (see Section 1.2.3 for a description of the different types of alternatives).

Table 5-8. Potential Opportunities to Mitigate the Earthquake Hazard

Community-Scale	Organizational -Scale	Government-Scale
Manipulate the hazard: ▪ Apply engineering solutions that minimize or eliminate the hazard **Reduce exposure and vulnerability:** ▪ Locate outside of the hazard area (off soft soils) ▪ Retrofit structure (anchor house structure to the foundation) ▪ Secure household items that can cause injury or damage (such as water heaters, bookcases, and other appliances) ▪ Build to higher design **Build local capacity:** ▪ 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	**Manipulate the hazard:** ▪ Apply engineering solutions that minimize or eliminate the hazard **Reduce exposure and vulnerability:** ▪ Locate or relocate mission-critical functions outside hazard areas where possible ▪ Build redundancy for critical functions and facilities ▪ Retrofit critical buildings and areas housing mission-critical functions **Build local capacity:** ▪ Adopt a higher standard for new construction; consider "functional recovery-based design" when building new structures ▪ Keep cash reserves for reconstruction ▪ Inform employees about the possible impacts of earthquakes and how to deal with them at work	**Manipulate the hazard:** ▪ Apply engineering solutions that minimize or eliminate the hazard **Reduce exposure and vulnerability:** ▪ Locate critical facilities or functions outside the hazard area where possible ▪ Harden infrastructure ▪ Provide redundancy for critical functions ▪ Adopt higher regulatory standards ▪ Encourage and invest in renewable energy and backup and storage, such as microgrids, for vital systems redundancy during power outages and interruptions **Build local capacity:** ▪ 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 the capital improvement plan ▪ Develop a strategy to take advantage of post-disaster opportunities ▪ Warehouse critical infrastructure components such as pipes, power lines, and road repair materials ▪ Develop and adopt a continuity of operations plan ▪ Initiate triggers guiding improvements (such as >50% substantial damage or improvements)

Community-Scale	Organizational -Scale	Government-Scale
▪ Become informed on the hazard and risk reduction alternatives available ▪ Develop a post-disaster action plan for your household ▪ Consider the purchase of earthquake insurance	▪ Develop a continuity of operations plan ▪ Consider the purchase of earthquake insurance	▪ 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 ▪ Evaluate earthquake insurance as an option ▪ Expand data collection capabilities of the California Earthquake Clearinghouse ▪ Broaden application of lessons learned from California Earthquake Clearinghouse ▪ Establish Local Assistance Centers
Nature-based opportunities: ▪ None identified		

5.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address the earthquake hazard:

- Action 2023-002: Conduct both structural and non-structural assessments of State-owned facilities that identify vulnerabilities and feasible alternatives to retrofit those vulnerabilities.
- Action 2023-003: Develop a Hazus repository for both earthquake and flood hazards where local planning efforts that create these models can share this information with the State once the models have been developed.
- Action 2023-004: Leverage existing State programs to develop and support programs for the assessment and retrofit of structures identified with soft-story construction.
- Action 2023-005: Coordinate planning efforts for aquifer storage and recharge actions within areas of known liquefaction risk (note that not all liquefaction areas in the State have yet been mapped) so that the risk is addressed if potentially increased by the storage basin mitigation action.

An Example Success Story for Earthquake Mitigation:

The California Residential Mitigation Program's Earthquake Brace + Bolt Program

Two homes after the 2022/2023 Ferndale Earthquakes – The house on the left fell off its foundation without retrofitting. The house on the right remained on its foundation due to retrofitting.

Problem: The California Earthquake Authority (CEA) estimates more than 1.2 million houses in high-seismic-hazard areas in California are vulnerable to earthquakes because of their construction types. Many of these homes were built before 1980, are wood-framed with a raised foundation, and may have a cripple wall in the crawl space. A 6.4 magnitude earthquake on December 20, 2022, followed by a 5.3 magnitude earthquake on January 1, 2023, damaged many wood-framed homes in Humboldt County that would have benefited from a retrofit.

Solution: Bolting the home to its foundation and bracing its cripple walls reduces the likelihood that these older homes will slide off their foundation during an earthquake. The California Residential Mitigation Program's Earthquake Brace + Bolt (EBB) program addresses this vulnerability. Retrofits must adhere to the California Existing Building Code. Since 2014 when the first EBB retrofit was completed, EBB grants have helped more than 19,000 homeowners retrofit their homes.

Cost and Funding: The California Residential Mitigation Program administers the EBB program, a Joint Exercise of Powers Agreement between CEA and Cal OES. The program provides up to $3,000 to qualifying homeowners to help pay for code-compliant seismic retrofits in 521 high-risk zip codes. To ensure that equity remains a guiding principle of the program, income-eligible homeowners may also qualify for supplemental grants to help cover up to 100 percent of the cost of a code-compliant seismic retrofit. The amounts vary depending on the region and type of retrofit completed and are available for households with an income at or below $72,080. Grants are contingent upon meeting eligibility requirements and available funds.

Benefits: Retrofitting a home help ensure a lower risk of damage and reduces the risk of injury to its occupants. Retrofitting more homes today will help prevent the current housing crisis from becoming far more acute after a damaging earthquake, as preserving the existing housing supply is critical. Completing an EBB seismic retrofit provides peace of mind to homeowners by knowing they have done what they can to protect their homes and family. After a damaging earthquake, more families will be able to stay in their homes and more communities will be able to rebuild faster because of EBB. The EBB Program has provided nearly $59 million in grants to homeowners and poured millions of dollars into California's construction industry.

Riverine, Stream, and Alluvial Flooding

Climate Impacts:
Frequent, larger rain events and snowmelt leading to more flooding
Equity Impacts:
35.9% of the population living in the 1% annual chance flood hazard area and 41.2% of the population living in the 0.2% annual chance flood hazard area) are identified as living in equity priority communities
State Facilities Exposed:
1,824 facilities in 1% annual chance flood hazard areas
Community Lifelines Exposed:
65 lifelines in the 1% annual chance flood hazard areas

Impact Rating: High (42)

6. Riverine, Stream, and Alluvial Flooding

Riverine, stream, and alluvial flooding has been identified as a high-impact natural hazard of interest based on the hazard impact rating protocol applied for this SHMP. Such flooding happens frequently in the State; over 15 percent of State-owned or -leased facilities and community lifelines are exposed. Approximately 15 percent of the State's population is exposed (living in the 1% and 0.2% annual chance flood hazard areas), and over 41 percent of that population has been identified as living in equity priority communities. Over 7 percent of the identified buildable lands within the State intersect mapped riverine, stream, or alluvial floodplains. The frequency and severity of riverine, stream, and alluvial flooding is anticipated to increase over the next 30 years due to the impacts from climate change.

6.1. HAZARD OVERVIEW

6.1.1. Types of Flooding

In terms of recent disasters and the probability of future destruction at increasing magnitudes, floods represent one of California's most destructive sources of hazard, vulnerability, and risk. This chapter assesses the State's risks associated with the following flood hazards (DWR 2019):

- **Riverine flooding** occurs when rivers, streams, and lakes overflow their banks. Areas adjacent to local streams and creeks can experience flooding due to excessive runoff from heavy rainfall and accumulation of water flowing over broad flat areas. Riverine flooding can be widespread, with floodwaters persisting for just a few hours or several weeks.

- A **flash flood** is a sudden, rapid flooding of low-lying areas, typically caused by intense rainfall. Flash flooding can quickly roll boulders, tear out trees, and destroy buildings and bridges. Flash floods can also occur from the collapse of a structure built by people. Rapidly rising water can reach heights of 30 feet or more.
- **Localized flooding** occurs during or after a storm when rainfall and subsequent runoff overwhelm drainage systems. When the system backs up, pooling water can flood streets, yards, and even the lower floors of homes and businesses. Even less intense storms can cause this type of flooding when leaves, sediment, and debris plug storm drains.
- **Alluvial fan flooding** is sudden and unpredictable flooding on alluvial fans – fan-shaped landforms created by sediment erosion from an upland water source. It is characterized by relatively shallow depths, high velocity, and moving soil and sediment, creating uncertainty on where rising water will travel.

6.1.2. Flood Zones

FEMA conducts flood studies that use historical records to determine the probability of occurrence for different flood levels in a community. Flood Insurance Rate Maps (FIRMs) show flood zones for rainfall flooding, riverine flooding, coastal flooding, and shallow flooding and distinguish areas where detailed studies have been conducted to determine flood elevations. The federal government started regulatory floodplain mapping on a nationwide basis in the late 1960s. FEMA's mapping reflects the risk from coastal and major inland flooding but does not generally reflect the risk of localized urban flooding. There is no statewide system for mapping risk from urban flooding. The location, extent, and vulnerability of such flooding are analyzed using the Special Flood Hazard Areas (SFHA) depicted on each county's FIRM.

6.1.3. Flood Frequency

The recurrence interval of a flood, or frequency, is the average number of years between floods of a certain size. Riverine flooding is measured using a discharge probability, 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 number of years between floods of any given size varies because of the natural variations in climate and weather events. FEMA FIRMs identify the flood hazard area as the area that would be inundated by a flood with a 1 percent chance of occurring in any given year (the 1% annual chance flood). FIRMs also typically show the extent of the flood with a 0.2 percent chance of occurring in any given year (0.2% annual chance flood). These measurements reflect statistical averages only, and it is possible for two or more floods with a 1% annual chance to occur in a short time period (USGS 2022i). Table 6-1 summarizes the concept of recurrence intervals and probabilities.

Table 6-1. Recurrence Intervals and Probabilities of Occurrence

Recurrence Interval (in years)	Probability of Being Equaled or Exceeded in Any Given Year	Percent Chance of Being Equaled or Exceeded in Any Given Year
100	1 in 100	1%
50	1 in 50	2%
25	1 in 25	4%
10	1 in 10	10%
5	1 in 5	20%
2	1 in 2	50%

Source: (USGS 2023b)

6.1.4. Repetitive Loss Properties and Areas

FEMA defines a repetitive loss (RL) property as a property insured through the National Flood Insurance Program (NFIP) that has experienced any of the following since 1978:

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

FEMA designates as severe repetitive loss (SRL) any NFIP-insured single-family or multi-family residential building for which either of the following is true:

- The building has incurred flood-related damage for which four or more separate claims payments have been made, with the amount of each claim (including building and contents payments) exceeding $5,000 and with the cumulative amount of such payments exceeding $20,000.
- At least two separate claims payments (building payments only) have been made under NFIP coverage, with the cumulative amount of claims exceeding the market value of the building.

To qualify as an SRL property, at least two of the claims must be within 10 years of each other (claims made within 10 days of each other are counted as one). In determining SRL status, FEMA considers the loss history since 1978 or from the building's construction if it was built after 1978, regardless of any changes in the ownership of the building.

FEMA encourages communities to identify and mitigate the causes of repetitive losses. FEMA-sponsored programs such as the Community Rating System (CRS) require participating communities to identify RL areas. A RL area is the portion of a floodplain holding structures that FEMA has identified as meeting the definition of RL. Identifying RL areas helps to identify structures at risk but not on FEMA's list of RL structures because no flood insurance policy was in force at the time of loss.

6.2. HAZARD LOCATION

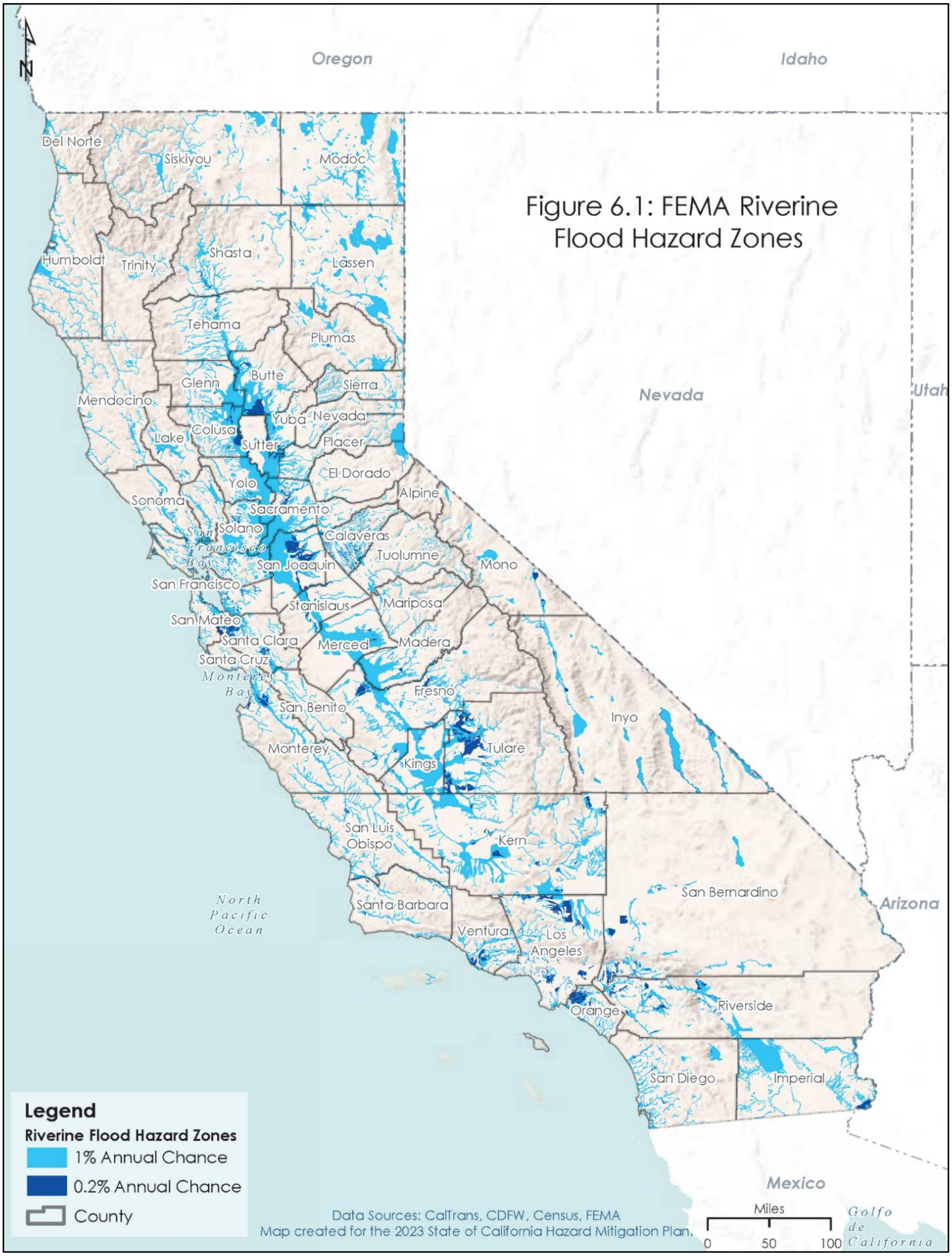
California faces widespread flooding. Figure 6-1 shows SFHAs in the State. FEMA FIRMs do not provide complete coverage of California and contain inaccuracies due to changes in development and infrastructure since the original surveying. FEMA has mapped a portion of California but has substantial areas yet to map. Efforts have been underway to update some FIRMs in the State through FEMA's Risk MAP (Mapping, Assessment, and Planning) Strategy.

All regions of California are susceptible to flooding at different times of the year and in different forms—ranging from alluvial fan flooding at the base of hillsides to fast-moving flash floods to slow-rise deep flooding in valleys. Flood risk varies across the State, generally increasing with development in floodplains (DWR 2022f).

Existing FIRMs for areas across the State show that flood hazard zones are common in populated areas. Every county in the State experiences floods, although the nature of flood events varies due to the State's diverse climatology and geography (DWR 2019):

- Riverine flooding can occur along any streams, creeks, or rivers. Of particular concern in California are the deep floodplains of the Central Valley, which are subject to periodic riverine flooding.
- Flash flooding can occur anywhere in the State.
- Localized flooding typically occurs in urban areas.
- Alluvial flooding occurs in mountainous areas, the foothills, or the coast. Alluvial fans are common in parts of Central and Southern California.

Figure 6-1. FEMA Riverine Flood Hazard Zones



6.3. PREVIOUS HAZARD OCCURRENCES

6.3.1. Disaster and Emergency Declarations

The following disaster declarations or emergency proclamations related to flooding have been issued for California (see Appendix F for details):

- Federal DR or EM declaration, 1953 – 2022: 37 events, classified as flood, flash flooding, severe storms, erosion, rain/snow/windstorms, landslides/mudslides, high tides, levee break, or coastal storm
- California Emergency Proclamations, 1950 – 2022: 124, classified as flood
- USDA agricultural disaster declarations, 2012 – 2022: None

From 2018 through September 2022, the following counties experienced 24 or more declared disasters:

- Kern, Los Angeles, Riverside, San Bernardino, Orange, and San Diego in Southern California
- Contra Costa, Alameda, San Mateo, Marin, Napa, and Santa Cruz in the San Francisco Bay Area
- Sacramento, Yolo, Sutter, El Dorado, and Yuba in the Sacramento/Sierra foothill area
- Humboldt, Trinity, Butte, and Mendocino in Northern California

6.3.2. Event History

Table 6-2 describes major riverine, flash, and alluvial fan flooding events (those that cause $25,000 or more in property damage) that impacted California between 2018 and 2022. Appendix K lists events before 2018.

Table 6-2. Major Flood Event History

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties Impacted
January 9, 2018	Debris Flow, Flash Flood	N/A	N/A	Riverside
Gusty winds, mountain snow, and heavy rainfall in Southern California. Rainfall totals of 1-2 inches occurred over the coast and valleys, with isolated amounts of 6-8 inches along coastal slopes. About 10 swift water rescues were reported in the Inland Empire and San Bernardino County Mountains. Several vehicles were stuck in the mud and flooded out. Urban flooding was reported elsewhere in the Inland Empire. Approximately $25,000 in property damage was reported.				
March 21-22, 2018	Flash Flood	N/A	N/A	Nevada, El Dorado, Tuolumne, Mariposa
Rain brought flash flooding to portions of the northern Sierra and Motherlode foothills. The heaviest flooding was in Groveland, where 4-5 inches of rain fell, combining with 8-9 inches in higher elevations. In Nevada County, Combie Road flooded, resulting in $100,000 in property damage. In El Dorado County, street flooding in Cameron Park Estates resulted in $100,000 in property damage. In Tuolumne County, 3 inches of rain in 4 hours upstream of Moccasin Dam led to erosion and at least one landslide. Water and debris ran down into the Moccasin Reservoir. The water level rose to 3 times the normal reservoir capacity, and the emergency spillway was used. There was severe erosion of the spillway and the potential for the dam to fail. Sewer systems were inundated with water and debris. Roads damaged included State Highways 49 and 132—approximately $43 million in damage. In Mariposa County, several homes flooded near Lake Don Pedro, Hornitos, and the City of Mariposa, and roadways washed out across the northwestern county. Approximately $2 million in property damage was reported, and two fatalities were recorded.				
July 12, 2018	Flash Flood	N/A	N/A	Inyo
Thunderstorms across the Mojave Desert and southern Great Basin produced severe weather and flash flooding. In Inyo County, several off-highway vehicle roads were flooded and had sinkholes, and a stretch of Highway 168 was closed. Approximately $125,000 in property damage was reported.				

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties Impacted
September 30, 2018	Flash Flood	N/A	N/A	Riverside
Moisture from Tropical Storm Rosa brought rain and thunderstorms to Southern California. Runoff from 2 to 4 inches of rain in Box Canyon near I-10 destroyed a dike operated by Coachella Valley Water District. A vehicle traveling on Box Canyon Road was swept away in a flash flood, and the driver drowned. $200,000 in property damage was reported. Significant damage to Box Canyon Road forced the road to be closed for days, resulting in $50,000 in damage.				
October 3, 2018	Flash Flood	N/A	N/A	Riverside, San Bernardino
Moisture from Tropical Storm Sergio brought heavy rain to Southern California. In Riverside County mountains and the Coachella Valley, some areas saw more than 1 inch of rainfall. The Coachella Valley Water District dike was blown out, resulting in $100,000 in property damage. Flash flooding across Joshua Tree National Park caused most of the paved and dirt roads to become closed. $25,000 in property damage was reported. In San Bernardino County, major flash flooding occurred in the Morongo Basin. Many roads were flooded, and numerous vehicles were washed off roads or stuck in floodwaters or mud. Three water lines were broken, leaving customers without water for up to 36 hours. $500,000 in property damage was reported.				
December 6, 2018	Flood	N/A	N/A	San Diego
A moisture plume brought showers and thunderstorms to Southern California, especially Orange and San Diego Counties. All mountains, coast, and valleys areas received 1-3 inches of rain, and some spots over higher terrain received over 4 inches. In Carlsbad County, five businesses in the Shoppes at Carlsbad reported flood damage. A roof collapsed at a childcare center. $50,000 in property damage was reported. The Alpha Project Bridge Shelter in East Village San Diego closed for a week due to flooding. $25,000 in property damage was reported.				

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties Impacted
January 16-17, 2019	Flash Flood	N/A	N/A	Riverside County
An atmospheric river brought heavy rain and snow to Southern California. Seal Beach reported 2 inches of rain in 2 hours, which caused extensive flash flooding. Water was up to doorways outside of homes, and the Pacific Coast Highway was closed for over a day in Huntington Beach. Swift water rescues occurred on the Santa Ana River in Riverside. Rainfall rates exceeded flash flooding thresholds for the Holy Fire burn scar. Highway 60 had lane closures due to heavy rain. Swift water rescues on the Santa Ana River included helicopter extractions along Fleetwood and Via Ricardo. $10,000 in property damage and $1,000 in crop damage were reported. Flash flooding from heavy rainfall over Holy Fire scar in Trilogy Parkway and Glen Eden resulted in water going around homes. $20,000 in property damage and $10,000 in crop damage were reported.				
February 2, 2019	Flash Flood	N/A	N/A	San Bernardino
A storm brought heavy rain and isolated flash flooding to San Bernardino County. Roads and intersections were flooded in Yucca Valley and Joshua Tree, at least four homes were flooded, at least four vehicles were stranded, and at least six swift water rescues occurred. One man was killed when flood waters swept away his vehicle. $100,000 in property damage was reported.				
February 13-14, 2019	Flood, Flash Flood	N/A	N/A	Lake, Sacramento, Orange, San Diego, San Bernardino, Riverside, Butte, Calaveras
▪ In Lake County, Heavy rain caused widespread road flooding. $20,000 in property damage was reported. ▪ In Sacramento County, $20,000 in property damage was reported. ▪ In Orange County, storm channels were inundated by flash flooding. Streets were closed, and homes were threatened. $80,000 in property damage was reported. ▪ In San Diego County, flooding occurred in Ramona with up to 2 feet of standing water—severely damaging portions of Highways 78 and 79. $100,000 in property damage was reported. Flooding in Mission Valley included Fashion Valley Mall. The San Diego River reached 12.1 feet. $100,000 in property damage was reported. Flash flooding in Pala resulted in road damage. $40,000 in property damage was reported. ▪ Big Bear City received 6 inches of rain in 24 hours. Flash flooding occurred with up to 1 foot of moving water and 2 feet of standing water. $100,000 in property damage was reported. Flash flooding closed Mt. Baldy Road and caused debris flows. $30,000 in property damage was reported. Emergency road repairs were needed. $5 million in property damage was reported.				

<table>
<tr><th>Date</th><th>Event Type</th><th>FEMA Declaration Number</th><th>USDA Declaration Number</th><th>Counties Impacted</th></tr>
<tr><td colspan="5">In Riverside County, heavy rainfall of 3-6 inches occurred. The Holy Fire scar flooded and sent debris flows through Temescal Canyon Road and into homes. Riverside County reported up to $70 million in flood control structure damage. Roads in Morongo Valley and Yucca Valley were flooded, and water entered at least one home, resulting in $50,000 in property damage. Flooding severely damaged Highway 111, causing a weeklong closure. $3 million in property damage was reported. Debris flows and heavy runoff into San Jacinto Creek caused widespread damage to State highway 74, including complete washouts at Strawberry Creek below the Cranston Burn Scar. $10 million in property damage was reported.
A flash flood on Palm Springs Tram Road destroyed the road. The tram and the road were closed through April 2. 3-5 inches of rain occurred on the dry side of Mt. San Jacinto. $1 million in property damage was reported. Widespread flooding and flash flooding were reported in Coachella Valley and tributaries to the Whitewater River. Palm Springs airport set a daily record for rainfall with 3.6 inches. The City of Indio reported $1 million in roadway damage from flooding, with $3 million in property damage. Debris flows and heavy runoff into San Jacinto Creek caused widespread damage to Highway 74, resulting in $10 million in property damage.
The Butte County Sheriff evacuated the Nord Cana Highway and Wilson Landing Road area south of Rock Creek after a levee breached and the creek flooded, resulting in $100,000 in property damage. Butte County firefighters located a truck and horse trailer underwater that were swept 150 feet off the roadway in the area of Lower Honcut Road and Highway 70.
In Calaveras County, floodwaters over Pool Station Road caused a bridge to crack, resulting in $500,000 in property damage.</td></tr>
<tr><td>February 26, 2019</td><td>Flood</td><td>N/A</td><td>N/A</td><td>Butte, Kern</td></tr>
<tr><td colspan="5">An atmospheric river brought heavy precipitation across interior Northern California. Evacuation of all residences was required on Taffee Avenue, Reavis Avenue, and Chico Avenue due to flooding from Little Chico Creek. $100,000 in property damage was reported. Swift water rescue occurred for six people in four cars stuck in a flooded roadway. $80,000 in property damage was reported.

In Kern County, roads were washed out by heavy rain, resulting in $50,000 in property damage.</td></tr>
<tr><td>March 27, 2019</td><td>Flash Flood</td><td>N/A</td><td>N/A</td><td>Shasta</td></tr>
<tr><td colspan="5">Thunderstorms brought flooding to Shasta County. There were 8 inches of water over Dry Creek and Deschutes Road in Bella Vista. Water was over a small bridge by a post office. A fire station flooded out, and 1-2 inches of water flowed through the station. $25,000 in property damage was reported.</td></tr>
<tr><td>April 5, 2019</td><td>Flash Flood</td><td>N/A</td><td>N/A</td><td>Shasta</td></tr>
<tr><td colspan="5">Thunderstorms brought road flooding and a minor debris flow. Rock Creek jumped its banks, occupied portions of the floodplain along Rock Creek Road, and overtopped several crossings, resulting in $50,000 in property damage.</td></tr>
</table>

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties Impacted
September 1, 2019		N/A	N/A	Riverside
Thunderstorms across far eastern Riverside County generated locally heavy rainfall with peak rain rates of over 1 inch per hour. Flash flooding along the lower Colorado River Valley north of Blythe affected motorists on Highway 95. Seven to eight vehicles became stuck in flooded portions of Highway 95. The highway was closed at Wind River Road due to flash flooding. $75,000 in property damage was reported.				
September 25, 2019	Flash Flood	N/A	N/A	Imperial
Thunderstorms across the eastern portion of Imperial County generated peak rain rates in excess of 1 inch per hour. Flash flooding resulted in a vehicle being washed out along Ogilby Road south of State Route 78. The driver was not injured. However, 30 more vehicles were stuck before a flowing wash in the vicinity. $40,000 in property damage was reported.				
November 19, 2019	Flash Flood	N/A	N/A	San Bernardino
Due to widespread rain and flooding in the Mojave Desert in San Bernardino County, Highways 95 and 62 were closed, there was at least one swift water rescue when a vehicle was washed away, and about 100 vehicles were stuck in the closures. $700,000 in property damage was reported.				
November 28, 2019	Flash Flood	N/A	N/A	Riverside, San Diego, San Bernardino
Riverside County saw 1 to 3 inches of rainfall at the coast and in the valleys. San Diego River reached 9.5 feet with flooding. Roadways were flooded. An RV Park in La Mesa experienced flash flooding. A sinkhole opened on the shoulder of I-10 in Redlands due to heavy rain. The total cost to repair the sinkhole was $760,000. Flash flooding resulted in a car becoming flooded and floating near the intersection of 6th Avenue and Highway 95. The driver was rescued through the roof of the vehicle. $30,000 in property damage was reported. In San Diego County, a driver was rescued after driving through 2 feet of water in Sorrento Valley. $30,000 in property damage was reported. In San Bernardino County, Highway 95 was completely washed out south of the Nevada state line, resulting in $50,000 in property damages.				
December 4, 2019	Flash Flood	N/A	N/A	Riverside
In Riverside County, heavy rain resulted in flooding of the San Diego River. Water levels at Fashion Valley peaked at 9 feet. Roads around Fashion Valley Mall were closed due to flooding. The Tijuana River flooded, closing roads and trapping cars in floodwaters. A search and rescue worker died during a search for a missing hiker. Interstate 10 in Redlands had a large sinkhole on the shoulder of the interstate. The cost to repair the damage was $759,000. Hollister Street flooded in the Tijuana River Valley. Cars stalled in 2 feet of water, some requiring water rescues. $40,000 in property damage was reported.				

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties Impacted
March 12, 2020	Flash Flood	N/A	N/A	Imperial
Rainfall that exceeded 1 inch in some places resulted in flooding and flash flooding over central Imperial County. Flowing water led to road closures. Flooding northeast of Brawley resulted in local traffic impacts. A vehicle was swept away in a flash flood on State Route 78 south of Palo Verde. All of the people were rescued. Multiple vehicles were stuck in or near flood waters at the intersection of State Route 78 and Milpitas Wash Road. $60,000 in property damage was reported.				
April 6-10, 2020	Flash Flood	N/A	N/A	Orange, San Diego
In Orange County, rainfall rates over 0.70 inches per hour caused 8 inches of swift-moving water to flood Lakeview Avenue north of Miraloma Avenue, resulting in $25,000 in property damage. In San Diego County, the City of Oceanside had significant damage to the wastewater treatment plant. Up to 2 million gallons spilled as the plant was inundated by flash flooding of Buena Vista Creek. $250,000 in property damage was reported. Twelve incidents of flooding and flash flooding were reported in Encinitas. People were evacuated from homes in the Encinitas Blvd/Quail Gardens Road area. Twenty persons were evacuated from a nursing home. $70,000 in property damage was reported.				
January 10, 2021	Flash Flood	N/A	N/A	Imperial
Isolated thunderstorms caused moderate to heavy rain rates and flash flooding east of the Imperial Valley. Flooding on Highway 78 resulted in vehicles being stranded about 5 miles east of Glamis. $30,000 in property damage was reported.				
January 27, 2021	Flood	N/A	N/A	San Benito
An atmospheric river caused flooding and 15 to 20 inches of rain in the Santa Lucia Mountains. In San Benito County, damage was reported to Cienega Road, resulting in $2.5 million in property damage; Union Road resulting in $250,000 in property damage; Southside Road resulting in $2 million in property damage; and Salinas Grade Road resulting in $2 million in property damage. New Idria Road was completely washed out from Panoche Valley to 20 miles south, resulting in $3.5 million in property damage. King City Road was damaged from SR 25 to Monterey County, resulting in $2 million in property damage. Coalinga Road was damaged from SR 25 to Fresno County, resulting in $3 million in property damage. Roadway flooding at Fairview Road and Mansfield Road resulted in $250,000 in property damage.				
January 29, 2021	Flood	N/A	N/A	Riverside
A weak atmospheric river brought flooding across Southern California. In Riverside County, a vehicle was stuck in water on San Jacinto and Murrieta Road in Perris, where a water rescue was conducted. $1 million in property damage was reported.				
March 10, 2021	Flash Flood	N/A	N/A	Orange
A storm brought widespread rain, snowfall, and areas of flooding. In Orange County, six homes had mud and water damage. Swift water rescues were performed. $75,000 in property damage was reported.				

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties Impacted
August 29-31, 2021	Flash Flood	N/A	N/A	San Bernardino, Imperial
A round of thunderstorms brought severe winds and flash flooding. In San Bernardino County, 30 low water crossings on Highway 95 between Needles and Havasu Lake Road were covered in mud and debris, resulting in $50,000 in property damage. In Imperial County, 7 inches of rain fell in 5 hours, and extensive flooding occurred along SR 78 from Palo Verde south, leading to extended closure for repairs and $1 million in property damage.				
October 21, 2021	Flash Flood	N/A	N/A	Trinity
Heavy rain across the River Complex burn scar in Trinity County caused one or more debris flows. Removal, protective measures, and repair costs from this debris flow were estimated to be $3.2 million.				
December 23, 2021	Flash Flood	N/A	N/A	Orange County
An atmospheric river moved into Southern California. In Orange County, Santiago Creek Road was blocked by high water and mud. Jackson Creek Road was flooded with mud and debris. $800,000 in property damage was reported.				

6.4. PROBABILITY OF FUTURE HAZARD EVENTS

6.4.1. Overall Probability

Flooding is common in California and can take place any time of the year. Based on historical flood events, the State has a high probability of future riverine, flash, localized, and alluvial fan flood events.

According to FEMA, USDA, and the National Oceanic and Atmospheric Administration (NOAA), California experienced 631 flash flood events and 510 flood events between 1996 and 2022—an average of more than 20 flash flood events and just under 20 flood events per year. Some areas in the State are more prone to flooding than others, and the frequency and size of flood events will vary.

6.4.2. Climate Change Impacts

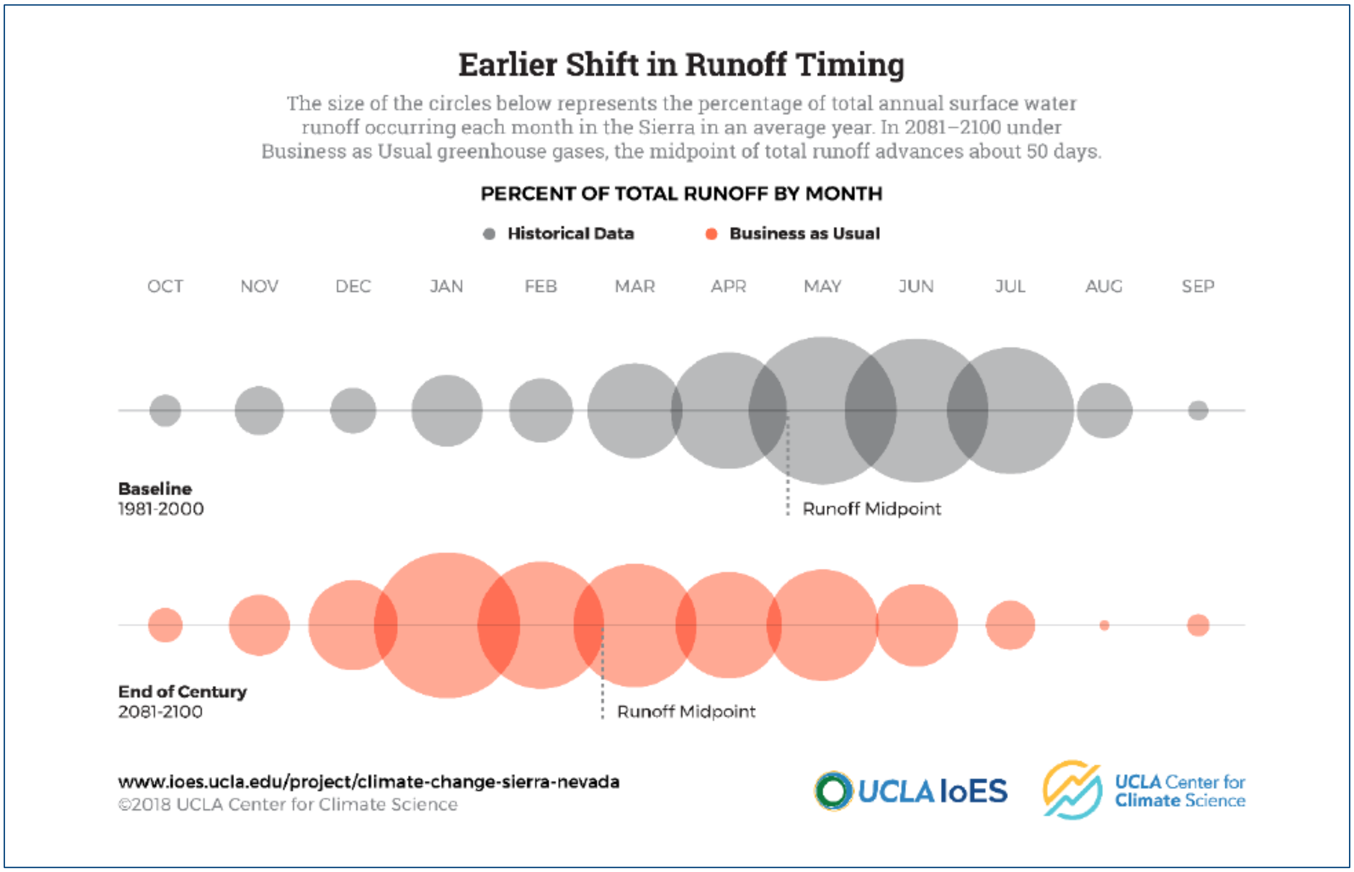
Current projections indicate the following climate change trends that may affect flood hazards.

Precipitation

Cal-Adapt mapping indicates a shift of precipitation events away from southern and inland regions toward central and northern regions (CEC 2017). However, decreases in annual precipitation in southern and inland regions may not be accompanied by a reduction in flooding. An increase in climate variance may result in these regions experiencing heavier, more intense episodic rainfall and flooding events due to the transport of warmer, moisture-laden air from the ocean (CNRA, CalEMA 2012).

The timing of precipitation and subsequent runoff is important for determining when stream flow occurs and how much is available for supply. Most precipitation in California falls during the wet season (generally October to April, depending on the region). Runoff peaks in winter and spring, when demand is lowest. Climate studies project that precipitation patterns will increasingly shift peak runoff earlier in the winter and spring as more precipitation falls as rain instead of snow, and snow melts off earlier. This is projected to be especially true in rain-dominated watersheds, with runoff peaking earlier and higher. In snow-dominated watersheds, relatively little change in seasonality or peak runoff is expected by mid-century (2050), but large April-to-July decreases in peak runoff are expected by 2100. Figure 6-2 shows the projected shift in the runoff by month from the historical baseline to 2081 through 2100.

Figure 6-2. Projected Shift in Runoff by Month From Historical Baseline to 2081-2100.



Source: (Schwarz, et al. 2020)

Snowpack

Snowpack in northern and coastal mountains and the Sierra Nevada mountains is projected to be reduced and accompanied by earlier rainfall with subsequent runoff downstream, particularly in the Sacramento River and San Joaquin River watersheds that converge in the California Delta. These trends suggest the potential for increased incidence of intense flooding in the Central Valley and the San Francisco Bay region.

Sea-Level Rise

The Sea-Level Rise Guidance 2018 Update prepared by the California Ocean Protection Council (OPC) provides sea-level rise projections by decade based on greenhouse gas (GHG) emissions scenarios (CNRA, OPC 2018). An extreme scenario included in the guidance, labeled as H++, projects a 10.2-foot sea-level rise by 2100 and a 21.9-foot rise by 2150. This increase will result in coastal areas experiencing increased inundation and may increase the extent of floodplains near the mouths of streams and rivers. Sea-level rise combined with high tides will increase the frequency and severity of flood events for areas adjoining places where coastal streams and rivers empty to the ocean.

Summary

In California, changing temperature, precipitation, runoff, and snowpack records have already altered annual runoff patterns (DWR 2015). A change from snowfall to rainfall may also contribute to an increased number and severity of flood events.

Climate change impacts on multiple natural hazards interact in ways that can exacerbate the severity and frequency of flood events. For example, larger and more frequent wildfires brought on by climate change can reduce the ability of a landscape to retain rainfall, which can lead to flooding and mudflows. Examples include the catastrophic mudflows that occurred in early 2018 in Santa Barbara County following heavy rainfall in an area where the 2017 Thomas Fire had denuded slopes of vegetation.

The Impact of Wildfire on Flooding

Flooding, erosion, and debris flows can also occur in California in the months and years following large hot fires. High-severity wildfires significantly reduce the amount of vegetation, which can reduce the amount of rainwater absorption, allowing excessive water runoff that often includes large amounts of debris. Structures located anywhere near a severe burn area are susceptible to flooding. Periods of high-intensity rainfall are of particular concern, but post-fire flooding can also occur during a normal rainy season.

Source: (USGS 2018a)

6.5. IMPACT ANALYSIS

Floods have the potential for numerous severe impacts (Cal OES 2018):

- Injuries and deaths occur
- Residences, businesses, and personal property are damaged
- Critical infrastructure is damaged and could be out of service for long periods
- Vital services become isolated or are closed
- Jobs are lost or put at risk when businesses are dislocated or closed
- The local and national economy can be disrupted due to damage to commercial and industrial buildings
- Water supplies and water quality are affected
- Vulnerable communities are displaced
- Natural resources and public access are damaged or eliminated
- Usable land is lost through erosion, contamination, or other flood-related means
- The transport of hazardous materials and debris could impact human and animal health and the environment

6.5.1. Severity

California has a chronic and destructive flooding history. All 58 counties have experienced at least one significant flood event in the past 25 years, resulting in loss of life and billions of dollars in damage. As seen in Table 6-2, California experienced 26 flood events over just a four-year period, with damage of at least $25,000 and up to many millions of dollars. Since 1950, floods have accounted for the second-highest combined losses of all natural hazard events in California (after earthquake) and the largest number of deaths.

Floods can be long-term events that may last for several days to weeks, and their severity depends on the amount of water that accumulates and the land's ability to manage this water. When the ground is saturated or frozen, infiltration into the soil slows, and any more accumulated water must flow as runoff (Harris 2008). Additional key factors in determining the severity of a flood are the depth of the floodwater at a particular point of interest and the velocity at which the floodwaters are moving.

Based on FEMA mapping, flood depths range from 0 feet to greater than 15 feet in zones mapped as A, AE, AH, and AO throughout the State. U.S. Army Corps of Engineers' (USACE) depth-damage curves indicate no more than 16 feet of flood depth for residential structures with or without basements, so any damage associated with depths greater than 16 feet would be considered substantial. The curves also do not account for damage associated with flood velocities. Per the National Weather Service (NWS):

- Six inches of water will reach the bottom of most passenger cars, causing loss of control and possible stalling.
- A foot of water will float many vehicles.
- Two feet of rushing water can carry away most vehicles, including sport utility vehicles and pickups.

Flooding and the Many Faces of California Climate

The chance of heavy flooding and flash flooding is greatest during California's rainy season from November to April. However, the diversity of climate patterns in California makes flooding more than a seasonal risk. The following are some of the weather and climate conditions that have a significant impact on the occurrence of flooding:

- El Niño conditions
- La Niña conditions
- Desert monsoons
- Tropical storms
- Gulf of Alaska storms
- Atmospheric river patterns

Source: (Cal OES 2018)

6.5.2. Warning Time

The NWS uses four categories to determine impending flood threats. Each category has a definition based on property damage and public threat (NWS 2011):

- ***Action Stage***—When reached by a rising stream, lake, or reservoir, this stage represents the level where the NWS or a partner needs to take some type of mitigation action in preparation for possible significant hydrologic activity.
- ***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 evacuations of people or transfer of property to higher elevations are necessary.
- ***Major Flooding***—Extensive inundation of structures and roads. Significant evacuations of people or transfer of property to higher elevations.

6.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may, in turn, trigger still others. The following are the most significant cascading impacts associated with riverine, stream, and alluvial flooding:

- Riverine flooding causes bank erosion, especially in the upper courses of rivers with steep gradients, where floodwaters can pass quickly without much flooding but scour the banks, edging properties closer to the floodplain or causing them to fall in.
- Flooding can cause landslides when high flows over-saturate soils on steep slopes, causing them to fail.
- Hazardous materials spills can result from flooding if storage tanks rupture and spill into streams, rivers, or drainage sewers.
- Flooding can result in the failure of critical infrastructure (i.e., roads, bridges, levees, etc.).

6.5.4. Environmental Impacts

Negative Environmental Impacts From Floods

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, levees, or logjams from timber harvesting, can increase stream bank erosion, causing rivers and streams to migrate into non-natural courses.

Many species of mammals, birds, reptiles, amphibians, and fish live in plant communities dependent on streams, wetlands, and floodplains. Wildlife and fish are impacted when plant communities are eliminated or fundamentally altered to reduce habitat. Since water supply is a major limiting factor for many animals, riparian communities are of special importance.

Floodwater can also alter the landscape, for instance, by eroding riverbanks and causing them to collapse. As floodwater carries material from the eroded banks, it suspends sediment in the water, which can degrade water quality and lead to harmful algae blooms. Suspended sediment eventually settles out of the water in a process called sedimentation, which can clog riverbeds and streams, smother aquatic organisms, and destroy habitats. Erosion and sedimentation have a more negative impact on ecosystems that are already degraded or heavily modified.

Floods are the leading cause of weather-related infectious disease outbreaks. Flooding increases the chance of spreading waterborne diseases such as hepatitis A and cholera. Receding floodwater can create stagnant pools of water, which provide a breeding ground for mosquitoes that can transmit malaria and other diseases. Floodwater that infiltrates buildings and homes can harbor mold, which can be inhaled and cause or exacerbate respiratory conditions. Furthermore, floods can lead to the release of toxic waste from facilities where it is stored. This can expose nearby communities in low-lying areas to dangerous runoff if floodwaters infiltrate those facilities.

Positive Environmental Impacts From Flooding

While floods bring hazards, they also bring nutrients and essential components for life. Seasonal floods can renew ecosystems. Floods transport nutrients such as nitrogen, phosphorus, and organic material to the surrounding land. When the water recedes, it leaves sediment and nutrients behind on the floodplain. This rich, natural fertilizer improves soil quality and has a positive effect on plant growth, thus increasing productivity in the ecosystem. Ancient civilizations first arose along the deltas of seasonally flooded rivers, such as the Nile in Egypt, because they provided fertile soil for farmland.

Floods can replenish underground water sources. Floodwater gets absorbed into the ground and then percolates through layers of soil and rock, eventually reaching underground aquifers. These aquifers supply clean freshwater to springs, wells, lakes, and rivers. Ecosystems rely heavily on groundwater during dry spells when it may be the only freshwater supply. A good groundwater supply positively impacts soil health and leads to more productive crop and pasture lands.

Floods can trigger breeding events, migrations, and dispersal in some species. In 2016, thousands of water birds flocked to the Macquarie Marshes in the Australian state of New South Wales. Flooding had filled their wetland habitat for the first time in years, triggering a mass breeding event (ANSTO 2016).

Small seasonal floods can be beneficial to native fish stocks and can help those fish outcompete invasive species that are not adapted to the river's cycles. Sediment deposited on riverbeds during floods can provide a nursery site for small fish. Nutrients carried by floodwater can support aquatic food webs by boosting productivity.

6.5.5. Local Hazard Impacts

LHMP Rankings

All but one of the hazard mitigation plans prepared for California's 58 counties list flood as a hazard of concern, and 38 counties rank it as a high-impact hazard.

- Amador
- Butte
- Colusa
- El Dorado
- Fresno
- Glenn
- Imperial
- Inyo
- Kern
- Kings
- Lake
- Lassen
- Madera
- Mendocino
- Merced
- Monterey
- Napa
- Nevada
- Placer
- Plumas
- Sacramento
- San Bernardino
- San Diego
- San Joaquin
- San Luis Obispo
- Santa Barbara
- Santa Clara
- Santa Cruz
- Shasta
- Sierra
- Siskiyou
- Solano
- Stanislaus
- Sutter
- Trinity
- Tulare
- Yolo
- Yuba

An additional 16 counties identified flood as a medium-impact hazard.

LHMP Estimates of Potential Loss

Table 6-3 summarizes potential losses to vulnerable structures based on estimates from the local risk assessments (as called for in FEMA's Standard State Mitigation Planning Requirement S6.b). Due to variances in approaches to assessing risk at the local level as well as the hazards assessed and the age of each assessment reviewed, this data is considered approximate.

Table 6-3. Riverine Stream and Alluvial Flood Risk Exposure Analysis for LHMP Reviews

Estimated Total Population Exposed	1,354,364*
Estimated Number of Structures at Risk	382,339
Estimated Value of Structures at Risk	$48.04 billion

* Population estimated within the FEMA-mapped 1% annual chance floodplain

6.6. VULNERABILITY ANALYSIS

To assess the State's risk to the riverine flood hazard, a spatial analysis was conducted in which mapped hazard areas (the 1% annual chance flood hazard zone and the 0.2% annual chance flood hazard zone) were overlaid with State assets to determine the total number and replacement cost values located in the hazard areas. If the asset is in the hazard area, it is deemed exposed to the hazard and potentially vulnerable to loss.

6.6.1. Exposure of State-Owned or -Leased Facilities

Table 6-4 and Table 6-5 summarize the numbers of State assets within the mapped 1% annual chance and 0.2% annual chance flood hazard zones. Figure 6-3 and Figure 6-4 summarize the exposed assets as a percentage of total assets statewide. Appendix I provides detailed results by county.

Table 6-4. State-Owned or -Leased Facilities Exposed to the Riverine or Stream Flood Hazard

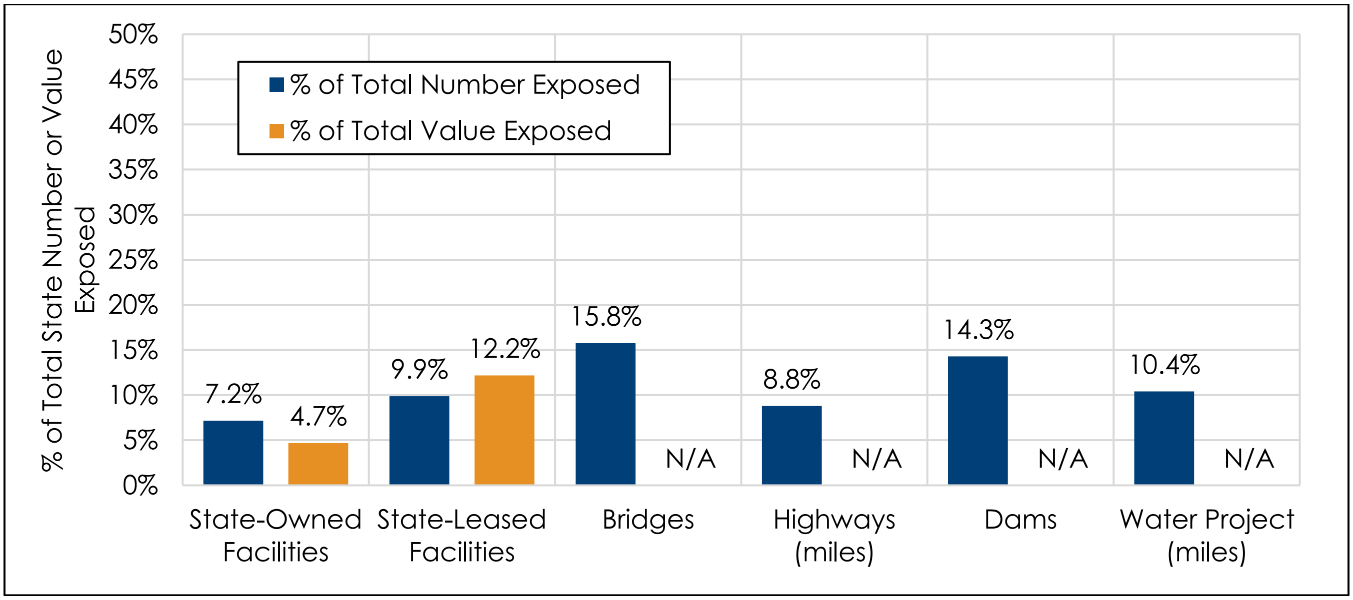
Type of Facility	Number of Structures	Total Area (sq. ft.)	Replacement Cost Value		
			Structure	Content	Total
State Facilities in the Mapped 1% Annual Chance Floodplain					
State-Leased Facilities	182	--	$839,048,220	$870,586,030	$1,709,634,251
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	266	3,405,313	$107,785,327	$107,785,327	$215,570,654
Development Center	0	0	$0	$0	$0
Hospital	0	0	$0	$0	$0
Migrant Center	5	329,500	$555,472,024	$280,239,085	$835,711,109
Special School	0	0	$0	$0	$0
All Other Facilities	1371	3,133,297	$613,992,207	$599,693,859	$1,213,686,066
Total State-Owned	***1642***	***6,868,110***	***$1,277,249,558***	***$987,718,271***	***$2,264,967,829***
Total Facilities	***1,824***	**N/A***	**$2,116,297,778**	**$1,858,304,301**	**$3,974,602,079**
State Facilities in the Mapped 0.2% Annual Chance Floodplain					
State-Leased Facilities	352	—	$1,845,598,009	$1,883,536,951	$3,729,134,960
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	308	3,720,744	$141,535,881	$134,076,508	$275,612,389
Development Center	0	0	$0	$0	$0
Hospital	0	0	$0	$0	$0
Migrant Center	9	512,233	$569,777,234	$290,194,941	$859,972,175
Special School	0	0	$0	$0	$0
All Other Facilities	2,134	13,157,442	$1,450,103,729	$1,503,938,251	$2,954,041,981
Total State-Owned	***2,451***	***17,390,419***	***$2,161,416,844***	***$1,928,209,700***	***$4,089,626,545***
Total Facilities	***2,803***	**N/A***	**$4,007,014,854**	**$3,811,746,651**	**$7,818,761,505**

* The inventory of State assets does not include building area for State-leased facilities, so no total area for all State facilities is provided; the building area of vulnerable assets is shown for State-owned facilities only.

Table 6-5. State-Owned Infrastructure Exposed to the Riverine or Stream Flood Hazard

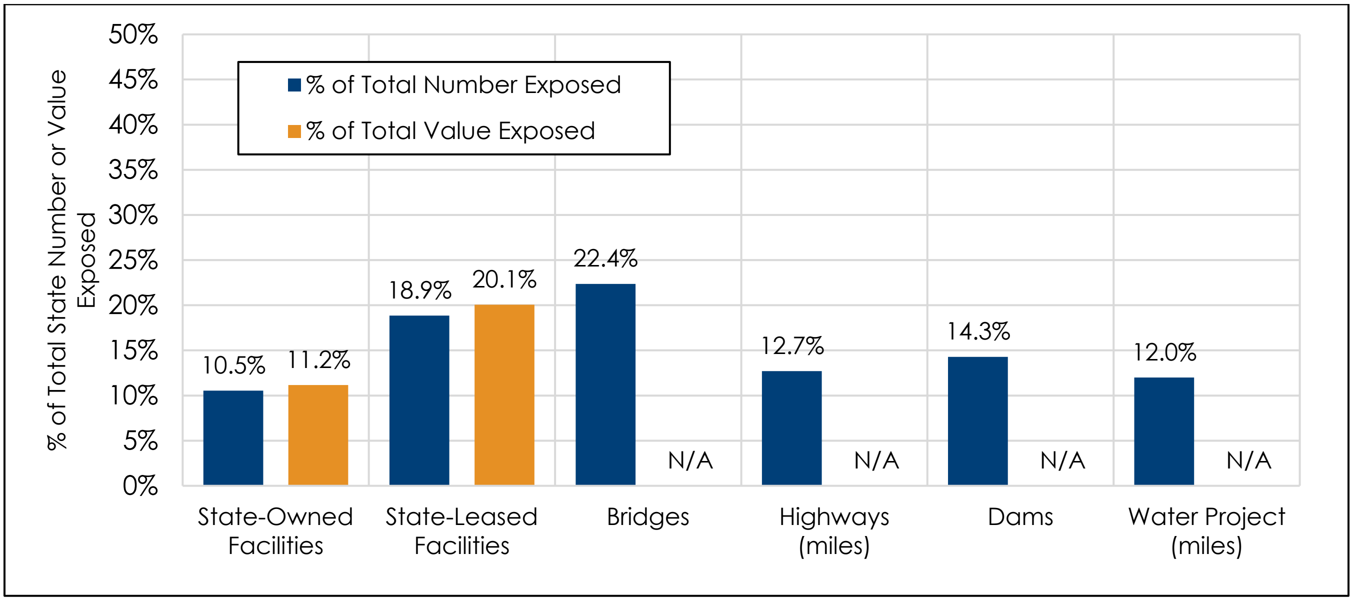
	State-Owned Infrastructure in the Mapped Hazard Area	
Type of Facility	**1% annual Chance Floodplain**	**0.2% annual Chance Floodplain**
Bridges	2,079	2,959
Highway (miles)	2,627	3,801.2
Dams	7	7
Water Project (miles)	74.4	85.7

Figure 6-3. State Assets Exposed to 1% annual Chance Floodplain, as % of Statewide Total



N/A: Values not defined for bridges, highways, dams, and water project

Figure 6-4. State Assets Exposed 0.2% annual Chance Floodplain, as % of Statewide Total



N/A: Values not defined for bridges, highways, dams, and water project

The following are significant results of the analysis of State-owned assets in mapped flood hazard areas:

- For facilities that the State owns within the 1% annual chance floodplain, the average building area is 4,183 square feet, with an average replacement cost value of $1.4 million.
- For facilities that the State owns within the 0.2% annual chance floodplain, the average building area is 7,095 square feet, with an average replacement cost value of $1.7 million.
- The average replacement cost value for State-leased facilities within the 1% annual chance floodplain is $9.4 million.
- The Average replacement cost value for State-leased facilities within the 0.2% annual chance floodplain is $10.6 million.
- The five State agencies with the most State-owned or -leased facilities within the 1% annual chance floodplain are as follows:
  - State Parks (580)
  - CDFW (318)
  - CDCR (268)
  - District Agricultural Associations (257)
  - Caltrans (158)

- The five State agencies with the most State-owned or -leased facilities within the 0.2% annual chance floodplain are as follows:
  - State Parks (669)
  - District Agriculture Associations (393)
  - CDFW (382)
  - Caltrans (351)
  - CDCR (324)
- The State agency with the highest total replacement cost for State-owned or lease facilities within the 1% annual chance floodplain is the District Agriculture Association, at $909 million.
- The State agency with the highest total replacement cost for State-owned or lease facilities within the 0.2% annual chance floodplain is the District Agriculture Association, at $1.2 billion.

6.6.2. Exposure of Critical Facilities and Community Lifelines

The Risk Assessment identified 65 critical facility and community lifelines within the 1% annual chance floodplain. The "food, water, shelter" lifeline category accounts for 42 percent of these, the "transportation" category accounts for 23 percent, and "energy" accounts for 16 percent. The County with the largest percentage of these facilities is Sacramento (8.7 percent), followed by Inyo and Kern Counties with 7.25 percent each.

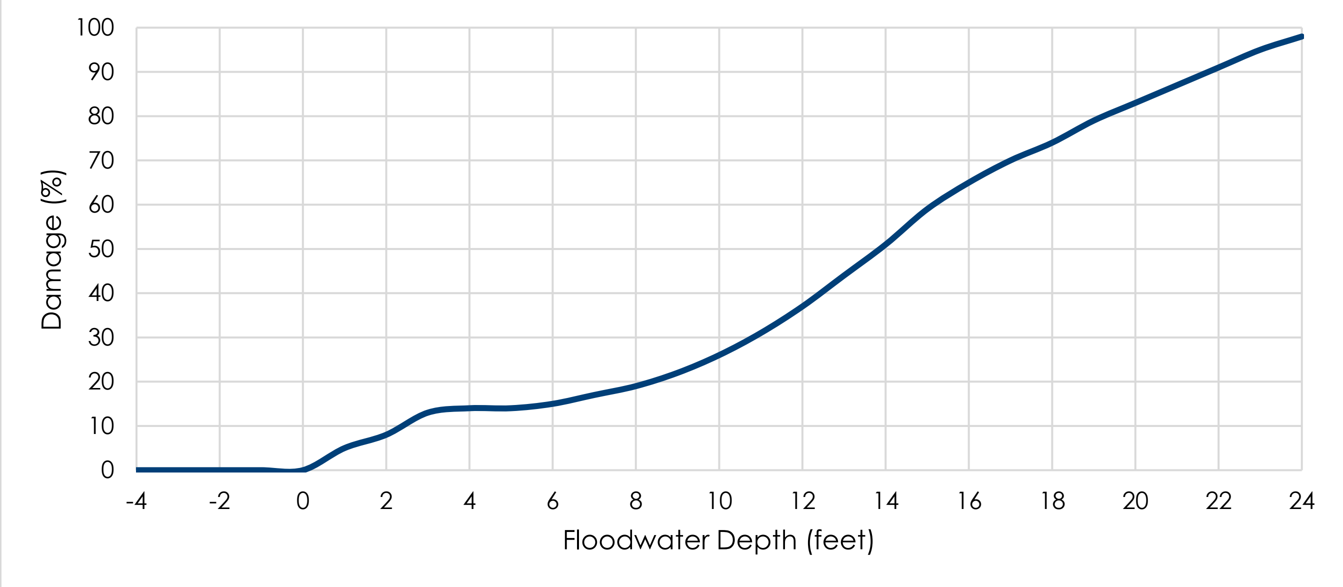
The Risk Assessment identified 125 critical facility and community lifelines within the 0.2% annual chance floodplain. The "food, water shelter" lifeline category accounts for 34 percent of these, the "transportation" category accounts for 21 percent, and "energy" accounts for 19 percent. The County with the largest percentage of these facilities is Santa Clara (9.3 percent), followed by San Bernardino (8.5 percent) and Fresno (7.8 percent). For a detailed breakdown of facility counts by County, see Appendix I.

Critical facilities and community lifelines exposed to the riverine flood hazard are likely to experience functional downtime following a flood event, which could increase the net impact of the event. Local governments are encouraged to use Hazus or similar tools when developing LHMPs.

6.6.3. Estimates of Loss

Loss estimations for hazard events that cause flooding typically use an approach that correlates damage to the depth of flood water at a structure and the time of inundation. USACE has established depth/damage correlations based on analysis of historical flood events. The assessment of potential loss associated with riverine flooding for this SHMP used the USACE depth-damage curve for facilities with "average government function" (see Figure 6-5).

Figure 6-5. Depth/Damage Curve for "Average Government Function" Occupancy



Source: Data taken from Hazus model developed for this SHMP

Table 6-6 shows the resulting estimates of potential damage to State-owned or -leased facilities in the 1% annual chance flood hazard zone per foot of flood depth up to the flood depth that would trigger substantial damage (50 percent of replacement cost value).

6.6.4. Buildable Lands

Of the 11.7 million acres of land available for development in California, 7.1 percent (834,480 acres) is within the 1% annual chance flood hazard zone, and 8.5 percent (997,939 acres) is within the 0.2% annual chance flood hazard zone.

Table 6-6. Estimates of Flood Loss for Facilities in the 1% annual Chance Flood Hazard Zone

Flood Depth (feet)	Estimates of Flood Loss*		
	State-Owned	State-Leased	Total
1	$200,350,743	$190,587,333	$390,938,075
2	$320,561,188	$304,939,732	$625,500,920
3	$520,911,931	$495,527,065	$1,016,438,996
4	$560,982,080	$533,644,531	$1,094,626,611
5	$560,982,080	$533,644,531	$1,094,626,611
6	$601,052,228	$571,761,998	$1,172,814,226
7	$681,192,525	$647,996,931	$1,329,189,456
8	$761,332,822	$724,231,864	$1,485,564,686
9	$881,543,268	$838,584,263	$1,720,127,531
10	$1,041,823,862	$991,054,129	$2,032,877,991
11	$1,242,174,605	$1,181,641,462	$2,423,816,066
12	$1,482,595,496	$1,410,346,261	$2,892,941,757
13	$1,763,086,536	$1,677,168,526	$3,440,255,062
14	$2,043,577,575	$1,943,990,792	$3,987,568,367

* Structure Losses only. Does not include contents losses.

Any development in these areas will be susceptible to damage associated with a riverine, stream, or alluvial flood event. Future development could increase flooding due to increased impervious surfaces and subsequent stormwater runoff. The population occupying these future-developed areas may also face increased exposure due to transportation networks located within hazard-prone areas to support increased development.

Not all flood risk in the State has been mapped, and the scope of regulatory oversight of new development is limited to known or mapped floodplains. However, the State's regulatory capabilities—such as growth management, participation in the NFIP, and general building codes and standards—position the State to manage future development in a manner to avoid adverse impacts and unintended consequences. It will be important to continually improve the understanding of flood risk within these buildable land areas so that the regulatory capacity of the State can be effective.

6.6.5. Repetitive Loss Analysis

As of August 31, 2022, the State of California has 3,660 FEMA-identified RL properties, of which 576 have been identified as SRL properties. Table 6-7 provides a breakdown of these properties by County.

Table 6-7. RL Data for California

	Numbers of Properties					Number of Losses	Loss Value	
County	RL	SRL	Mitigated	NFIP-Insured	Outside SFHA		Cumulative	Average
Alameda	15	2	3	1	10	30	$625,526	$20,851
Alpine	0	0	0	0	0	0	$0	$0
Amador	5	0	0	1	1	11	$368,102	$33,464
Butte	35	6	0	11	11	102	$2,257,357	$22,131
Calaveras	5	0	0	2	3	17	$773,829	$45,519
Colusa	22	3	0	4	20	59	$1,627,461	$27,583
Contra Costa	76	9	6	20	34	208	$4,827,616	$23,210
Del Norte	2	0	0	0	1	4	$139,395	$34,489
El Dorado	8	0	0	0	4	16	$749,000	$46,816
Fresno	9	1	4	1	7	22	$396,750	$18,034
Glenn	21	1	0	6	7	51	$876,897	$17,194
Humboldt	14	4	1	2	3	38	$1,173,181	$30,873
Imperial	14	0	0	0	2	31	$240,897	$7,771
Inyo	0	0	0	0	0	0	$0	$0
Kern	3	0	0	1	1	8	$109,573	$13,697
Kings	0	0	0	0	0	0	$0	$0
Lake	167	28	9	30	28	508	$9,336,350	$18,379
Lassen	1	0	0	0	0	2	$36,094	$18,047
Los Angeles	479	39	41	86	293	1,164	$19,809,904	$17,019
Madera	2	0	0	1	0	8	$138,759	$17,345
Marin	234	28	3	69	63	684	$14,185,977	$20,740
Mariposa	0	0	0	0	0	0	$0	$0
Mendocino	3	1	0	0	0	8	$288,771	$28,596
Merced	15	0	0	9	1	33	$759,710	$23,021
Modoc	0	0	0	0	0	0	$0	$0
Mono	1	0	0	0	0	2	$377,751	$18,876
Monterey	123	8	4	27	18	261	$8,501,845	$32,574
Napa	126	27	29	40	21	357	$11,974,973	$33,543
Nevada	4	0	0	1	2	10	$426,733	$42,673
Orange	126	9	29	30	62	257	$5,463,031	$21,257
Placer	63	7	36	26	26	145	$4,881,887	$33,668

	Numbers of Properties					Number of Losses	Loss Value	
County	RL	SRL	Mitigated	NFIP-Insured	Outside SFHA		Cumulative	Average
Plumas	3	1	0	0	1	9	$322,046	$35,783
Riverside	80	3	16	16	41	105	$3,037,681	$28,930
Sacramento	238	40	70	99	127	567	$14,882,503	$26,248
San Benito	11	0	0	4	2	33	$1,197,590	$36,291
San Bernardino	36	2	4	4	15	73	$1,198,615	$16,419
San Diego	150	17	13	35	88	264	$7,977,113	$30,216
San Francisco	4	0	0	0	1	11	$112,901	$1,173
San Joaquin	8	2	3	1	6	17	$428,304	$25,194
San Luis Obispo	38	2	0	9	17	91	$1,534,574	$16,863
San Mateo	48	6	3	14	28	129	$4,090,052	$31,709
Santa Barbara	78	5	1	27	40	171	$3,972,781	$23,233
Santa Clara	35	9	6	10	8	111	$2,748,422	$24,761
Santa Cruz	102	13	18	27	44	309	$5,262,348	$17,030
Sierra	0	0	0	0	0	0	$0	$0
Shasta	20	2	0	6	8	53	$824,884	$15,564
Siskiyou	2	0	0	0	1	4	$9,299	$2,325
Solano	57	5	1	17	21	144	$4,984,634	$34,616
Sonoma	951	268	87	215	113	3,262	$86,700,101	$26,579
Stanislaus	18	2	0	6	6	45	$1,311,715	$29,149
Sutter	11	0	1	0	4	31	$367,715	$11,861
Tehama	42	6	2	7	18	104	$1,572,825	$15,123
Tuolumne	0	0	0	0	0	0	$0	$0
Trinity	0	0	0	0	0	0	$0	$0
Tulare	12	2	0	3	3	25	$400,603	$16,024
Ventura	91	12	5	24	50	236	$5,547,420	$23,506
Yolo	40	6	11	7	10	99	$1,603,262	$16,195
Yuba	12	0	1	2	6	27	$705,260	$26,121
Total	**3,660**	**576**	**407**	**901**	**1,276**	**9,956**	**$241,140,017**	**$24,221**

Source: FEMA PIVOT Database (August 31, 2022)

The following is a summary analysis of RL statistics:

- 15.7 percent of the 3,660 RL properties have been identified as SRL by FEMA
- The county with the most SRL properties is Sonoma County, with 268 (28.2 percent of its total RL properties)
- 34.8 percent of the 3,660 RL properties in the State are outside of the SFHA

- The county with the most RL properties outside the SFHA is Los Angeles County (61.2 percent of its total RL properties)
- 24.6 percent of the 3,660 RL properties are insured under the NFIP
- 11.1 percent of the 3,660 RL properties have been identified as mitigated
- The county with the most mitigated RL properties is Sonoma County (87), followed by Sacramento County (70) and Los Angeles County (41)
- The 3,660 identified RL properties have accounted for 9,956 total losses, with a total value of $241 million in claims paid by the NFIP: this amounts to an average claim of $24,241. This is below the national average flood insurance claim under the NFIP of just over $31,000 per claim
- 50 of the 58 counties in the State (86.2 percent) have identified RL properties
- The top five RL counties in the State are:
    - Sonoma County (951 properties)
    - Los Angeles County (479 properties)
    - Sacramento County (238 properties)
    - Marin County (234 properties)
    - Lake County (167 properties)
- The county with the highest average loss per claim is El Dorado County at $46,816

6.6.6. Equity Priority Communities

The risk analysis for riverine flooding found the following vulnerability of equity priority communities (a breakdown by county is included in Appendix I):

- 35.9 percent of people living in the 1% annual chance flood hazard zone live in equity priority communities (486,048 people)
- 41.2 percent of people living in the 0.2% annual chance flood hazard zone live in equity priority communities (2,153,503 people)

6.6.7. NRI Scores

According to the NRI, all the State's counties have riverine flood risk, rated from very low to very high. Table 6-8 shows scores for the six counties with the highest rating. See Section 4.1.3 for a description of the components of the NRI.

Table 6-8. NRI Scoring of Counties for Riverine Flood

County	Expected Annual Loss	Social Vulnerability Rating	Community Resilience Rating	Community Risk Factor	Risk Value	Score
Kern	$47,867,304	Very High	Very Low	1.41	$72,069,983	99.59
Ventura	$42,303,163	Relatively High	Relatively Moderate	1.22	$54,069,269	99.52
San Bernardino	$30,907,939	Very High	Relatively Moderate	1.34	$42,775,664	99.36
Marin	$28,231,043	Relatively Low	Very High	1.02	$30,230,864	98.98
Riverside	$18,804,063	Very High	Relatively Low	1.34	$27,982,149	98.92
Fresno	$16,491,298	Very High	Relatively Low	1.53	$25,232,318	98.82

6.7. MITIGATING THE HAZARD

6.7.1. Existing Measures to Mitigate the Hazard

The National Flood Insurance Program

The NFIP provides flood insurance to homeowners, renters, and business owners in participating communities. For most such communities, FEMA has prepared a detailed Flood Insurance Study that shows flood data for specific water courses, lakes, and coastal areas. The study report contains detailed flood elevation data in flood profiles and data tables. FEMA produces FIRMs as part of the NFIP.

As of this plan update, 528 California communities participate in the NFIP (FEMA 2022s). Five communities in the State are eligible but do not participate. One community has been suspended from the program. The status of all 528 participating NFIP communities in California can be seen on FEMA's website. As of August 31, 2022, 191,488 flood insurance policies were in force in the participating communities, with a total coverage of $58 billion and a total annual premium of $161 million (FEMA n.d.).

The Community Rating System

The CRS is an extension of the NFIP that provides insurance premium discounts of up to 45 percent based on a community's enforcement of higher regulatory standards. The CRS is a voluntary incentive program that encourages community floodplain management activities that exceed the minimum NFIP requirements. Participating communities' flood insurance premium rates are discounted to reflect the reduced risk.

Currently, California has 89 communities participating in the CRS. This accounts for 66 percent of the NFIP policy base statewide. The CRS benefits more than 167,000 policyholders and saves property owners and businesses over $14.5 million annually.

Climate Change Information

California offers a variety of resources, including the California Climate Change Assessments and Cal-Adapt, that aggregate peer-reviewed climate projection data and allow users to assess exposure and vulnerability across the local, State, and regional scales. While medium and long-term climate projections are subject to changing dynamics, assessing vulnerability under changing climate conditions plays a critical role in planning and anticipating risk.

6.7.2. Opportunities for Mitigating the Hazard

Flood hazards can be mitigated using both structural and non-structural solutions. A range of potential opportunities for mitigating the riverine stream and alluvial flood hazard is provided in Table 6-9. See Section 1.2.3 for a description of the different types of alternatives.

6.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address riverine flooding:

- Action 2023-003: Develop a Hazus repository for both earthquake and flood hazards where local planning efforts that create these models can share this information with the State once the models have been developed.
- Action 2023-009: Implement the 2022 Central Valley Flood Protection Plan (CVFPP).
- Action 2023-012: Continue to support programs that promote the mitigation of FEMA-identified RL and SRL properties.

Table 6-9. Potential Opportunities to Mitigate the Flood Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ Clear storm drains and culverts ▪ Use green infrastructure **Reduce exposure and vulnerability:** ▪ Locate outside of the hazard area ▪ Elevate utilities above base flood elevation ▪ Use low-impact development ▪ Raise structures above base flood elevation ▪ Elevate items in the house above the	**Manipulate the hazard:** ▪ Clear storm drains and culverts ▪ Use low-impact development **Reduce exposure and vulnerability:** ▪ Locate outside the hazard area ▪ Use low-impact development ▪ Build redundancy for critical functions or retrofit critical buildings ▪ Provide flood-proofing when new critical infrastructure must be	**Manipulate the hazard:** ▪ Maintain drainage system ▪ Institute low-impact development techniques on property ▪ Dredging, levee construction, and providing regional retention areas ▪ Use structural flood control (levees, etc.) only when no nature-based option is feasible ▪ Stormwater management regulations and master planning ▪ Acquire vacant land or promote open space uses in developing watersheds to control runoff **Reduce exposure and vulnerability:** ▪ Locate or relocate critical facilities outside the hazard area ▪ Acquire or relocate identified RL properties ▪ Promote open space uses in identified high-hazard areas via planned unit developments, easements, setbacks, greenways, sensitive area tracks, etc. ▪ Adopt land development criteria such as clustering, planned unit developments, density transfers ▪ Institute low impact development techniques on property ▪ Facilitate retreat from or upgrade of at-risk areas ▪ Require accounting of sea-level rise in applications for new shoreline development ▪ Implement Assembly Bill (AB) 162 requiring flood information in local general plans **Build local capacity:** ▪ 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 the capital improvement plan ▪ Develop a strategy to take advantage of post-disaster opportunities ▪ Warehouse critical infrastructure components ▪ Develop and adopt a continuity of operations plan

Community-Scale	Organizational Scale	Government-Scale	
base flood elevation ▪ Build new home above base flood elevation ▪ Flood-proof structures **Build local capacity:** ▪ Buy flood insurance ▪ Develop a household plan, such as retrofit savings, communication with the outside, 72-hour self-sufficiency during and after an event	located in floodplains **Build local capacity:** ▪ Keep cash reserves for reconstruction ▪ Support and implement hazard disclosure for the sale of property in risk zones ▪ Solicit cost-sharing through partnerships with others on projects with multiple benefits.	▪ Acquire vacant land or promote open space uses in developing watersheds to control runoff ▪ Preserve undeveloped and vulnerable shoreline ▪ Restore existing flood control and riparian corridors, including the removal of invasive species in the floodplain to reduce bulk flows and infrastructure impacts ▪ Harden infrastructure, bridge replacement program ▪ Provide redundancy for critical functions and infrastructure ▪ Adopt regulatory standards such as freeboard standards, substantial improvement or damage, substantial damage threshold, compensatory storage, and non-conversion deed restrictions ▪ Stormwater management regulations and master planning ▪ Adopt "no-adverse impact" floodplain management policies to limit increases in the flood risk on downstream communities	▪ Consider participation in the CRS ▪ 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 hazard mitigation fee ▪ Integrate floodplain management policies into other planning mechanisms within the planning area ▪ Consider the probable impacts of climate change on the risk associated with the flood hazard ▪ Consider the residual risk associated with structural flood control in future land use decisions ▪ Enforce NFIP requirements ▪ Adopt a stormwater management master plan ▪ Develop an adaptive management plan to address the long-term sea-level rise

<table>
<tr><th>Community-Scale</th><th>Organizational Scale</th><th>Government-Scale</th></tr>
<tr><td colspan="3">Nature-based opportunities:
Restore and reconnect floodplains that have been degraded by development and structural flood control.
Use soft approaches for stream bank restoration and hardening (e.g., introducing large woody debris into a system).
Set back levees on systems that rely on levee protection to allow the river channel to meander, which reduces erosion and scour potential.
Acquire property within the floodplain, remove or relocate structures, and preserve these areas as open space in perpetuity.
Preserve floodplain storage capacity by limiting or prohibiting the use of fill in the floodplain.
Incorporate green infrastructure into stormwater management facilities
Protect or restore riparian buffers</td></tr>
</table>

An Example Success Story for Riverine Flood Mitigation:

Sonoma County Flood Elevation Program, Russian River

Russian River flooding, 2019

Elevated living spaces stay above floodwaters

The Russian River in Sonoma and Mendocino Counties poses a substantial threat of flooding for adjacent communities. The 110-mile river is a critical resource and provides potable water to communities in Sonoma, Mendocino, and Marin Counties

Problem: Sonoma County has one of the country's highest concentrations of repetitive flood loss properties due to flooding along the Russian River. Since 1940, Sonoma County has sustained more than $5 billion in damage from severe storms and flooding and received 14 presidential flood disaster declarations. During the same period, the town of Guerneville flooded 38 times.

Solution: In 1995, Sonoma County established the Sonoma County Flood Elevation Program to elevate flood-prone structures. The projects consisted of elevating structures to a minimum of 1 foot above the base flood elevation.

Cost and Funding: Sonoma County has elevated 290 structures for $20,380,443, funded through FEMA's Hazard Mitigation Grant Program (HMGP) and Flood Mitigation Assistance (FMA) Program, administered by Cal OES.

Benefits: In February 2019, torrential rainfall caused the Russian River to swell to its highest levels in 25 years. The river crested 15 feet above flood level. Guerneville and Monte Rio were cut off from land travel. More than 2,600 homes across the County were affected, and hundreds of residents were displaced. Of the 290 structures elevated, 197 were impacted by the 2019 flood. Cal OES conducted a loss avoidance study to quantify the damage prevented from that flood as a result of the home elevation projects. The loss avoidance study found the following:

- Completed Structure Elevation Costs – $20,380,443
- Structure and Content Value – $136,059,075
- Pre-Mitigation Flood Losses – $51,946,012
- Post-Mitigation Flood Losses – $1,280,447
- Total Losses Avoided – $50,665,565

The avoided losses divided by the project cost represent a return on investment of 249 percent.

EXTREME HEAT

Climate Impacts:
More frequent and intense events
Equity Impacts:
30.4% of the exposed population (all persons in the State are exposed) identified as living in equity priority communities
State Facilities Exposed:
All facilities exposed
Community Lifelines Exposed:
All lifelines exposed

Impact Rating: High (39)

7. Extreme Heat

Extreme heat has been identified as a high-impact natural hazard of interest based on the hazard impact rating protocol applied for this SHMP. Extreme heat events frequently happen in the State, and all State-owned or -leased facilities and community lifelines are exposed to this hazard but have a limited risk of damage. The exposure of and impacts on the general population and equity priority communities poses a serious risk. While some portions of the State may get hotter than others, all populations in the State can experience extreme heat events relative to their area. These events are likely to impact equity priority communities more than the general populations due to many factors. Exposure to extreme heat events could increase if all buildable lands were developed. The frequency and severity of extreme heat events is anticipated to increase over the next 30 years due to impacts from climate change.

7.1. HAZARD OVERVIEW

Extreme heat is defined as temperatures that hover 10 °F or more above the average high temperatures for a region for several days or weeks. Extreme heat events can lead to an increase in heat-related illnesses and deaths, worsen drought, and impact water supplies and other infrastructure such as transportation, agriculture, and energy.

7.1.1. Impacts on Human Health

Extreme heat is one of the leading causes of weather-related deaths in the United States, killing an average of more than 702 people per year from 2004–2018, more than all other weather hazards (except hurricanes) combined. The Billion Dollar Weather Disasters database compiled by NOAA lists heat waves as six of the top 10 deadliest U.S. disasters since 1980 (NOAA 2023b).

Heat-related illness includes a spectrum of illnesses ranging from heat cramps to severe heat exhaustion and life-threatening heat stroke. Table 7-1 describes common heat-related illnesses are listed.

Table 7-1. Typical Heat-Related Illnesses

Definition	Symptoms	First Aid
Heat Stroke		
Heat stroke occurs when the body can no longer control its temperature: the body's temperature rises rapidly, the sweating mechanism fails, and the body is unable to cool down. When heat stroke occurs, the body temperature can rise to 106 °F or higher within 10 to 15 minutes.	Confusion, altered mental status, slurred speech; loss of consciousness (coma); hot, dry skin or profuse sweating; seizures; very high body temperature; fatal if treatment delayed	▪ Call 911 ▪ Stay with sufferer until help arrives ▪ Move sufferer to a shaded, cool area and remove outer clothing ▪ Circulate air to speed cooling ▪ Place cold wet cloths or ice on head, neck, armpits, and groin
Heat Exhaustion		
Heat exhaustion is the body's response to an excessive loss of water and salt, usually through excessive sweating. Heat exhaustion is most likely to affect older adults, infants and children, people with chronic medical conditions, athletes, pregnant women, and those working outdoors or in a hot environment.	Headache; nausea; dizziness; weakness; irritability; thirst; heavy sweating; elevated body temperature; decreased urine output	▪ Take sufferer to a clinic or emergency room for medical evaluation and treatment ▪ Call 911 if medical care is unavailable ▪ Stay with sufferer until help arrives ▪ Remove sufferer from hot area and give liquids to drink ▪ Remove unnecessary clothing ▪ Cool the sufferer with cold compresses or cold water ▪ Encourage frequent sips of cool water
Rhabdomyolysis		
Rhabdomyolysis is a medical condition associated with heat stress and prolonged physical exertion. It causes the rapid breakdown, rupture, and death of muscle. When muscle tissue dies, electrolytes and large proteins are released into the bloodstream. This can cause irregular heart rhythms, seizures, and damage to the kidneys.	Muscle cramps/pain; abnormally dark urine; weakness; exercise intolerance	▪ Stop activity ▪ Drink more liquids (water preferred) ▪ Seek immediate care at the nearest medical facility ▪ Ask to be checked for rhabdomyolysis

Definition	Symptoms	First Aid
Heat Syncope		
Heat syncope is a fainting (syncope) episode or dizziness that usually occurs when standing for too long or suddenly standing up after sitting or lying. Factors that may contribute to heat syncope include dehydration and lack of acclimatization.	Fainting (short duration); dizziness; light-headedness from standing too long or suddenly rising from a sitting or lying position	▪ Sit or lie down in a cool place ▪ Slowly drink water, clear juice, or a sports drink
Heat Cramps		
Heat cramps usually affect workers who sweat a lot during strenuous activity. This sweating depletes the body's salt and moisture levels. Low salt levels in muscles cause painful cramps. Heat cramps may also be a symptom of heat exhaustion.	Muscle cramps, pain, or spasms in the abdomen, arms, or legs	▪ Drink water and have a snack or drink that replaces carbohydrates or electrolytes every 15 to 20 minutes ▪ Avoid salt tablets ▪ Get help if the sufferer has heart problems, is on a low-sodium diet, or has cramps that do not subside within 1 hour
Heat Rash		
Heat rash is a skin irritation caused by excessive sweating during hot, humid weather.	Red clusters of pimples or small blisters, usually on the neck, upper chest, groin, under the breasts, and in elbow creases	▪ Work in a cooler, less humid environment if possible ▪ Keep rash area dry ▪ Apply powder to increase comfort ▪ Do not use ointments or creams

Source: (CDC 2022e)

Heat-related illness results from the body's inability to dissipate heat produced by metabolic activity, often as a result of increased ambient temperature (State of California 2022j). Heat waves do not strike victims immediately, but their cumulative effects slowly cause harm to vulnerable populations. Elevated nighttime temperatures are likely key ingredients in causing heat-related illness and mortality. When there is no break from the heat at night, it can cause discomfort and lead to health problems, especially for those who lack access to cooling and health care, which are often people who have low incomes or are experiencing homelessness. Other groups that are particularly vulnerable to heat stress include older adults, infants and children, people with chronic health conditions, people with disabilities, outdoor workers, and others within identified equity priority communities.

Some studies have indicated that extreme heat has negative impacts on mental health. A study in New York found that hot days were associated with a higher risk of emergency room visits for substance abuse, mood and anxiety disorders, schizophrenia, and dementia. Extreme heat is also associated with increases in depression, suicide, aggression, and domestic violence. Those with severe mental illnesses or currently on psychiatric medications may be more vulnerable to exacerbated mental or physical health impacts of extreme heat (Clayton, et al. 2017, Dodgen, et al. 2016).

7.1.2. Impacts on Infrastructure

Cascading impacts on urban systems can result from extreme heat stress applied on water, power, and transportation systems (UCLA Luskin Center for Innovation 2021). Heat can compromise infrastructure safety and reliability; it can cause issues such as train track buckling and road material softening. Extreme heat can also prevent aircraft from taking off as it reduces the density of air mass, making it more difficult for aircraft to lift, in addition to possibly softening tarmac materials (UCLA Luskin Center for Innovation 2021).

7.1.3. Urban Heat Islands

Large urban areas often experience higher temperatures in summer than more rural communities—a phenomenon known as the urban heat island effect. Heat islands are created by a combination of heat-absorptive surfaces (such as dark pavement and roofing), heat-generating activities (such as engines and generators), and the absence of vegetation (which provides evaporative cooling) (CalEPA 2022). In certain urban settings where conditions create heat islands, occupants face a greater risk of heat-related diseases (UCAR Center for Science Education 2022).

Heat island effects can occur in urban areas when natural surfaces and materials such as grass, trees, and soil, which dissipate heat, are replaced by roads and buildings with materials that increase absorption (and reduce dissipation) of heat. As a result of building and road construction and other human activities, more heat is generated and retained, and air temperatures in urban heat island areas are consistently higher than in surrounding areas (CalEPA 2022). Increased temperatures also add to the heat load of buildings in urban areas, adding to the risk of high ambient temperatures.

The transportation sector, with its roads, highways, and pavements, is both a major contributor to the urban heat island effect and vulnerable to its effects. As heat increases, pavement begins to deteriorate and rail and bridge joints are more likely to buckle, increasing maintenance costs (Sacramento Metropolitan Air Quality Management District 2017).

7.1.4. The Heat Index

The heat index is a measure of how temperature feels to the human body when combined with relative humidity. When the body gets hot, it begins to perspire to cool itself. When perspiration evaporates off the body, it effectively reduces the body's temperature. When the atmospheric moisture content (i.e., relative humidity) is high, the rate of evaporation from the body decreases. When relative humidity decreases, the rate of evaporation increases, so the body actually feels cooler in arid conditions. Figure 7-1 shows heat index ratings based on humidity and temperature.

Figure 7-1. 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

Source: (NWS 2023a)

7.2. HAZARD LOCATION

California has a diversity of climates, and statewide provisions to the California Energy Code account for these variations using a set of 16 climate zones (CEC n.d.-a). Extreme heat impacts the entire State of California.

7.3. PREVIOUS HAZARD OCCURRENCES

7.3.1. Disaster and Emergency Declarations

The following disaster declarations or emergency proclamations related to energy shortage have been issued for California (see Appendix F for details):

- Federal DR or EM declaration, 1953 – 2022: none
- California Emergency Proclamations, 1950 – 2022: 2 events, classified as heat wave
- USDA agricultural disaster declarations, 2012 – 2022: 50 events

7.3.2. Event History

California has experienced many extreme heat events. The 2018 SHMP did not chronicle past extreme heat events. Table 7-2 lists prominent events since 2018 that resulted in property damage, crop damage, or casualties.

2021 Western Heat Wave

During June and July 2021, the western United States experienced a record-breaking heat wave for several days. Based on a comparison of health records from the period June 26–July 10, 2020, to those from the same period in 2021, heat-related deaths increased from 2 to 145 in Washington, 0 to 119 in Oregon, and 12 to 25 in California. These estimates were provided by the California Department of Public Health (CDPH), Oregon Health Authority, and Washington State Department of Health. An increase in heat-related emergency room visits was observed during the heatwave. According to a Centers for Disease Control and Prevention (CDC) report, the mean daily number of emergency room visits due to heat-related illnesses in Alaska, Idaho, Oregon, and Washington was 69 times higher from June 25–30, 2021 than for the same period in 2019.

Table 7-2. Extreme Heat Events in the State of California (2018 to 2022)

<table>
<tr><th>Date</th><th>Event Type</th><th>FEMA Declaration Number</th><th>USDA Declaration Number</th><th>Counties/Areas Impacted</th></tr>
<tr><td>June 12 – 13, 2018</td><td>Extreme Heat</td><td>N/A</td><td>N/A</td><td>Death Valley National Park</td></tr>
<tr><td colspan="5">Temperatures reached Excessive Heat Warning levels on June 12 and 13. One hiker suffering from dehydration and heat exposure was rescued from Death Valley National Park on the 15.</td></tr>
<tr><td>July 6 – 7, 2018</td><td>Extreme Heat</td><td>N/A</td><td>N/A</td><td>San Diego County Valley, Coachella Valley, San Bernardino County, Riverside County, Orange County Inland Zone</td></tr>
<tr><td colspan="5">Extreme hot temperatures and dry conditions impacted southern California. Inland Orange County, San Diego Valleys, Inland Empire, and the deserts. Thermal and Chino reached 120 °F and San Bernardino and Riverside Airport reached 118 °F. San Diego Public Health and 211 services reported a large number of heat-related calls. One fatality and 50 injuries were reported as a result of this event.</td></tr>
<tr><td>August 2 – 5, 2019</td><td>Extreme Heat</td><td>N/A</td><td>N/A</td><td>Coachella Valley, San Diego County, San Bernardino County, Riverside County</td></tr>
<tr><td colspan="5">Between August 2 and 4, temperatures ranged from 98 °F in the Inland Empire to 115 °F in Palm Springs. Between August 5 and 6, temperatures ranged from 103 °F in the Inland Empire cities to 121 °F at Palm Springs. Approximately $1.5 million in property damage was recorded.</td></tr>
<tr><td>July 5, 2020</td><td>Extreme Heat</td><td>N/A</td><td>N/A</td><td>San Diego County, Orange County</td></tr>
<tr><td colspan="5">A hiker required medical rescue due to heat-related illness near doghouse Junction on Otay Mountain. Around 1:15 pm, temperature at Otay Mountain was 87 °F.</td></tr>
<tr><td>August 13 – 20, 2020</td><td>Extreme Heat</td><td>N/A</td><td>N/A</td><td>Joshua Tree National Park, Salton Sea, Imperial County</td></tr>
<tr><td colspan="5">Strong high pressure caused excessive heat for multiple days across southeast California. A heat-caused fatality was reported in Joshua Tree National Park on August 20 after an individual's vehicle became disabled along an unmaintained road.</td></tr>
<tr><td>August 14 – 18, 2020</td><td>Extreme Heat</td><td>N/A</td><td>N/A</td><td>Tulare County, Kern County</td></tr>
<tr><td colspan="5">A high-pressure center over central California caused oppressive heat for several days. An Excessive Heat Warning was posted for the San Joaquin Valley and Sierra Foothills for five days and for the Kern County Deserts for seven days. New records were set for afternoon high temperatures and overnight high minimum temperatures. Several locations reported highs above 110 °F and lows above 80 °F. Several cities opened cooling centers. Local emergencies were declared in Fresno, Tulare, and Kings Counties due to an unusually high rate of livestock fatalities.</td></tr>
<tr><td>September 4 – 7, 2020</td><td>Excessive Heat</td><td>N/A</td><td>N/A</td><td>Joshua Tree National Park, Salton Sea, Chuckwalla Mountains, Imperial County, Palo Verde Valley, Chiriaco Summit</td></tr>
<tr><td colspan="5">High pressure led to excessive heat across southeast California during the Labor Day weekend. Temperatures across the region reached around 115 to 120 °F. A young person died from the heat after setting out on a hike in Joshua Tree National Park during the afternoon of September 5.</td></tr>
</table>

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties/Areas Impacted
September 2022	Heat Dome	Declaration Requested	N/A	All Counties
In early September 2022, a long-lasting heat dome settled over the U.S. West and brought scorching temperatures that set all-time record highs. The extreme heat fueled wildfires and stressed the power grid before an eastern Pacific tropical storm moved into the region and broke the warm spell. On September 7, 2022, more than 61 million people were under active extreme heat advisories, watches, and warnings, according to the National Weather Service.				

Source: (NCEI 2022)

7.4. PROBABILITY OF FUTURE HAZARD EVENTS

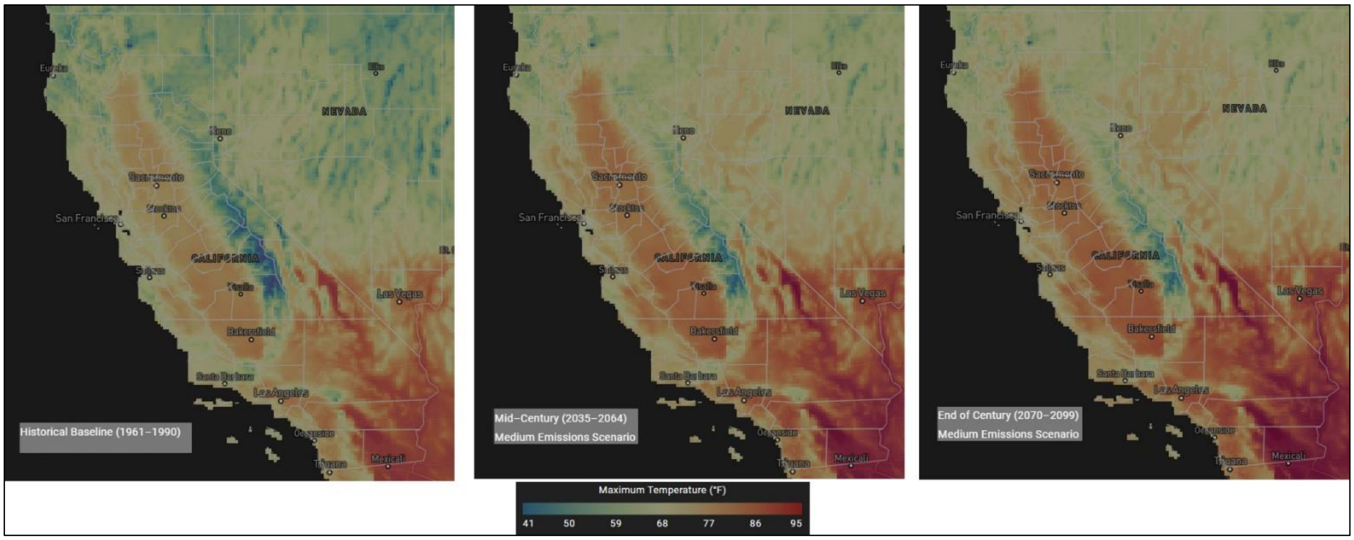
7.4.1. Overall Probability

California's 990 recorded extreme heat events between 1953 and 2022 represent an average of almost 15 events per year (NCEI 2022). The State expects to continue experiencing a similar number of extreme heat events per year on average, or possibly more due to climate change.

7.4.2. Climate Change Impacts

California is already experiencing the impacts of climate change. When comparing average annual temperatures from 1901–1960 to those of 1986 – 2016, most of California has experienced increases exceeding 1°F, with some areas exceeding 2°F (OPR 2022). The daily maximum average temperature, an indicator of extreme temperature shifts, is expected to rise 4.4 °F to 5.8 °F by 2050 and 5.6 °F to 8.8 °F by 2100 (State of California 2022j). Figure 7-2 illustrates the statewide temperature increase trend.

Figure 7-2. California Historical and Projected Temperature, 1961-2099



Source: (Cal-Adapt 2022)

Different regions of the State experience extreme heat differently – some areas accustomed to hot temperatures are experiencing very hot conditions and some that have been historically cool are experiencing warmer temperatures (State of California 2022j). Climate models project that by mid-century, Los Angeles County will experience an average of nine days of extreme heat per year, growing to 12 days per year by the final decades of the century (LAO 2022). Sacramento County is projected to experience 20 days per year of extreme heat by mid-century and 28 days annually by the end of the century (LAO 2022). These trends will be even more severe in some inland counties. In Fresno County, the historical trends of five days of extreme heat per year are projected to increase to 29 days annually between 2035 and 2064 and to 43 days annually between 2070 and 2099 (LAO 2022).

With rising temperatures, the State of California will experience more extreme heat events with greater severity and for longer periods of time. This trend is accentuated specifically for humid heat waves, which are expressed very strongly in nighttime temperatures (Gershunov, Cayan and Jacobellis 2009) (Gershunov and Guirguis 2012).

For many cities in the State, extreme heat days—daily high temperatures that used to occur about four times a summer—will occur 40 to 70 days during the summer by 2050, according to an analysis based on Cal-Adapt (CalEPA n.d.). Without appropriate preparation, communities unaccustomed to repeated heat events will be unprepared to address the health consequences of extreme heat.

Heat waves that result in public health impacts, also referred to as heat-health events, are also projected to worsen throughout the State. By 2050, average heat-health events are projected to last two weeks longer in the Central Valley and four to 10 times more often in the Northern Sierra region (State of California 2022j).

7.5. IMPACT ANALYSIS

7.5.1. Severity

According to the California Climate Adaptation Strategy, heat waves have claimed more lives in California than all other declared disaster events combined.

Several regions have seen record-breaking temperatures in recent years. In 2020, parts of Los Angeles County hit 121 °F, while the Coachella Valley hit its all-time high of 123°F in 2021 (Carpenter 2022).

7.5.2. Warning Time

The NWS heat risk forecast (see Figure 7-3) provides a quick view of heat risk potential over the upcoming seven days. The heat risk is portrayed in a numeric scale (0-4) and a color scale (green/yellow/orange/red/magenta). It provides one value each day that indicates the approximate level of heat risk concern for any location, along with identifying the groups who are most at risk.

Figure 7-3. NWS Heat Risk Forecasting System

Category	Level	Meaning
Green	0	No Elevated Risk
Yellow	1	Low Risk for those extremely sensitive to heat, especially those without effective cooling and/or adequate hydration
Orange	2	Moderate Risk for those who are sensitive to heat, especially those without effective cooling and/or adequate hydration
Red	3	High Risk for much of the population, especially those who are heat sensitive and those without effective cooling and/or adequate hydration
Magenta	4	Very High Risk for entire population due to long duration heat, with little to no relief overnight

Source: (NWS 2023)

The NWS issues excessive heat watches, excessive heat warnings and heat advisories to warn of an extreme heat event (a "heat wave") within the next 36 hours.

If forecasters predict an excessive heat event in the three- to seven-day timeframe, then the NWS issues messaging in the form of a special weather statement, emails, and social media. The NWS uses the Heat Risk Forecasting System to determine if an excessive heat watch/warning or heat advisory is warranted:

- **Heat Advisory**—Heat Risk output is on the orange/red (Level 2-3) thresholds (orange will not be an automatic heat advisory).
- **Excessive Heat Watch/Warning**—Heat Risk output is on the red/magenta (Level 3-4) thresholds.

An excessive heat watch warns the public and emergency officials that extreme temperatures are expected. If significantly hot temperatures remain in the forecast for 24 to 28 hours, the excessive heat watch is upgraded to an excessive heat warning, indicating that extreme heat has arrived or is expected soon.

7.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with extreme heat events:

- Poor air quality, which can occur when stagnant atmospheric conditions trap humid air and pollutants near the ground. Ozone, a major component of smog, is created in the presence of sunlight via reactions between chemicals in gasoline vapors and industrial smokestacks. Hot weather can increase ozone levels. High ozone levels often cause or worsen respiratory problems (EPA 2022b).
- Climate change-influenced heat events may also create a conducive environment for vector-borne diseases. Extended heat events can result in the emergence of vectors that can carry infectious diseases—such as dengue, Zika, yellow fever, and chikungunya—in areas of California that have not historically experienced their occurrence. Recent surges in Zika and dengue fever infections present an example. For these two pathogens, an increase in temperature allows mosquitoes to feed more frequently, breed more prolifically, and live longer, which ultimately results in their ability to travel farther to spread carried viruses (CDPH 2022b).
- Air conditioning used during extreme heat events increases energy demand and could increase the risk of energy shortages. In the summer of 2020, the demand for electricity during heat waves in California contributed to the State's

first rolling blackout in nearly 20 years (Kim, et al. 2021). The three largest utilities—Pacific Gas & Electric, Southern California Edison and San Diego Gas & Electric—turned off power to more than 410,000 homes and businesses for about an hour at a time until the Emergency Declaration ended after several hours (Har and Beam 2020).

- PSPSs are cascading hazards associated with extreme heat events. Under certain severe weather conditions, including extreme heat, utility service providers shut off power to help prevent wildfire and keep communities safe. A PSPS may be called in response to a combination of dry vegetation and high winds that can uproot trees, blow branches onto power lines or create sparks if power lines contact one another.
- Extreme heat contributes to more severe wildfires in a longer wildfire season and increases the health and safety risk experienced by wildland firefighters and populations near wildfires due to additional reductions in air quality. Wildfire can also further exacerbate worsening air quality caused by extreme heat, placing all vulnerable populations at risk of new or worsened respiratory conditions.
- Heat evaporation can lead to loss of stored water in reservoirs and aqueducts. The amount of water lost depends largely on local climate conditions. High air temperatures, low humidity, strong winds and sunshine will increase evaporation.
- Power outages are associated with extreme heat events, which could impact critical facilities infrastructure.
- Ozone can impact plant health, by interfering with plants’ ability to produce and store food. This can lead to reduction in agricultural yields of many crops, from wheat and cotton to soybeans (Avnery, et al. 2011, Ainsworth 2017).

7.5.4. Environmental Impacts

Extreme heat events, especially when accompanied by drought conditions, can lead to environmental consequences. Increasing temperatures can lead to exacerbated risk of wildfire; drought and its effects on the health of watersheds; and increased stress, migration, and death in plants and animals. These shifts result in significant cultural impacts on Tribal Nations, where plants and animals that have been used as traditional food, medicine, or materials, or in ceremony are no longer present (State of California 2022j). Alpine trees are vulnerable to temperature changes, resulting in mass tree deaths and a loss of habitat for animals (Mooney and Zavaleta 2016).

7.5.5. Impacts on Agriculture

Increased extreme heat events will likely impact California's agriculture sector negatively. Although heatwaves are usually considered a summer problem, warm winter and spring temperatures can also be a problem for fruit and nut trees. For example, many of California's perennials require exposure to cool temperatures during the winter in order to bloom and develop correctly in the spring. When crops do not receive enough winter chill, the timing of bloom may be delayed, which can cause problems for pollination. In 2015 a warm winter and a lack of chill devastated California's pistachio crop and caused more than $180 million in crop damage.

In the future, warming winter temperatures are expected to reduce the exposure of perennials to needed cool temperatures. This reduction in winter chill could effectively eliminate the production of some fruits and nuts in California by the end of the 21st century. For example, by the mid-21st century, up to 75 percent of California's Central Valley may be too warm for crops that need more than 700 chill hours. As much as 98 percent of the region may be too warm by the end of the century.

7.5.6. Local Hazard Impacts

LHMP Rankings

County hazard mitigation plans often identify "severe weather" as a hazard of concern without separating hot or cold temperatures from each other or from other weather types. Of the 58 counties in California, 54 assessed severe weather as a hazard of concern in their hazard mitigation plans: 17 specified extreme temperature (hot or cold). None ranked extreme temperature as high risk; 13 ranked it as medium risk, and 4 ranked it as low risk. The following counties listed extreme temperature as a medium-risk hazard:

- Amador
- Butte
- Calaveras
- El Dorado
- Fresno
- Lake
- Madera
- Modoc
- Mono
- Monterey
- Nevada
- Placer
- San Benito
- Tulare

LHMP Estimates of Potential Loss

A review of the LHMPs in the counties (as called for in FEMA's Standard State Mitigation Planning Requirement S6.b) found no quantitative risk analysis that identifies population or structures exposed to this hazard. This can be attributed to the lack of extent and location hazard mapping to use for such an analysis. Therefore, no summary of risk for local plan reviews is provided for this hazard.

7.6. VULNERABILITY ANALYSIS

7.6.1. Exposure of State-Owned or -Leased Facilities, Critical Facilities, and Community Lifelines

All State-owned or -leased assets, as listed in Table 4-1 and Table 4-2, are exposed to extreme heat. This includes 23,961 State-owned facilities, and 1,893 State-leased facilities. All 755 State critical facilities and community lifelines, as listed in Table 4-3, are exposed to this hazard as well.

Functional downtime associated with power interruption is the most significant impact on critical facilities and community lifelines from extreme heat events. The level of impact depends on the amount of time it takes to restore power to operational status at impacted facilities.

7.6.2. Estimates of Loss

Extreme heat events do not typically impact buildings; however, losses may be associated with the urban heat island effect and overheating of heating, ventilation, and air conditioning systems. This can impact power and cooling dependent upon power, which could impact infrastructure that needs temperature control, such as information technology equipment. There are no standard generic formulas for estimating associated losses. Instead, loss estimates were developed representing 10 percent, 30 percent, and 50 percent of the replacement cost value of the contents all State-owned facilities (see Table 7-3). This allows the State to select a range of potential economic impacts based on an estimate of the percentage of damage.

Table 7-3. Loss Potential of State-Owned Asset Contents for Extreme Heat

Type of Facility	Total Replacement Cost Value (contents only)	Estimated Loss Potential Based on % Damage		
		10% Damage	30% Damage	50% Damage
Facilities Housing Vulnerable Populations				
Correctional Facility	$2,254,012,157	$225,401,216	$676,203,647	$1,127,006,079
Development Center	$390,885,847	$39,088,585	$117,265,754	$195,442,924
Hospital	$454,638,764	$45,463,876	$136,391,629	$227,319,382
Migrant Center	$341,691,270	$34,169,127	$102,507,381	$170,845,635
Special School	$63,904,858	$6,390,486	$19,171,457	$31,952,429
All Other Facilities	**$14,057,592,693**	**$1,405,759,269**	**$4,217,277,808**	**$7,028,796,347**
Total	**$17,562,725,589**	**$1,756,272,559**	**$5,268,817,677**	**$8,781,362,795**

Increased extreme heat events will likely impact California's agriculture sector negatively. Although heatwaves are usually considered a summer problem, warm winter and spring temperatures can also be a problem for fruit and nut trees. For example, many of California's perennials require exposure to cool temperatures during the winter in order to bloom and develop correctly in the spring. When crops do not receive enough winter chill, the timing of bloom may be delayed, which can cause problems for pollination. In 2015 a warm winter and a lack of chill devastated California's pistachio crop and caused more than $180 million in crop damages (USDA n.d.).

Extreme heat threatens the State's fish and wildlife, ecosystems, and native plants, contributing to biodiversity loss. It is estimated that 45 to 56 percent of the natural vegetation in California will be climatically stressed by 2100 under current emission levels (State of California 2018).

In the future, warming winter temperatures are expected to reduce the exposure of perennials to needed cool temperatures. This reduction in winter chill could effectively eliminate the production of some fruits and nuts in California by the end of the 21st century. For example, up to 75 percent of California's Central Valley may be too warm for crops that need more than 700 chill hours by the mid-21st century. As much as 98 percent of the region may be too warm by the end of the century (USDA n.d.).

7.6.3. Buildable Land

An estimated 11.7 million acres of land is available for development in California. Because the entire State is vulnerable to extreme heat, any type of development of any of this land will be susceptible to damage and impacts from this hazard.

7.6.4. Equity Priority Communities

Extreme heat conditions can impact the entire population of the State; however, for equity priority communities these conditions can be dangerous and deadly, as heat risk is associated and correlated with physical, social, political, and economic factors (State of California 2022j). Older populations, infants and children, pregnant people, and people with chronic illness can be especially sensitive to heat exposure. Combining these characteristics and existing health inequities with additional factors, such as poverty, linguistic isolation, housing insecurity, limited to no access to cooling or shade, and the legacy of racist redlining policies, can put individuals at disproportionately high risk of heat-related illness and death (State of California 2022j).

Low-income individuals are more likely to live in poorly ventilated dwellings, lack air conditioning, or be unable to afford cooling; people experiencing homelessness lack shelter, cooling apparatus, and consistent access to water to minimize heat impacts (Center for Climate and Energy Solutions 2021). Indigenous, Black, Latina/e/o, Asian, Hawaiian and Pacific Islander, and other populations of color are vulnerable to extreme heat impacts due to underinvestment in their communities, leaving many with inadequate housing, infrastructure, and health services to manage extreme heat days (Center for Climate and Energy Solutions 2021).

Because the entire population of the State of California is exposed and vulnerable to extreme heat, the exposed population in equity priority communities is equal to the statewide percentage: 30.4 percent of the total population (12 million people).

7.6.5. NRI Scores

According to the NRI, all of the State’s counties have heat wave risk, rated from very low to very high. Table 7-4 shows scores for the six counties with the highest rating. See Section 4.1.3 for a description of the components of the NRI.

Table 7-4. NRI Scoring of Counties for Heat Wave

County	Expected Annual Loss	Social Vulnerability Rating	Community Resilience Rating	Community Risk Factor	Risk Value	Score
Tulare	$19,484,740	Very High	Very Low	1.55	$30,585,603	99.65
Fresno	$12,873,728	Very High	Relatively Low	1.53	$19,280,399	99.46
Sacramento	$12,434,271	Relatively High	Relatively High	1.22	$15,543,423	99.24
Merced	$7,593,791	Very High	Very low	1.55	$11,815,569	99.01
Madera	$7,522,714	Very High	Very Low	1.41	$11,138,740	98.95
Riverside	$7,651,092	Very High	Relatively Low	1.34	$10,323,436	98.76

7.7. MITIGATING THE HAZARD

7.7.1. Existing Measures to Mitigate the Hazard

New legislation in California has been introduced to rank heat waves similarly to hurricanes. Assembly Bill (AB) 2238 and AB 2076 each propose solutions designed to protect people from heat and improve heat resilience and mitigation efforts. Among the ideas proposed, the bills would establish a Chief Heat Officer role, an interagency heat task force, and an extreme heat advisory council.

7.7.2. Opportunities for Mitigating the Hazard

Table 7-5 provides a range of potential alternatives for mitigating extreme heat.

7.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address the extreme heat hazard:

- Action 2018-008: Develop a database containing a description of the specific natural hazard event for which each project was designed to mitigate.
- Action 2018-090: Extreme Heat Vulnerability: Identify areas of the State most vulnerable to climate impacts.
- Action 2018-091: Extreme Heat Vulnerability: Identify vulnerable populations (e.g., people experiencing homelessness, lower-income households, older adults).

Table 7-5. Potential Opportunities to Mitigate the Extreme Heat Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ Plant trees to create shade in urban areas ▪ Remove concrete and other hard surfaces and replace them with native vegetation **Reduce exposure and vulnerability:** ▪ Insulate residential and non-residential structures to provide greater thermal efficiency ▪ Provide redundant power sources ▪ Get air conditioning installed ▪ Plant appropriate trees near home and power lines ("Right tree, right place" National Arbor Day Foundation Program) **Build local capacity:** ▪ Promote 72-hour self-sufficiency ▪ Obtain a NOAA weather radio	**Manipulate the hazard:** ▪ Plant trees in urban areas experiencing urban heat island effects or with below average tree canopy coverage ▪ Remove concrete and other hard surfaces and replace them with native vegetation **Reduce exposure and vulnerability:** ▪ Relocate critical infrastructure (such as power lines) underground ▪ Reinforce or relocate critical infrastructure such as power lines meet resiliency expectations against all-hazard impacts ▪ Install tree wire ▪ Provide cooling centers for employees ▪ Install "cool roofs" and "green roofs." **Build local capacity:** ▪ Create redundancy in power supply ▪ Equip facilities with a NOAA weather radio	**Manipulate the hazard:** ▪ Plant trees in urban areas experiencing urban heat island effects or with below average tree canopy coverage ▪ Remove concrete and other hard surfaces and replace them with native vegetation **Reduce exposure and vulnerability:** ▪ Harden infrastructure such as locating utilities underground ▪ Trim trees back from power lines ▪ Install "cool roofs," "green roofs," and other green infrastructure ▪ Use the best available technology to enhance the warning systems for all severe weather events **Build local capacity:** ▪ Increase communication alternatives ▪ Enhance public awareness campaigns to address actions to take during extreme heat events ▪ Coordinate severe weather warning capabilities and the dissemination of warning among agencies with the highest degree of capability ▪ 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 ▪ Review and update heat response plan in light of climate change projections ▪ Promote programs that support community-scale microgrids ▪ Evaluate and revise, as needed, building codes to address and mitigate extreme heat impacts on residents

Community-Scale	Organizational Scale	Government-Scale
▪ Obtain an emergency generator or community microgrid	▪ Equip vital facilities with emergency power sources	

Nature-based opportunities

- Green roofs can be up to 40 °F cooler than typical roofs and reduce community temperatures by up to 5 °F. They can reduce building air conditioning costs by up to 75 percent. Green roofs provide benefits up to $14 more per square foot than traditional roofs
- Tree can lower surface temperatures by providing shade and through evapotranspiration, which can reduce peak local summer temperatures by 2 °F to 9° F. Shady areas can be between 20 °F and 45 °F cooler than sunny areas, providing safe resting places outside. A study found cities see benefits equivalent to $1.50 to $3 for every $1 invested in tree planting
- The Planting of native plants—including along parking lots, streets, and in yards—can provide cooling effects. Vertical gardens, also referred to as green or living walls, involve planting on walls to provide shade for buildings. This helps to cool the building and surrounding area
- Any solutions that convert built environments to natural environments such as forests, wetlands, and vegetation can aid in lowering temperatures. Natural environments and green vegetation provide more shade, moisture, and evaporation than built environments, all of which help reduce temperatures. These systems sequester carbon, helping to minimize future warming

EXTREME COLD OR FREEZE

Climate Impacts:
More frequent and intense events
Equity Impacts:
30.4% of exposed population (all persons in the State are exposed) identified as living in equity priority communities
State Facilities Exposed:
All facilities exposed
Community Lifelines Exposed:
All lifelines exposed

Impact Rating: High (39)

8. Extreme Cold or Freeze

Extreme cold or freeze has been identified as a high-impact natural hazard of interest based on the hazard impact rating protocol applied for this SHMP. Extreme cold events happen frequently in the State and all State-owned or -leased facilities and community lifelines are exposed to this hazard, although the damage caused would be limited. While some portions of the State may get colder than others, all populations in the State could experience extreme cold or freeze events relative to their area. These events are likely to impact equity priority communities more than the general populations due to many factors. Exposure to extreme cold or freeze events could increase if all buildable lands are developed, but the vulnerability of that exposure is considered low because it would be new development subject to codes and standards. The frequency and severity of extreme cold or freeze events is anticipated to increase over the next 30 years due to the impacts from climate change.

8.1. HAZARD OVERVIEW

Extreme cold events are when temperatures drop well below the temperatures that are normal in an area. Depending on what is normal, this may mean temperatures around the freezing point (32 °F) or below 0 °F. Freeze events are when temperatures remain below freezing for a sustained period.

The impact of extreme cold and freezing temperatures on people is generally measured through the wind chill temperature index. The wind chill temperature is the temperature that people feel when outside. It is based on the rate of heat loss from exposed skin due to the effects of wind and cold. As the wind increases, the body is cooled at a faster rate, causing the skin's temperature to drop. The wind chill temperature index includes a frostbite indicator, showing the temperature, wind speed, and exposure time that will produce frostbite to humans, as shown on Figure 8-1 (NWS 2022b).

Figure 8-1. NWS Wind Chill Index

Wind (mph)	Temperature (°F)																	
Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes; 10 minutes; 5 minutes

Source: (NWS 2021a)

8.2. HAZARD LOCATION

The entire State is at risk for extreme cold and freeze events. California has a diversity of climates, and statewide provisions to the California Energy Code account for these variations using a set of 16 climate zones (CEC n.d.-a). Much of the impact of this hazard will be seen in the central and northern portions of the State, though areas in Southern California can also experience extreme cold events.

Extreme cold temperature events are typically isolated to more mountainous communities. Bodie State Park in Mono County is considered the coldest place in California (Bartell 2019).

8.3. PREVIOUS HAZARD OCCURRENCES

Many sources provided historical information regarding previous occurrences and losses associated with extreme temperatures throughout the State of California; therefore, the loss and impact information for many events could vary depending on the source. The accuracy of monetary figures discussed is based only on the available information in cited sources.

8.3.1. Disaster and Emergency Declarations

The following disaster declarations or emergency proclamations related to extreme cold, or freeze have been issued for California (see Appendix F for details):

- Federal DR or EM declaration, 1953 – 2022: 3 events, classified as "severe freeze" or "citrus crop damage"
- California Emergency Proclamations, 1950 – 2022: 9 events, classified as "freeze"
- USDA agricultural disaster declarations, 2012 – 2022: 1 event

8.3.2. Event History

Most extreme cold and freeze events in California take place in the winter, primarily between December and February. According to the NOAA National Centers for Environmental Information Storm Events Database, there have been over 500 extreme cold and freeze events in the State since 2000, most of them occurring between November and March. Refer to Appendix K for the history of cold/freeze events since 1969.

The 2018 SHMP discussed cold/freeze events that occurred in the State from 1969 to 2017. An additional event since then occurred February 20 – 21, 2018, in the San Joaquin Valley, which experienced its coldest morning in several years at many locations. Many weather stations reported several hours of subfreezing temperatures. Numerous crops experienced significant damage from the cold. The snap pea crop was nearly wiped out and the almond crop was also hit hard. Damage to citrus was mitigated by the fact that much of the crop had already been harvested. About $150 million in crop damage resulted.

8.4. PROBABILITY OF FUTURE HAZARD EVENTS

8.4.1. Overall Probability

California's 1,373 recorded extreme cold/freeze events between 1953 and 2022 represent an average of almost 20 events per year. The State expects to continue experiencing a similar number of extreme cold/freeze events each year.

8.4.2. Climate Change Impacts

When comparing average annual temperatures from 1901–1960 to those of 1986 – 2016, most of California has experienced increases exceeding 1°F, with some areas exceeding 2°F (OPR 2022). This general warming trend has the potential to reduce the occurrence and range of anticipated intensities of extreme cold or freeze events in the future.

8.5. IMPACT ANALYSIS

Extreme cold and freeze events can have significant impacts on the State. This includes loss of life, illnesses, and economic costs in transportation, agriculture, energy, and infrastructure. The State faces the following risks associated with extreme cold or freeze events, which can last several days (Rand 2018):

- Extremely cold temperatures often accompany winter weather. which can cause power failures and icy roads.
- People may have inadequate heat in their homes because of a power failure, because of an inadequate heating system or no heating system at all, or because the household cannot afford to operate the heating system.
- The use of space heaters and fireplaces to keep warm increases the risk of household fires and carbon monoxide poisoning.
- Sustained temperatures below freezing can cause life loss and health risks to vulnerable populations in areas where such temperatures are not common.
- Freezing temperatures occurring during winter and spring growing seasons can cause extensive crop damage.

8.5.1. Severity

The coldest temperature on record in California is –45 °F, recorded January 20, 1937, in the community of Boca in Nevada County (Western Regional Climate Center n.d.) Bodie State Park in Mono County is considered the coldest place in California overall. During the 2018 – 2019 winter, the average observed temperature in the park was -7 °F (Bartell 2019).

8.5.2. Warning Time

Meteorologists can accurately forecast the timing and severity of extreme temperature events with several days' lead time. These forecasts provide an opportunity for public health and other officials to notify vulnerable populations.

Currently, the only way to headline very cold temperatures is with the use of the NWS-designated Wind Chill Advisory or Warning products. When actual temperatures reach Wind Chill Warning criteria with little to no wind, extreme cold warnings may be issued (NWS 2021a).

8.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with extreme cold or freeze events:

- Cold temperatures can freeze pipes, causing them to burst and create water leaks and water supply issues. Infrastructure such as roads and utilities are at risk to freezing temperatures, causing failures and hazardous road conditions (OTS 2022) (Center for Disaster Philanthropy 2022).
- Exposure to cold temperatures can cause hypothermia and frostbite. Infants and older adults are particularly at risk, but anyone can be affected (CDC 2005). Slip and fall risk increases during extreme cold events (BLS 2016). Carbon monoxide exposures and poisonings occur more often during fall and winter when people are using gas furnaces and heaters (CDC 2008).

8.5.4. Environmental Impacts

Freezing and warming weather patterns create changes in natural processes. An excess amount of snowfall followed by early warming periods may affect natural processes such as flow of water resources.

8.5.5. Local Hazard Impacts

LHMP Rankings

County hazard mitigation plans often identify "severe weather" as a hazard of concern without separating hot or cold temperatures from each other or from other weather types. Of the 58 counties in California, 54 assessed severe weather as a hazard of concern in their hazard mitigation plans: 17 specified extreme temperature (hot or cold). None ranked extreme temperature as high risk; 13 ranked it as medium risk, and 4 ranked it as low risk. The following counties listed extreme temperature as a medium-risk hazard:

- Amador
- Butte
- Calaveras
- El Dorado
- Fresno
- Lake
- Madera
- Modoc
- Mono
- Monterey
- Nevada
- Placer
- San Benito
- Tulare

LHMP Estimates of Potential Loss

A review of the LHMPs in the counties (as called for in FEMA's Standard State Mitigation Planning Requirement S6.b) found no quantitative risk analysis that identifies population or structures exposed to this hazard. This can be attributed to the lack of extent and location hazard mapping to use for such an analysis. Therefore, no summary of risk for local plan reviews is provided for this hazard.

8.6. VULNERABILITY ANALYSIS

8.6.1. Exposure of State-Owned or -Leased Facilities, Critical Facilities, and Community Lifelines

All State-owned or -leased assets, as listed in Table 4-1 and Table 4-2, are exposed to extreme cold or freeze. This includes 23,961 State-owned facilities, and 1,893 State-leased facilities. All 755 State critical facilities and community lifelines, as listed in Table 4-3, are exposed to this hazard as well.

Functional downtime associated with power interruption is the most significant impact on critical facilities and community lifelines from extreme cold or freeze events. The level of impact depends on the amount of time it takes to restore power to operational status at impacted facilities. Water supply infrastructure (pipes, pumps, and wells) can also be subject to impacts from freezing if they are shallow subsurface elevations or not protected from the elements.

8.6.2. Estimates of Loss

State assets could be damaged by extreme cold or freeze events, but there are no standard generic formulas for estimating associated losses. Instead, loss estimates were developed representing 10 percent, 30 percent, and 50 percent of the replacement cost value of all State-owned facilities (see Table 8-1). This allows the State to select a range of potential economic impacts based on an estimate of the percentage of damage. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure.

Table 8-1. Loss Potential of State-Owned Assets for Extreme Cold or Freeze

Type of Facility	Total Replacement Cost Value (contents only)	Estimated Loss Potential Based on % Damage		
		10% Damage	30% Damage	50% Damage
Facilities Housing Vulnerable Populations				
Correctional Facility	$5,673,743,477	$567,374,348	$1,702,123,043	$2,836,871,738
Development Center	$696,669,418	$69,666,942	$209,000,825	$348,334,709
Hospital	$837,461,197	$83,746,120	$251,238,359	$418,730,598
Migrant Center	$996,980,976	$99,698,098	$299,094,293	$498,490,488
Special School	$128,610,363	$12,861,036	$38,583,109	$64,305,182
All Other Facilities	**$28,392,185,985**	**$2,839,218,598**	**$8,517,655,796**	**$14,196,092,992**
Total	**$36,725,651,416**	**$3,672,565,142**	**$11,017,695,425**	**$18,362,825,708**

8.6.3. Buildable Land

An estimated 11.7 million acres of land is available for development in California. Because the entire State is vulnerable to extreme cold or freeze, any type of development of any of this land will be susceptible to damage and impacts from this hazard.

8.6.4. Equity Priority Communities

Because the entire population of the State of California is exposed and vulnerable to extreme cold or freezing, the exposed population in equity priority communities is equal to the statewide percentage: 30.4 percent of the total population (12 million people). Cold temperatures most immediately impact populations who lack the resources to access a warm environment during the cold weather event.

8.6.5. NRI Scores

According to the NRI, six of the State's counties have cold wave risk, rated from very low to relatively moderate. Table 8-2 shows scores for these six counties. See Section 4.1.3 for a description of the components of the NRI.

Table 8-2. NRI Scoring of Counties for Cold Wave

County	Expected Annual Loss	Social Vulnerability Rating	Community Resilience Rating	Community Risk Factor	Risk Value	Score
Modoc	$98,176	Relatively High	Relatively Low	1.35	$133,771	60.48
Siskiyou	$58,958	Relatively High	Relatively Moderate	1.39	$92,996	55.2
Shasta	$0	Relatively High	Relatively Moderate	1.26	$0	27.65
Lassen	$0	Relatively High	Relatively Moderate	1.14	$0	27.46
Mono	$0	Relatively Moderate	Relatively High	1.17	$0	27.33
Inyo	$0	Relatively Moderate	Relatively Low	1.31	$0	26.92

8.7. MITIGATING THE HAZARD

8.7.1. Opportunities for Mitigating the Hazard

Table 8-3 provides a range of potential alternatives for mitigating the extreme cold and freeze hazard. See Section 1.2.3 for a description of the different types of alternatives.

Table 8-3. Potential Opportunities to Mitigate the Extreme Cold or Freeze Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ None **Reduce exposure and vulnerability:** ▪ Insulate residential and non-residential structures to provide greater thermal efficiency and reduce heat loss ▪ Provide redundant heat and power ▪ Ensure natural gas input/release valves do not get covered in snow and ice, leading to freezing **Build local capacity:** ▪ Prepare emergency food and supplies to be self-sufficient for at least 72 hours in the event of severe winter weather ▪ Obtain an emergency generator	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Relocate critical infrastructure (such as power lines) underground ▪ Reinforce or relocate critical infrastructure such as power lines to meet performance expectations ▪ Provide warming centers for employees **Build local capacity:** ▪ Create redundancy ▪ Equip facilities with a NOAA weather radio ▪ Equip vital facilities with emergency power sources	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Harden infrastructure such as locating utilities underground ▪ Provide backup power sources at vital critical facilities ▪ Establish warming centers **Build local capacity:** ▪ Enhance public awareness. campaigns to address issues of warnings and actions to take during extreme cold events ▪ Use the best available technology to enhance the warning systems for all severe weather events ▪ Coordinate severe weather warning capabilities and the dissemination of warning amongst agencies with the highest degree of capability ▪ Provide NOAA weather radios to the public ▪ Retrofit above-ground utilities to underground facilities if appropriate ▪ Create a salt reserve or research alternates to stretch salt reserve ▪ Evaluate and revise, as needed, building codes to address and mitigate extreme cold and freeze impacts on residents
Nature-based opportunities ▪ Where available, take advantage of geothermal resources for heating assets subject to extreme cold or freeze.		

8.7.2. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address the extreme cold/freeze hazard:

- Action 2023-006: Prohousing Designation Program: Promote the Program to encourage cities and counties to apply for this designation to receive points or preference in competitive housing, community development, and infrastructure programs.
- Action 2018-006: Enhance Collaboration on the Development and Sharing of Data Systems and geographic information systems (GIS) modeling.
- Action 2018-008: Develop a database containing a description of the specific natural hazard event for which each project was designed to mitigate.

WILDFIRE

Climate Impacts:

If GHG emissions continue to rise, California is likely to see a 50% increase in fires larger than 25,000 acres as well as a 77% increase in average area burned by 2100

Equity Impacts:

7% of exposed population (those living in high and very high fire hazard severity zones) identified as living in equity priority communities

State Facilities Exposed:

5,038 State facilities in high and very high fire hazard severity zones; $1.9 billion in total replacement cost values for facilities in high and very high fire hazard severity zones

Community Lifelines Exposed:

71 community lifelines in high and very high fire hazard severity zones

Impact Rating: High (36)

9. WILDFIRE

Wildfire has been identified as a high-impact natural hazard of interest based on the hazard impact rating protocol applied for this SHMP. Wildfires happen frequently in the State. About 21 percent of State-owned or -leased facilities and 10 percent of community lifelines are exposed to this hazard. Approximately 9 percent of the State's population is exposed this hazard, and over 7 percent of that population has been identified as living in equity priority communities. Over 45 percent of identified buildable lands in the State intersect identified high fire severity zones. The frequency and severity of wildfire is anticipated to increase over the next 30 years due to the impacts of climate change.

9.1. HAZARD OVERVIEW

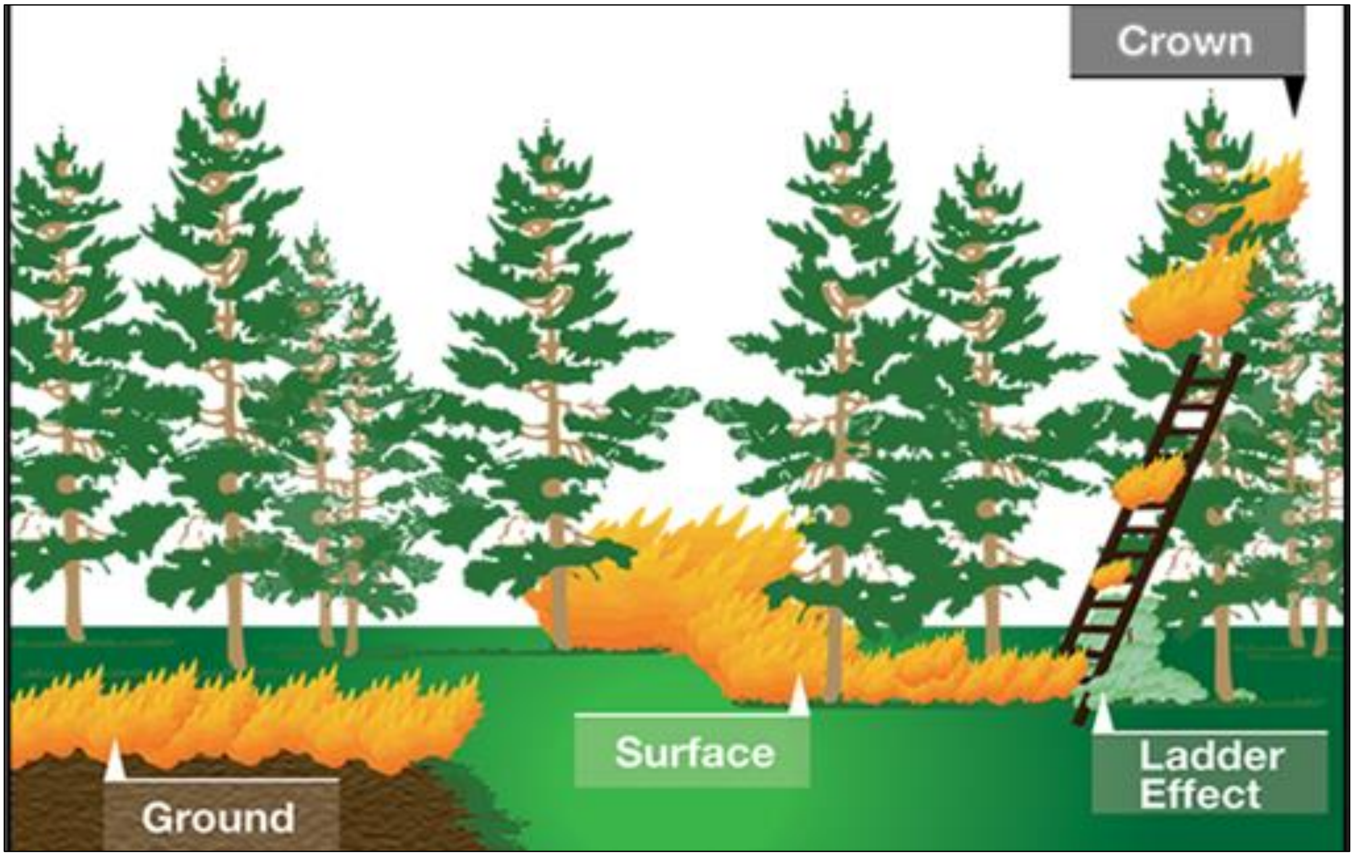
Wildfire has been among the three greatest sources of hazard to California. With the catastrophic wildfire events from 2017 through 2022, fire has emerged as an annual threat roughly comparable to floods and surpassed in risk level only by earthquakes, which occur less frequently but can be more destructive. The final impact rating for wildfire in this Plan differs from the initial estimate determined through the risk ranking. However, both rate wildfire in California as "high."

In California, wildfire is common due to the combination of complex terrain, Mediterranean climate that annually facilitates several month-long rain-free periods, productive natural plant communities that provide ample fuels, and ample natural and anthropogenic ignition sources (UC n.d.). The State has an extensive history of severe wildfire events and faces the probability of future events that are even more destructive than those of the past. Wildfires are the most frequent source of declared disasters and account for the third highest combined losses of natural hazards in the State.

9.1.1. General Wildfire Types

Flammable expanses of brush, diseased timberland, overstocked forests, hot and dry summers, extreme topography, intense fire weather wind events, summer lightning storms, and human acts all contribute to California's wildfire threat. Wildfires can generally be classified as follows (see Figure 9-1):

Figure 9-1. Types of Wildfires



Source: (Haygot Technologies 2020)

- Ground fires occur when fuels ignite and burn underground. Ground fires may eventually burn through the ground surface and become surface fires.
- Surface fires burn on the surface of the ground and are primarily fueled by low-lying vegetation.
- Ladder fuels are vegetation that allow surface fires to climb into the tree canopy and become crown fires (National Wildfire Coordinating Group 2021).
- Crown fires spread from treetop to treetop spread at a rapid pace. Crown fires are often pushed by wind and can be extremely intense (De La Torre 2021).

What is a Wildfire?

In general, the following characteristics define a wildfire:

- A free-burning (unplanned) vegetative fire
- Started by an unplanned ignition that may be either natural (e.g., lightning) or human-caused (e.g., power lines, mechanical equipment, discarded cigarettes, escaped prescribed fires, or intentionally set fires)
- With a management objective of full suppression.

Source: (National Wildfire Coordinating Group 2021)

9.1.2. Factors Affecting Fire Behavior

Fire behavior is based on factors such as the following (CAL FIRE 2021):

- **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 *Arundo donax* and other 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. Conditions are very favorable for extensive and severe wildfires when the temperature is high, relative humidity is low, wind speed is increasing and coming from the east (offshore flow), and there has been little or no precipitation, so vegetation is dry. These conditions occur more frequently inland where temperatures are higher, and fog is less prevalent.
- **Terrain**—The slope and elevation 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 landforms (fire spreads more easily uphill than downhill).

9.1.3. Wildland Fire vs. Wildland Urban Interface Fires

Fire science distinguishes between wildland fires, which burn predominately in undeveloped areas, and wildland urban Interface (WUI) fires (USFS 2019). Mitigation actions, response actions and damage associated with the two types of fire may differ significantly (McCaffrey, et al. 2020).

Wildland Fires

Wildland fires that burn in undeveloped settings are part of a natural fire regime and may be beneficial to the landscape if they burn within the historical range of variability for fire size and intensity. Many species are adapted to California's natural fire regimes and flourish after a low or mixed severity burn. These fires also enhance ecosystem function by creating landscapes that have more variation, are more resilient to other disturbances, and are better suited to withstand extremes in precipitation (UC 2017). However, wildland fires still pose a threat and can have catastrophic impacts on wildlife and habitat.

A wildland fire may result in secondary negative impacts in the form of air pollution, including GHG emissions, soil erosion (resulting in siltation of streams and lakes), post-fire flooding, or mudslides. The impacts can even extend beyond State borders. In 2020, wildfire smoke not only blanketed large swaths of California, but also worsened air quality across the United States (Saldanha, et al. 2021).

Unless wildland fires or their related cascading hazards occur in or near developed areas, they are rarely classified as disasters because they do not pose severe risk to life or widescale damage to the environment. Wildland fires that burn primarily on federally managed lands are only rarely classified as disasters. For example, the 2007 Zaca Fire (240,207 acres) and 2009 Station Fire (160,577 acres), both of which burned on U.S. Forest Service lands, were enormous in size but did not result in federal disaster status. Those fires stand in contrast to the October 2017 Northern California Wildfires, which were smaller in area but much more destructive, due to their proximity to larger urbanized areas.

WUI Fires

The WUI has been defined as "the area or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels" (U.S. Fire Administration 2022a). The WUI can be configured in many ways including a classic "interface" (e.g., a community that abuts a National Forest at a distinct boundary), an "intermix" (e.g., vegetative fuels distributed between buildings throughout a subdivision between buildings), or an "occlusion" (e.g., a community that completely surrounds a designated open space area) (Federal Register 2001). The combination of natural and human-made fuels that are burned in WUI fires may lead to the formation or release of toxic emissions not found in purely wildland fires (Committee on the Chemistry of Urban Wildfires 2022).

WUI fires represent an increasingly significant concern for California. California has a chronic and destructive WUI fire history with significant losses of life, structures, infrastructure, agriculture, and businesses (USFS 2019). Most local governments that have prepared LHMPs have identified fire and WUI fires as specific hazards. Even relatively small WUI fires may result in disastrous damage (Li and Banerjee 2021).

Most WUI fires are suppressed before they exceed 100 acres (Li and Banerjee 2021). The remainder usually occur during episodes of hot, windy conditions that exceed initial attack capabilities and are more likely to cause heightened losses to the built environment. Many WUI fires occur in areas that have a historical pattern of wildland fires that burn under extreme conditions. The pattern of increased damage is directly related to increased urban spread into areas that have historically had wildfire as part of the natural ecosystem (Doumar 2018).

California has a strong statewide approach toward WUI planning and regulatory requirements, including minimum WUI building code requirements, Fire Safe regulations, and State land use planning guidance from the California Governor's Office of Planning and Research (OPR) (Community Wildfire Planning Center 2021).

9.1.4. The Role of Wildfire in Broader Ecosystems

Fire is a natural part of California's diverse landscapes and is vital to many ecosystems across the State. For centuries, many California Native American Tribal Nations recognized the interdependence between fire, communities, culture, and the environment and used prescribed burning—the intentional ignition of small, low-intensity fires—to maintain and restore environmental health and promote resilience against catastrophic wildfires (Cal OES 2018b).

While wildfires can lead to benefits to an ecosystem if within the range of natural variability for a given geographical area, they can also lead to harmful effects to the natural and built environment (CAL FIRE n.d.-a).

Research into the century-old policies of fire exclusion and suppression has provided better understanding of the importance of fire in the natural cycle of some ecotypes, particularly mixed-conifer forests (National Park Service 2015). As a result, prescribed fires have been used more extensively as a land management tool to replicate natural fire cycles. Unfortunately, a century of fire exclusion has led to a significant buildup of fuels in many mixed-conifer forests, which historically experienced frequent, low-intensity surface fires. Thus, there are significant areas where prescribed fires, in conjunction with mechanical thinning, may be appropriate to restore more natural forest conditions (California Wildfire & Forest Resilience Task Force 2022).

9.1.5. Firefighting Responsibility in California

Across California, many agents provide firefighting functions. There are three land classifications to identify the agency with primary financial responsibility for preventing and suppressing wildfire at any given location in the State:

- Local Responsibility Area is primarily the responsibility of the local jurisdiction (local fire departments and districts)
- State Responsibility Area is primarily the responsibility of the State (CAL FIRE).
- Federal Responsibility Area is primarily the responsibility of a federal government agency (U.S. Forest Service, Bureau of Land Management, etc.)

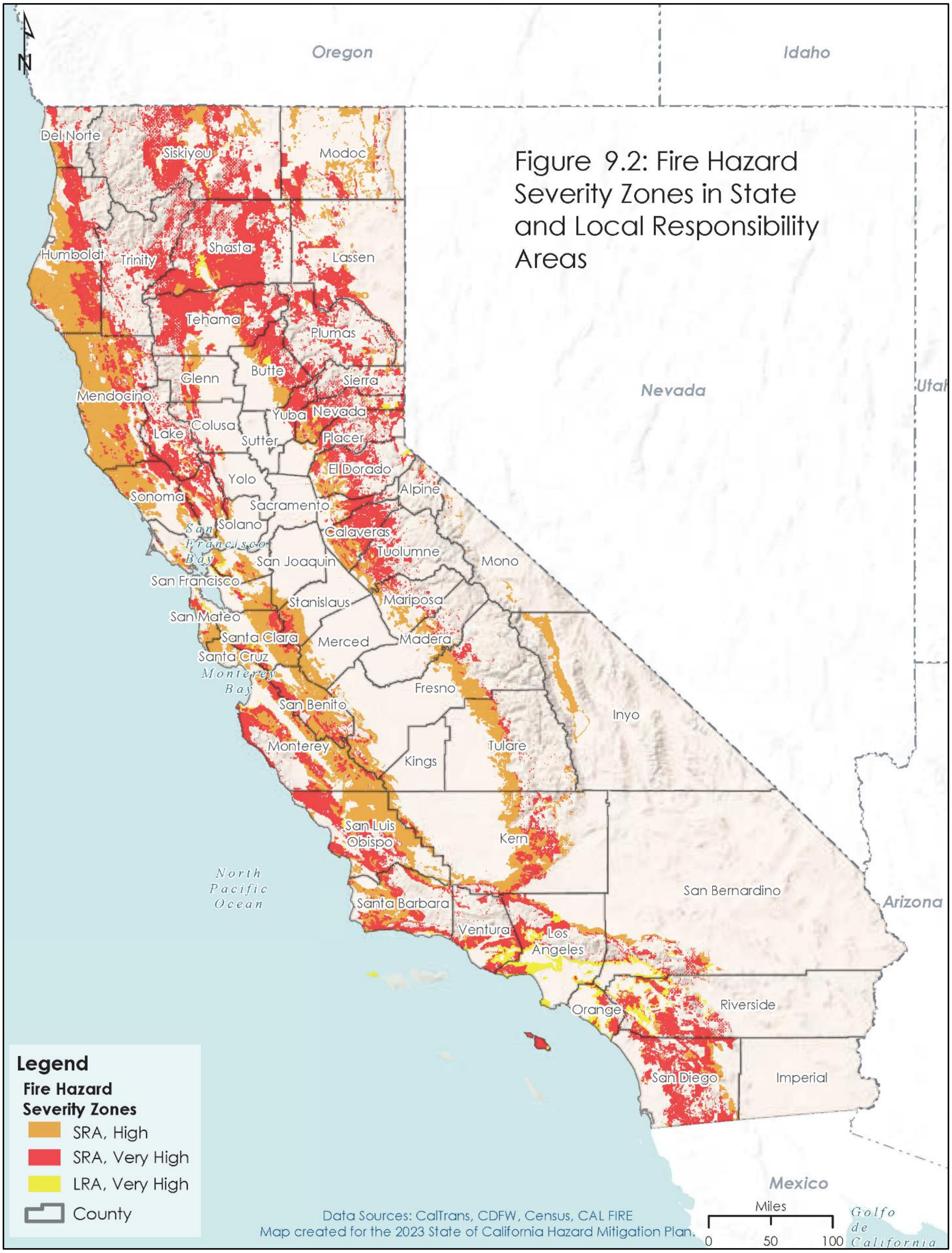
9.2. HAZARD LOCATION

Every county in California is susceptible to wildfire. Fuel-dominated wildfires are common in the timber-rich forests of the Sierra Nevada Mountain Range that contain large fuel loads due to successful fire suppression and timber harvesting. Counties west of the Sierra Nevada Mountains are more susceptible to wind-dominated wildfires. In the northern part of the State, north winds drive wildfires, while Santa Ana Winds drive wildfires in southern California (Keeley and Syphard 2019). The most common extreme fire behavior factor is high, dry, warm winds, such as Santa Ana or Diablo winds, which occur in a predictable location and seasonable pattern (Ekwurzel 2018).

9.2.1. Fire Hazard Severity Zone Mapping

CAL FIRE has mapped wildfire hazard zones using a model that designates moderate, high, or very high Fire Hazard Severity Zones (FHSZ), based on how a fire would behave in an area and the probability of flames and embers threatening buildings. For wildland areas, the FHSZ model uses burn probability and fire behavior based on weather, fuel, and terrain. For urban areas, hazard levels are based on vegetation density, distance from wildlands, and the levels assigned to surrounding zones. Each area gets a score for flame length, embers, and the likelihood of burning. Scores of smaller areas are averaged over larger zones that encompass them. Figure 9-2 shows the moderate, high, and very high FHSZs for State and local responsibility areas.

Figure 9-2. Fire Hazard Severity Zones in State and Local Responsibility Areas

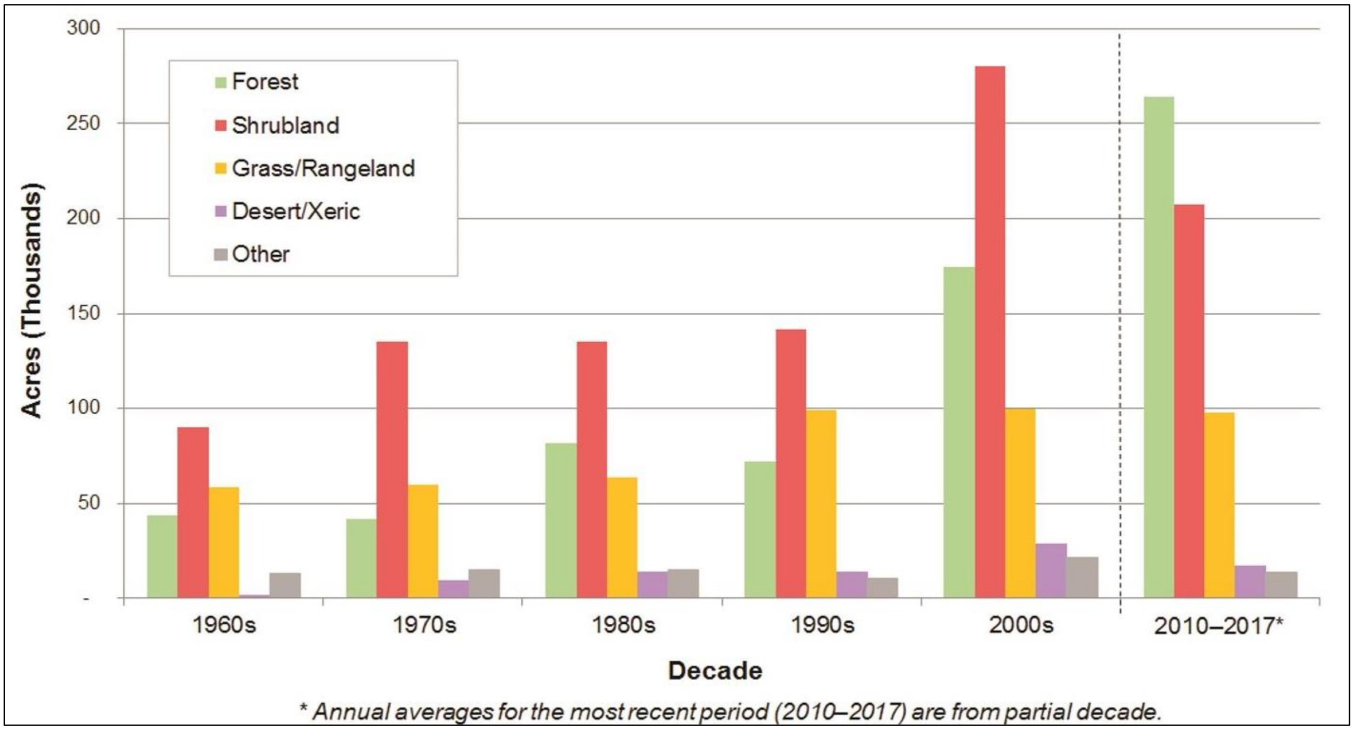


FHSZ ratings are derived from a combination of fire frequency (how often an area burns) and expected fire behavior under severe weather conditions. CAL FIRE's model derives fire frequency from 50 years of fire history data. It also is based on frequency of fire weather, ignition patterns, and expected 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 start new fires and spread to adjacent structures. The model refines the zones to account for fire exposure mechanisms that cause ignitions to structures. Significant land-use changes are accounted for through periodic model updates.

9.2.2. Historical Fire Locations

Figure 9-3 shows that shrublands have historically experienced the greatest number of acres burned in California. Shrublands are commonly found near higher urban populations, resulting in an increased number of human ignitions. Coniferous forests are burning in larger acreages in recent decades, which may be due to increased fuel loading, or build-up of burnable debris, or "fuel," in a general area.

Figure 9-3. Annual Acres Burned by Vegetation Type and Decade, 1960-2017



Source: (CAL FIRE 2017)

Figure 9-4 shows fire frequency from 1950 to 2017 across the State, based on datasets prepared by CAL FIRE. Historic fire perimeters indicate a pattern that many wildfires occur in the foothills of the coastal and interior mountain ranges, especially in mountainous regions near populated areas of Southern California. The 2018 Camp Fire burned 18,804 structures, making it the most destructive wildfire in California history (CAL FIRE 2022b). The 2020 August Complex fire burned 1,032,648 acres, making it the largest wildfire in the State's history (CAL FIRE 2022b).

An analysis of repeat fires in a given area, as shown in Figure 9-5, illustrates that some areas in California are prone to burn with greater regularity than other areas. This is of special concern in the South and Central Coast regions, which show the highest frequencies. These regions have significant amounts of shrubland plant communities where wildfires typically occur as high-intensity, stand-replacement fires.

9.2.3. Areas Susceptible to WUI Fires

Wildfire vulnerability in California is found chiefly in WUI communities, located largely on the periphery of suburban areas in Southern California, coastal mountains, and heavily wooded areas of Northern California and the Sierra Nevada. Some areas burn frequently, particularly the hills surrounding Los Angeles, San Diego, and Big Sur, as well as more isolated mountains in the Coast Ranges and Sierra Nevada.

As populations increase and communities continue to expand into the WUI throughout the State, more areas are expected to become vulnerable to wildfires. This is in part because human-caused wildfires are responsible for most of the wildfires in the WUI (Silvis Lab 2021). Figure 9-6, based on CAL FIRE's Fire and Resource Assessment Program, or FRAP, data, shows an increasing pattern of projected development encroaching into previously wildland area. The California State Forester manages a list of Communities at Risk, currently numbering 1,333 in all 58 counties (CAL FIRE 2022).

Figure 9-4. Fire Frequency (Number of Times Burned), 1950-2017

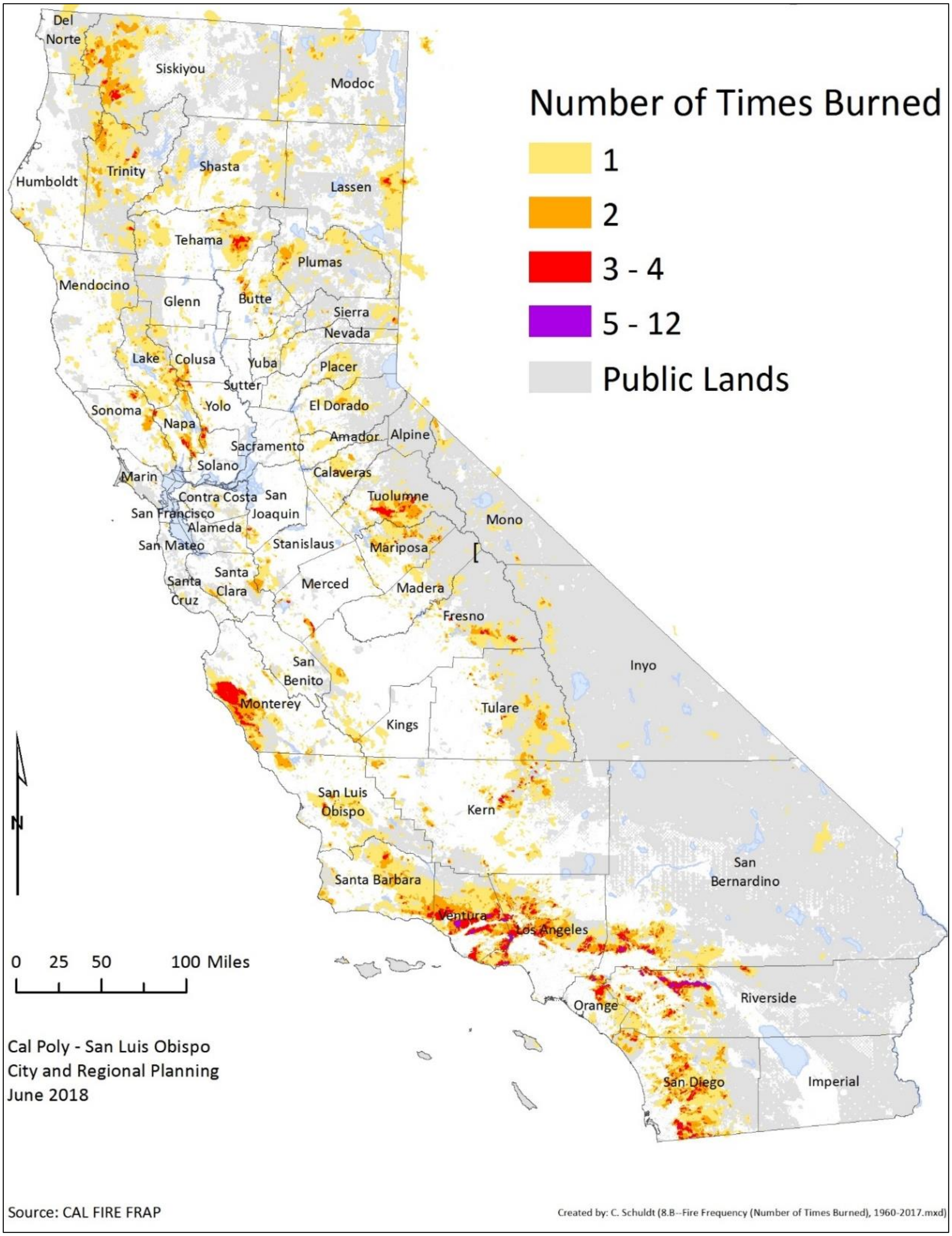


Figure 9-5. State and Federal Declared Fire Disasters, 1993 – Present

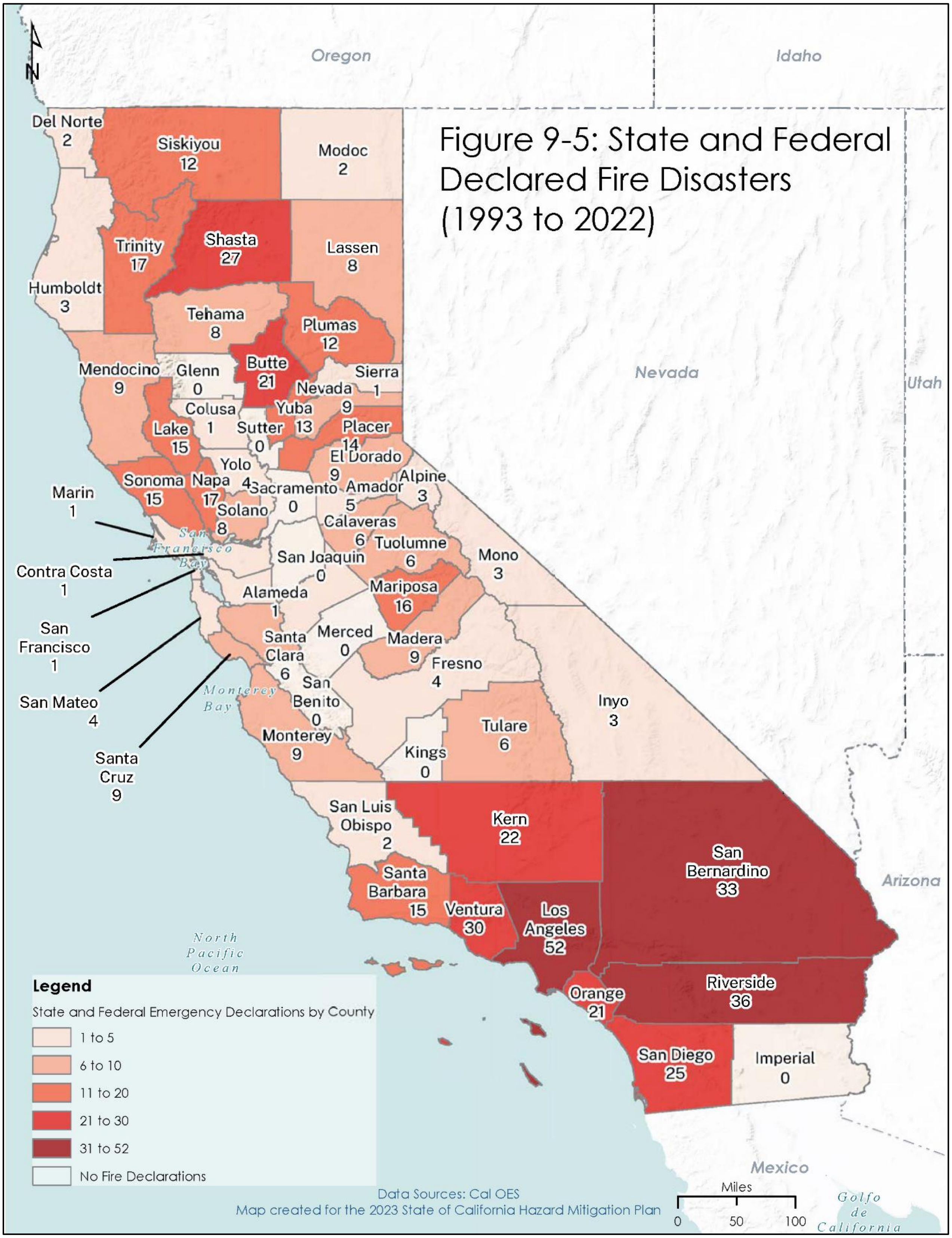
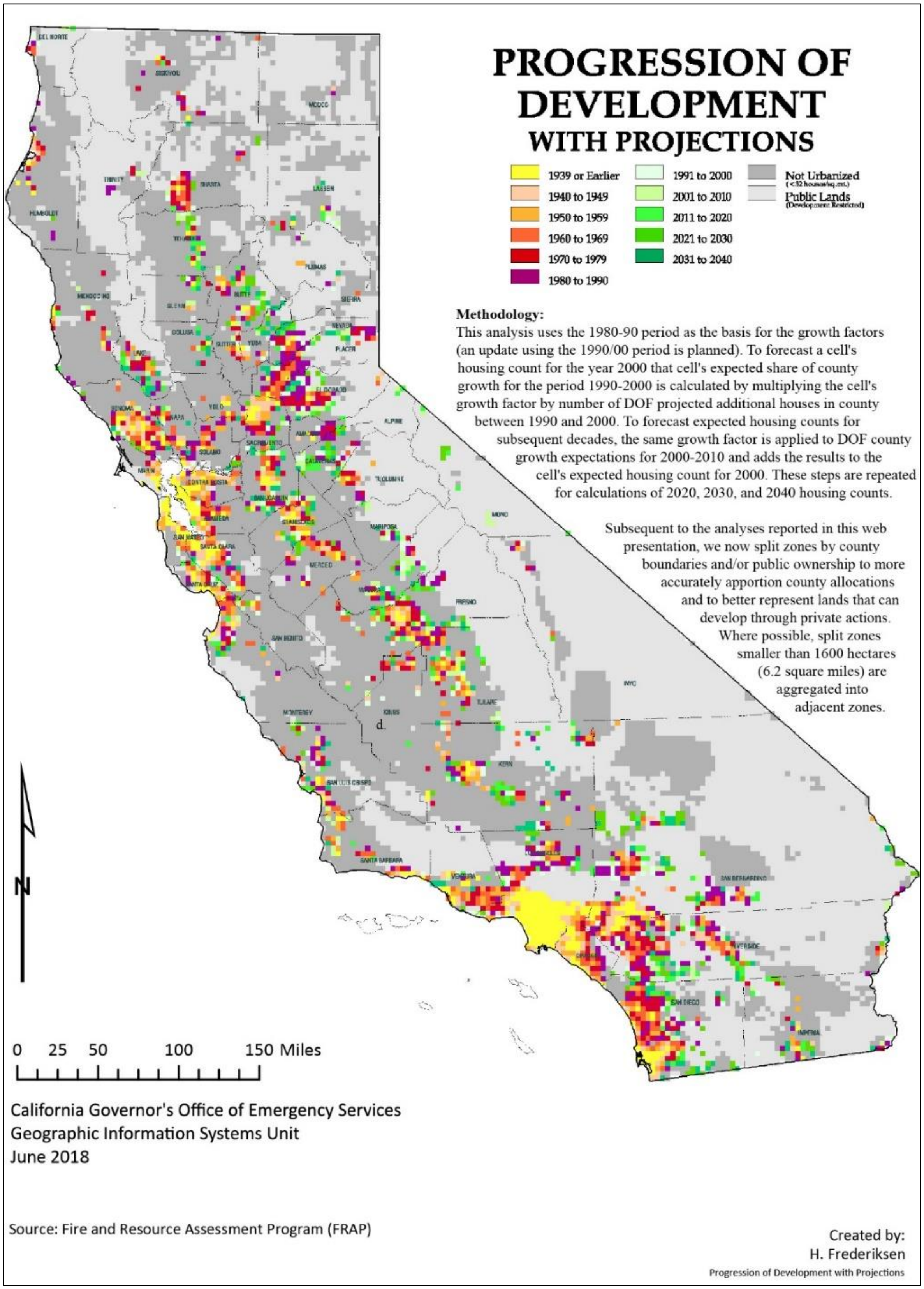


Figure 9-6. California's Projection of Development Based on Historical Factors



9.2.4. Northward Trend

Most FEMA wildfire declarations in California have covered Southern California—due to its large, exposed population base and annually occurring Santa Ana winds. However, there are growing concerns about wildfire in Northern California. These concerns have been substantiated by a series of catastrophically destructive fires between 2017 and 2021, including the following (CAL FIRE 2022d):

- 2017 Northern California fires in Sonoma, Napa, and Solano Counties
- 2018 Carr Fire in Shasta and Trinity Counties
- 2018 Mendocino Complex in Mendocino, Lake, Glenn, and Colusa Counties
- 2018 Camp Fire in Butte County; the 2020 North Complex in Butte, Plumas, and Yuba Counties
- 2020 LNU Lightning Complex in Napa, Solano, Sonoma, Yolo, Lake, and Colusa Counties
- 2020 CZU Lightning Complex in Santa Cruz and San Mateo Counties
- 2020 August Complex in Mendocino, Humboldt, Trinity, Tehama, Glenn, Lake, and Colusa Counties
- 2020 Glass Fire in Napa and Sonoma Counties
- 2021 Dixie Fire in Butte, Plumas, Lassen, and Tehama Counties
- 2021 Caldor Fire in Alpine, Amador, and El Dorado Counties

9.3. PREVIOUS HAZARD OCCURRENCES

California is susceptible to thousands of wildfires every year, impacting all 58 counties. In the past, fire season was mainly from May through October. With climate change as a contributing factor, fire season begins earlier and ends later each year; wildfires are now taking place year-round (Frontline 2022).

9.3.1. Disaster and Emergency Declarations

The following disaster declarations or emergency proclamations related to wildfire have been issued for California (see Appendix F for details):

- Federal DR, EM, Fire Management Assistance (FM), or Fire Suppression Authorization (FS) declarations, 1953 – 2022: 274 events, classified as forest fire, brush fire, timber fire, urban fire, grass fire, wildlands fire, fire storm or complex fire
- California Emergency Proclamations, 1950 – 2022: 134 events, classified as wildfire
- USDA agricultural disaster declarations, 2012 – 2022: 50 events

Of the 274 FEMA declarations for fire events between 1953 and 2022, 142 were issued since 2010. FEMA declaration of a wildfire event as a federal disaster is based on thresholds of monetary damage. Some wildfires, while significant in size and destruction of natural resources, may be in remote areas with minimal development and result in relatively low dollar value of losses to structures or infrastructure.

9.3.2. Event History

California has long been recognized as one of the most fire-prone natural landscapes in the world. Between 1987 and July 2022, California annually averaged 8,650 fires that burned 772,817 acres. The average number of fires per year has declined since 1987, but the number of acres burned annually is highly variable between years. In some years with drought and high winds larger single fires burn larger areas.

Twenty fires larger than 177,000 acres have burned in California since 1932. While modern fires still burn far fewer acres than in the past, in general, large, destructive wildfires are becoming common in California, even with increased firefighting personnel, equipment, technology, and training.

As shown in Table 9-1, 18 of the largest wildfires in California history have occurred since 2003, with 8 of them occurring within the last 5 years, including the largest ever recorded, the August Complex Fire which was ignited in August 2020 (CAL FIRE 2022d).

Table 9-1. Largest California Wildfires by Acres Burned

Fire Name (Cause)	Ignition Date	County	Number of Acres Burned*	Structures Destroyed	Deaths
August Complex (Lightning)	August 2020	Mendocino, Humboldt, Trinity, Tehama, Glenn, Lake, Colusa	1,032,648	935	1
Dixie (Powerlines)	July 2021	Butte, Plumas, Lassen, Shasta, Tehama	963,309	1,329	1
Mendocino Complex (Human Related)	July 2018	Mendocino, Lake, Colusa, Glenn	459,123	280	1
SCU Lightning Complex (Lightning)	August 2020	Stanislaus, Santa Clara, Alameda, Contra Costa, San Joaquin	396,624	222	0
Creek (Undetermined)	September 2020	Fresno, Madera	379,895	853	0
LNU Lightning Complex (Lightning/ Arson)	August 2020	Napa, Solano, Sonoma, Yolo, Lake, Colusa	363,220	1,491	6
North Complex (Lightning)	August 2020	Butte, Plumas, Yuba	318,935	2,352	15
Thomas (Powerlines)	December 2017	Ventura, Santa Barbara	281,893	1,063	2
Cedar (human related)	October 2003	San Diego	273,246	2,820	15
Rush (Lightning)	August 2012	Lassen	271,911	0	0
RIM (Human related)	August 2013	Tuolumne	257,314	112	0
Zaca (Human related)	July 2007	Santa Barbara	240,207	1	0
Carr Fire (Human related)	July 2018	Shasta, Trinity	229,651	1,614	8
Monument (Lightning)	July 2021	Trinity	223,124	50	0
Caldor (Human Related)	August 2021	Alpine, Amador, El Dorado	221,835	1,003	1
Matilija (Undetermined)	September 1932	Ventura	220,000	0	0
River Complex (Lightning)	July 2021	Siskiyou, Trinity	199,343	122	0
Witch (Powerlines)	October 2007	San Diego	197,990	1,650	2

Fire Name (Cause)	Ignition Date	County	Number of Acres Burned*	Structures Destroyed	Deaths
Klamath Theater Complex (Lightning)	June 2008	Siskiyou	192,038	0	2
Marble Cone (Lightning)	July 1977	Monterey	177,866	0	0

* Area burned in California only; burned area in other states not included for fires that crossed State lines.

Source: (CAL FIRE 2022d)

This increase in destructive fires is due to a number of factors:

- Increased fuel loading following a century of fire exclusion policies
- More human-caused ignitions
- Climate change, which is influencing drought and extreme heat events
- Greater silvicultural insect and disease impacts
- Increased tree mortality
- Lengthening of the "fire season," or annual time frame during which vegetative fuels are receptive to combustion

California has a long history of destructive WUI fires, beginning with the 1923 Berkeley Fire that destroyed 584 buildings while burning only 123 acres (Burress 1998). Many geographic areas have experienced repetitive WUI fires. For example, the area burned in the 1923 Berkeley Fire burned again in the 1991 Tunnel Fire, which is the third most destructive fire in State history (Krans 2021). Similarly, the 2007 Witch Creek Fire (1,650 structures burned) in San Diego County reburned portions of the 2003 Cedar Fire area (2,820 structures burned).

Table 9-2 shows the most disastrous WUI fires based on number of structures destroyed. As of June 2022, 92.7 percent of the most damaging WUI fires (as measured by number of structures burned) have occurred in the last two decades.

Table 9-3 summarizes, by year, the number of wildfires, structures burned, acres burned, and deaths, along with descriptions of significant events, between 2017 and 2022. The events during this timeframe have been the most destructive and deadliest wildfires in recent California history. For events prior to 2017, refer to Appendix K.

Table 9-2. Top 20 Most Destructive Wildfires in California, by Structures Destroyed

Fire name (cause)	Ignition Date	County	Acres Burned	Structures Destroyed	Deaths
Camp (Powerlines)	November 2018	Butte	153,336	18,804	85
Tubbs (Electrical)	October 2017	Sonoma	36,807	5,636	22
Tunnel (Rekindle)	October 1991	Alameda	1,600	2,900	25
Cedar (Human Related)	October 2003	San Diego	273,246	2,820	15
North Complex (Lightning)	August 2020	Butte, Plumas, Tuba	318,935	2,352	15
Valley (Electrical)	September 2015	Lake, Napa, Sonoma	76,067	1,955	4
Witch (Powerlines)	October 2007	San Diego	197,990	1,650	2
Woolsey (Electrical)	November 2018	Ventura	96,949	1,643	3
Carr (Human Related)	July 2018	Shasta, Trinity	229,651	1,614	8
Glass (Undetermined)	September 2020	Napa, Sonoma	67,484	1,520	0
LNU Lightning Complex (Lightning/Arson)	August 2020	Napa, Solano, Sonoma, Yolo, Lake, Colusa	363,220	1,491	6
CZU Lightning Complex (Lightning)	August 2020	Santa Cruz, San Mateo	86,509	1,490	1
Nuns (Powerline)	October 2017	Sonoma	54,382	1,355	2
Dixie (Under Investigation)	July 2021	Butte, Plumas, Lassen, Tehama	963,309	1,329	1
Thomas (Powerline)	October 2017	Ventura, Santa Barbara	281,893	1,063	2
Caldor (Human Related)	September 2021	Alpine, Amador, El Dorado	221,835	1,003	1
Old (Human Related)	October 2003	San Bernardino	91,281	1,003	6
Jones (Undetermined)	October 1999	Shasta	26,200	954	1
August Complex (lightning)	August 2020	Mendocino, Humboldt, Trinity, Tehama, Glenn, Lake Colusa	1,032,648	935	1
Butte (Powerlines)	September 2015	Amador, Calaveras	70,868	921	2

Source: (CAL FIRE 2022b)

Table 9-3. Wildfire Events in the State of California (2017 to 2022)

Year	Number of Wildfires	Structures Burned	Acres Burned	Number of Deaths
2017	9,270	10,280	1,548,429	47
▪ Northern California Wildfire Complex in October—started by lightning strikes and driven by extreme weather and drought conditions in the WUI ▪ Thomas Fire in December—started by power lines coming into contact during high winds and driven by extreme weather and drought conditions in the WUI ▪ Tubbs Fire in October—started by a private electrical system failure, destroyed over 5,000 structures and took the lives of 22 people ▪ Nuns Fire in October—started by electrical equipment				
2018	7,948	24,226	1,975,086	100
▪ Mendocino Complex Fire in July—started by a spark from a hammer driving a metal stake into the ground, burned over 450,000 acres ▪ Carr Fire in July—started by an auto accident and driven by high winds destroyed over 1,600 structures, caused multiple fatalities, and burned 229,651 acres ▪ Camp Fire in November—caused by electrical transmission lines destroyed over 18,800 structures and resulted in 85 deaths ▪ Woolsey Fire in November—started by electrical and communication equipment burned nearly 198,000 acres and took the lives of 3 people				
2019	7,860	732	259,823	3
▪ Kincade Fire in October—started by an electrical transmission line failure during a high wind event ▪ Walker Fire in September—started by lightning strikes				
2020	8,648	11,116	4,304,379	33
▪ August Complex in August—started by lightning strikes burned over 1 million acres and 935 structures ▪ SCU Complex in August—started by lightning strikes burned nearly 400,000 acres and 222 structures ▪ North Complex in August—started by lightning strikes burned nearly 319,000 acres, 2,352 structures, and resulted in 15 deaths ▪ LNU Complex in August—started by lightning strikes burned 363,220 acres and nearly 1,500 structures ▪ CZU Complex in August—started by lightning strikes burned 1,490 structures ▪ Creek Fire in September—started by lightning strikes ▪ Glass Fire in September burned 1,520 structures				

Year	Number of Wildfires	Structures Burned	Acres Burned	Number of Deaths
2021	8,835	3,629	2,568,948	3
▪ Dixie Fire in July—started by an electrical distribution line burned over 963,000 acres and 1,329 structures ▪ River Complex in July—started by lightning strikes ▪ Monument Fire in July—started by lightning strikes burned 223, 124 acres and 50 structures ▪ Caldor Fire in August—started by a firearm projectile burned 221,835 acres and over 1,000 structures				
2022	4,026	2	27,848	0
▪ Oak Fire in July (Figure 9-7)—cause under investigation and driven by extreme heat, drought, and dry fuel from mass tree fatality ▪ McKinney Fire in July (Figure 9-8)—started by lightning strikes still burning at 60,392 acres, 185 structures, and 4 fatalities				

Sources: (CAL FIRE 2022c), (Cal OES 2018a), (Jacobo 2022)

Figure 9-7. Helicopter Water-Drop Efforts During the Oak Fire in July 2022

Source: (Berger 2022)

Figure 9-8. 2022 McKinney Fire Burns Along California Highway 96

Source: (Berger 2022)

Figure 9-9 is based on CAL FIRE datasets of fire perimeters from 1985 to 2017. Fires are shown by 10-year period, overlaid on public lands. The most significant 2017 fires—the Thomas Fire, which at that time burned the largest number of acres ever recorded, and the fires that make up the Northern California Wildfire Complex, which at that time burned the largest number of structures on record—are delineated with special coloring on the map.

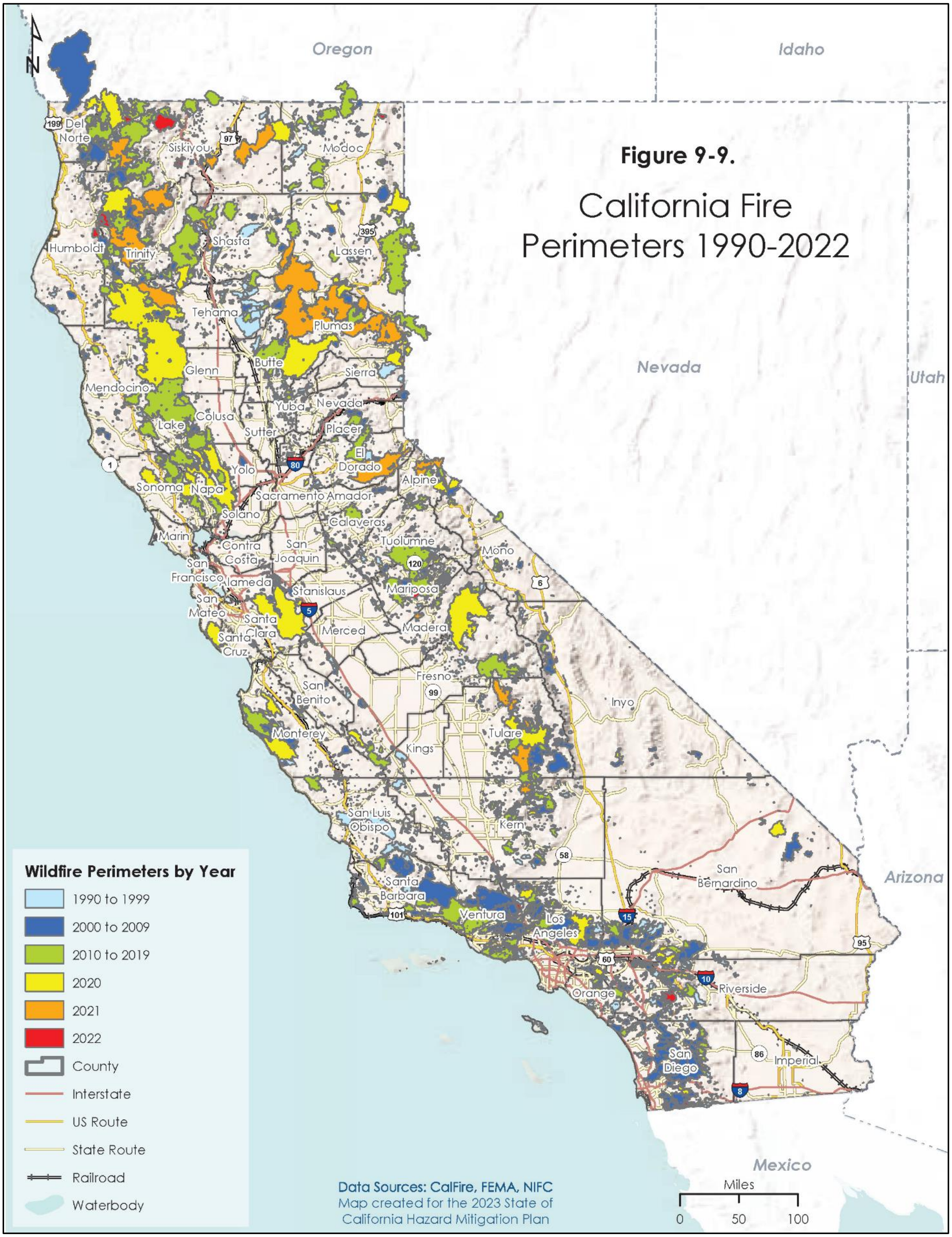
9.4. PROBABILITY OF FUTURE HAZARD EVENTS

9.4.1. Overall Probability

According to CAL FIRE, the State of California experienced 77,518 wildfire events between 2013 and July 9, 2022. Based on these statistics, the State can expect about 8,000 wildfires each year.

Due to fuel buildup following a century of fire exclusion, a lengthened fire season predicted by many climate change models, forest management practices which removed many of the older, larger trees, and massive tree die-off following epidemic bark beetle infestations, fires in mixed-conifer forests are likely to continue to grow in both size and intensity (Steel, Safford and Viers 2015) (Wayman and Safford 2021).

Figure 9-9. California Fire Perimeters 1990 – 2022



9.4.2. Climate Change Impacts

According to California's Fourth Climate Change Assessment, if GHG emissions continue to rise, California is likely to see a 50 percent increase in fires larger than 25,000 acres and a 77 percent increase in average area burned by 2100. Numerous climactic drivers will influence wildfire risk differently between California regions:

- *Increasing Temperatures:* Wildfire risk in the San Francisco Bay Area is rising in tandem with increasing temperatures. Further upstate, in the Sacramento, Sierra Nevada, and North Coast regions, forests that experience drought are also more susceptible to wildfire. High heat not only influences fire risk directly but can also produce indirect impacts. For instance, in the San Joaquin Valley, where fire hazard is typically low, warming temperatures will likely worsen air quality due to extended agriculture fallowing. This, in turn, can exacerbate health impacts from wildfire smoke.
- *Shifting Wind Patterns:* The Santa Ana, Sundowner, and Diablo winds will continue to shape wildfire activity across Southern, Central, and Northern California, respectively. Modelers are still working to determine how these wind events will be impacted by climate change.
- *Shifting Water Patterns*: Climate change will cause shifting water patterns that can impact wildfire risk across the State. In the inland desert, the potential weakening of the North American Monsoon signal could reduce the threat of fire starts due to lightning. Changing patterns of rainfall will impact plant growth in the desert, thereby altering the amount of fuel for fires. Mediterranean ecosystems along the central coast have a similar response to water availability since they are situated in a transition zone. In Southern California and San Diego, meanwhile, changing precipitation will factor heavily into post-fire risk assessments since these landscapes are especially vulnerable to post-fire flooding and landslides.
- *Shifting Insect Habitat*: Bark beetle infestations are rising in response to the changing climate, increasing tree mortality—particularly in the southern Sierra Nevada —and reducing carbon storage.
- *Human Impacts:* Across all of California's landscapes human factors, such as development patterns and risk mitigation strategies, will have a direct impact on communities' ability to mitigate and adapt to the impacts of climate change. Local decisions are a large factor in determining the future health of a community.

9.5. IMPACT ANALYSIS

9.5.1. Severity

The August Complex in 2020 was California's largest wildfire complex to date, with 1,032,648 acres burned. The Camp Fire of 2018 resulted in the loss of 18,804 structures, the most destroyed in any California wildfire. The Camp Fire also caused the most deaths of any other wildfire with 85 human lives lost due to flames. An estimated 3,652 lives were lost due to smoke from wildfires in 2018 (Wang, et al. 2022).

9.5.2. Warning Time

Of the largest and most destructive fires listed in Table 9-1 and Table 9-2, the majority (61 percent) were caused by humans and power lines. There is no way to predict when a human-caused wildfire will break out. Prolonged drought and severe winds can greatly increase the likelihood of a wildfire event (Goss, et al. 2020). Severe weather can be predicted, so special attention can be paid during weather events that may increase wildfire events, such as lightning storms.

If a wildfire breaks out and spreads rapidly, residents may need to evacuate immediately. According to the U.S. Forest service, a fire's peak burning period generally is between 10 a.m. and sundown (USFS n.d.-a). Once a fire has started, fire alerting is reasonably rapid in most cases. The rapid spread of cellular and two-way radio communications in recent years has further contributed to significant improvements in warning time. Residents in many communities can sign up for local emergency alerts (DHS 2022).

Both hazard and extent scales have been developed to estimate wildfire danger. The State uses these scales to predict when wildfires are likely to occur and how a wildfire will behave based on air and fuel moisture content, lighting events, and wind conditions. The sections below describe the metrics currently available.

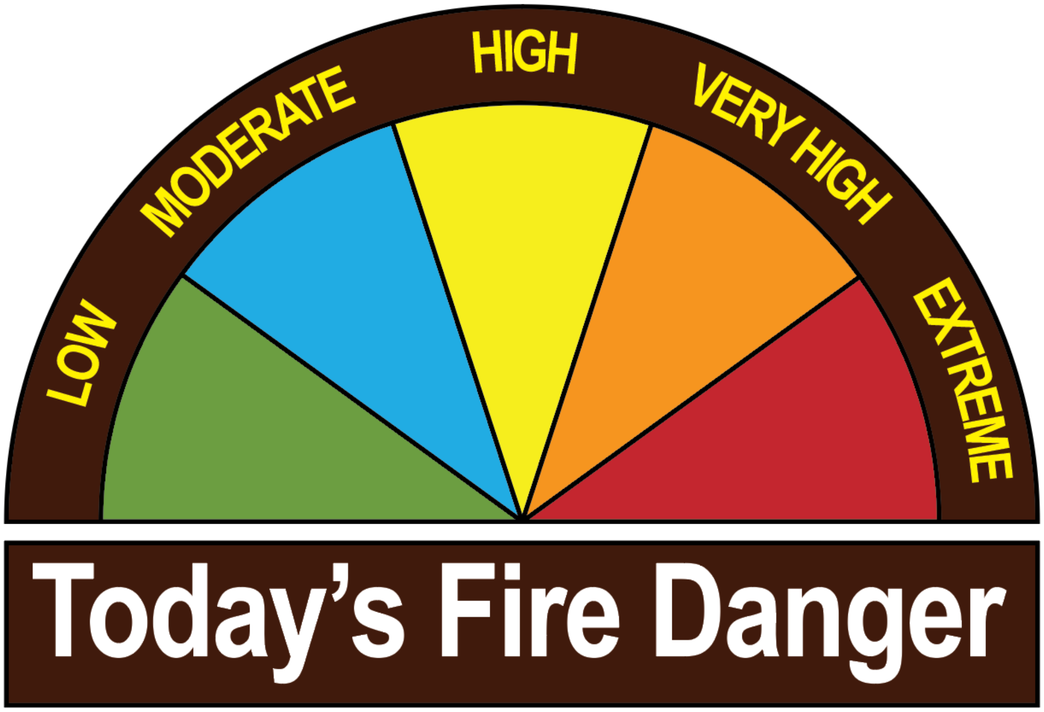
WUI Hazard Scale

The WUI Hazard Scale assigns a measure of severity to embers and fire from 1 (no exposure) to 4 (most severe exposure) (National Institute of Standards and Technology 2012). To implement the WUI Hazard Scale, the National Institute of Standards and Technology, CAL FIRE, and the Insurance Institute for Business & Home Safety published a document called the WUI Structure/Parcel/Community Fire Hazard Mitigation Methodology.

National Fire Danger Rating System

The National Fire Danger Rating System is used for determining fire danger for a given area. Based on that determination, restrictions or closures to public land may be imposed, and fire managers will plan for staff and equipment to fight fires and decide whether to suppress or allow fires to burn under prescribed conditions (National Park Service 2021). The rating system uses five color-coded levels (see Figure 9-10) indicating fire potential (USFS 2022); (National Park Service 2021):

Figure 9-10. National Fire Danger Rating System



Source: (USFS 2022)

- **Fire Danger Level: Low (Green)**—When the fire danger is "low" it means that fuels do not ignite easily from small embers, but a more intense heat source, such as lightning, may start fires in duff or dry rotten wood. Fires in open, dry grasslands may burn easily a few hours after a rain, but most wood fires will spread slowly, creeping or smoldering. Control of fires is generally easy.
- **Fire Danger Level: Moderate (Blue)**—When the fire danger is "moderate" it means that fires can start from most accidental causes, but the number of fire starts is likely to be pretty low. If a fire does start in an open, dry grassland, it will

burn and spread quickly on windy days. Most wood fires will spread slowly to moderately. Average fire intensity will be moderate except in heavy concentrations of fuel, which may burn hot. Fires are still not likely to become serious and are often easy to control.

- **Fire Danger Level: High (Yellow)**—When the fire danger is "high," fires can start easily from most causes and small fuels (such as grasses and needles) will ignite readily. Unattended campfires and brush fires are likely to escape. Fires will spread easily, with some areas of high-intensity burning on slopes or concentrated fuels. Fires can become serious and difficult to control unless they are put out while they are still small. Outdoor burning should be restricted to early mornings and late evenings.
- **Fire Danger Level: Very High (Orange)**—When the fire danger is "very high," fires will start easily from most causes. The fires will spread rapidly and have a quick increase in intensity, right after ignition. Small fires can quickly become large fires and exhibit extreme fire intensity, such as long-distance spotting and fire whirls. These fires can be difficult to control and will often become much larger and longer-lasting fires. Outdoor burning is not recommended.
- **Fire Danger Level: Extreme (Red)**—When the fire danger is "extreme," fires of all types start quickly and burn intensely. All fires are potentially serious and can spread very quickly with intense burning. Small fires become big fires much faster than at the "very high" level. Spot fires are probable, with long-distance spotting likely. These fires are very difficult to fight and may become very dangerous and often last for several days. No outdoor burning should take place in areas with extreme fire danger.

National Weather Service Fire Weather Criteria—Red Flag Program

The NWS issues red flag warnings and fire weather watches to alert land management agencies about the onset, or possible onset, of weather and fuel moisture conditions that could lead to wildfire (NWS 2022d). Fire Weather Watches and Red Flag Warnings are issued when the combination of fuels and weather conditions support extreme fire danger and/or fire behavior:

- A fire weather watch is used to alert agencies to the potential for development of a Red Flag event in the 18- to 96-hour time frame (at least 50 percent confidence). The watch may be issued for all or selected portions of a fire weather zone or zones.

- A red flag warning is used to inform agencies of impending or occurring red flag conditions. A red flag warning is issued when there is high confidence that red flag criteria will be met within the next 48 hours or are already being met. Longer lead times are allowed when confidence is very high, or the fire danger situation is critical. The warning may be issued for all or selected portions of a fire weather zone or zones.

Fire weather watches and red flag warnings are included in all affected forecasts. All NWS fire weather web pages also highlight any watch or warning issuances.

NWS offices normally call affected dispatch offices and affected agencies as well as their respective Geographic Area Coordination Centers when red flag warnings and fire weather watches are issued or updated. Watches and warnings are available on the internet via the California Fire Weather web page, the web sites of the issuing NWS offices, the NWS National Fire Weather Page and www.weather.gov/fire.

NWS weather forecast offices serving California have the option to use the phrase "Particularly Dangerous Situation" within the red flag warning headline and body of the product (this is not a new red flag warning product). The objective is to highlight exceptional fire weather conditions (combination of meteorological and fuels) considered rare or especially impactful to the public and firefighting community. Where appropriate, inclusion of the Particularly Dangerous Situation language must be coordinated between adjacent offices prior to product issuance and messaging.

Lower Atmosphere Stability Index (Haines Index)

The Haines Index is used to indicate the potential for wildfire growth by measuring the stability and dryness of the air over a fire. It is calculated by combining the stability and moisture content of the lower atmosphere into a number that correlates well with large fire growth. The stability term is determined by the temperature difference between two atmospheric layers; the moisture term is determined by the temperature and dew point difference.

This index has been shown to be correlated with large fire growth on initiating and existing fires where surface winds do not dominate fire behavior (USFS n.d.-b). The Haines Index can range between 2 and 6.

- 2—Very Low Potential (Moist Stable Lower Atmosphere)
- 3—Very Low Potential
- 4—Low Potential

- 5—Moderate Potential
- 6—High Potential (Dry Unstable Lower Atmosphere)

The drier and more unstable the lower atmosphere is, the higher the index.

Burning Index

The Burning Index is an estimate of the potential difficulty of fire containment related to the flame length at the head of a fire. It is a relative number related to the contribution that fire behavior makes to the amount or effort needed to contain a fire in a specified fuel type. Doubling the burning index indicates that twice the effort will be required to contain a fire in that fuel type as was previously required, providing all other parameters are held constant (National Wildfire Coordinating Group 2021).

9.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with wildfires:

- Wildfires strip slopes of vegetation, exposing them to greater amounts of runoff. This in turn can weaken soils and cause failures on slopes (USGS 2021a). Major landslides can occur several years after a wildfire (DOC 2019d).
- 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 (California Ecosystems Climate Solutions 2020). This increases the runoff generated by storm events, thus increasing the chance of flooding (NWS n.d.-d).
- Flooding after fire is often more severe, as debris and ash left from the fire can form mudflows. As rainwater moves across charred and denuded ground, it can also pick up soil and sediment and carry it in a stream of floodwaters. These mudflows can cause significant damage.
- Fire weather conditions pre-event can cause power interruptions due to PSPS scenarios initiated by public utility service providers. PSPS events are addressed in Chapter 24.
- Critical infrastructure disruptions or delays can be triggered by wildfire events.
- Fires can contaminate drinking water supplies.
- Fires can negatively affect air quality.

9.5.4. Impacts of Smoke

Wildfire smoke has grown significantly as a hazard in recent years. The number of people in the Western U.S. experiencing at least one extreme smoke day with serious impacts increased by a factor of 27 over the last decade (Childs, et al. 2022). Over 30 million Californians experienced significant wildfire smoke in 2020 alone (Rosenthal, et al. 2022). Wildfire smoke typically kills many times as many people as wildfire flames (see Table 9-4).

Table 9-4. Deaths From Flames and Smoke for Select Heavy Wildfire Before 2020

Fire Year (Region)	Counties Evaluated	Deaths From Flames	Deaths From Smoke
2003 (Southern California)	Los Angeles, Riverside, San Bernardino, San Diego, Santa Barbara, Ventura	24	133
2018 (Statewide)	Statewide	104	3,652

Sources: (Kochi, et al. 2012); (Wang, et al. 2022)

The danger of wildfire smoke comes primarily from particulate matter (PM), consisting of fine particles that are 2.5 micrometers (about a ten-thousandth of an inch) or less in diameter ($PM_{2.5}$). On a given day, California wildfires can produce 10 times more $PM_{2.5}$ air pollution than is produced by all other pollution sources combined (Associated Press 2020). The small particles in $PM_{2.5}$ pollution are capable of reaching deep into the lungs, causing a host of complications, including significantly increased risks of heart disease, respiratory disease, asthma, and premature mortality. Health problems related to wildfire smoke exposure can be as mild as eye and respiratory tract irritation and as serious as worsening of heart and lung disease, including asthma, and even death. Smoke from wildfires that burn homes and other structures can additionally contain toxic materials such as asbestos and heavy metals. Studies indicate that wildfire smoke is up to 10 times more harmful than other forms of $PM_{2.5}$ pollution (Aguilera, et al. 2021).

Not all individuals are equally exposed to the hazard of wildfire smoke, nor are they equally vulnerable. Outdoor workers and unhoused individuals have especially high exposure to outdoor air, and younger individuals are especially vulnerable to unhealthy air. On November 15, 2018, over 1 million California children had classes canceled due to wildfires and wildfire smoke (Holm, Miller and Balmes 2020). Because $PM_{2.5}$ pollution affects the immune and cardiovascular systems, other vulnerable populations include people with medical conditions, including diabetes and heart and lung conditions. These vulnerable populations together represent a significant fraction of the California population and indicate inequity in impacts.

At least 95 percent of Californians suffered unhealthy levels of particle pollution due to wildfires in 2020 (Los Angeles Times 2020). Worse air quality leads to illnesses, emergency room visits, and hospitalizations for chronic health conditions, including chronic obstructive pulmonary disease, asthma, chronic bronchitis, and other respiratory and cardiovascular conditions as well as increased risk for respiratory infections, which all result in greater health costs to the State (Romley, Hackbarth and Goldman 2010, Wang, Aaron and Madrigano 2019, Inserro 2018).

9.5.5. Environmental Impacts

Fire is a natural process in most terrestrial ecosystems, affecting the types, structure, and spatial extent of native vegetation. Fire can act as a catalyst for promoting biological diversity and healthy ecosystems, reducing buildup of organic debris, releasing nutrients into the soil, and triggering changes in vegetation community composition (CDFW 2022d). However, in some circumstances it can also cause severe negative environmental impacts, such as the following:

- **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 (California Ecosystems Climate Solutions 2020).
- **Reduced Agricultural Resources**—Wildfire can have disastrous consequences on agricultural resources, removing them from production and necessitating lengthy restoration programs (Philip 2019).
- **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 (U.S. Department of the Interior, Office of Wildland Fire 2022).
- **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 (The White House n.d.).
- **Destroyed Endangered Species Habitat**—Wildfire can have negative consequences on endangered species by degrading their habitat (Butcher, Kristin 2019).

- **Soil Sterilization**—Some wildfires burn so hot that they can sterilize the soil. Topsoil exposed to extreme heat can become water repellant, and soil nutrients may be lost (FireSafe Sonoma 2020).
- **Damaged Fisheries**—Fisheries can suffer from increased water temperatures, sedimentation, and changes in water quality (NASA Jet Propulsion Laboratory, California Institute of Technology 2022); (Beakes, et al. 2014).
- **Damaged Cultural and Historical Resources**—The destruction of cultural and historic resources may occur, scenic vistas can be damaged, and access to recreational areas can be reduced (National Park Service 2021).

9.5.6. Local Hazard Impacts

LHMP Rankings

All but one of the hazard mitigation plans prepared for California's 58 counties list wildfire as a hazard of concern, and 45 counties rank it as a high-impact hazard:

- Alameda
- Alpine
- Amador
- Butte
- Calaveras
- Colusa
- El Dorado
- Fresno
- Glenn
- Humboldt
- Inyo
- Kern
- Kings
- Lake
- Lassen
- Los Angeles
- Madera
- Marin
- Mariposa
- Mendocino
- Modoc
- Mono
- Monterey
- Napa
- Nevada
- Placer
- Plumas
- Riverside
- Sacramento
- San Bernardino
- San Diego
- San Luis Obispo
- Santa Barbara
- Santa Cruz
- Shasta
- Sierra
- Siskiyou
- Solano
- Sonoma
- Tehama
- Trinity
- Tulare
- Tuolumne
- Yolo
- Yuba

An additional 10 counties identified wildfire as a medium-impact hazard.

LHMP Estimates of Potential Loss

Table 9-5 summarizes potential losses to vulnerable structures based on estimates from the local risk assessments (as called for in FEMA's Standard State Mitigation Planning

Requirement S6.b). Due to variances in approaches to assessing risk at the local level as well as the hazards assessed and the age of each assessment reviewed, this data is considered approximate.

Table 9-5. Wildfire Risk Exposure Analysis for LHMP Reviews

Estimated Total Population Exposed	3,629,974
Estimated Number of Structures at Risk	848,115
Estimated Value of Structures at Risk	$232 billion

9.6. VULNERABILITY ANALYSIS

To assess the vulnerability of State assets to the wildfire hazard, GIS software was used to overlay CAL FIRE's fire hazard severity zones with State assets. The analysis included only very high and high hazard zones in the State responsibility areas and local responsibility areas combined. The areas used are shown in Figure 9-2.

9.6.1. Exposure of State-Owned or -Leased Facilities

Table 9-6 and Table 9-7 summarize the number and replacement cost value of State assets located in high and very fire hazard severity zones. Figure 9-11 summarizes the exposed assets as a percentage of total assets statewide. Appendix I provides detailed results by county.

9.6.2. Exposure of Critical Facilities and Community Lifelines

The Risk Assessment identified 71 community lifelines in the "high" or "very high" wildfire hazard severity zones. The "food, water, shelter" lifeline category accounts for 44 percent of these, the "energy" category accounts for 35 percent, and "transportation" accounts for 10 percent. For a detailed breakdown of facility counts by County see Appendix I. Critical facilities and community lifelines that are exposed to the wildfire hazard are likely to experience functional downtime following these events that could increase the net impact of these events in a region.

Table 9-6. State-Owned or -Leased Facilities Exposed to High or Very High FHSZ

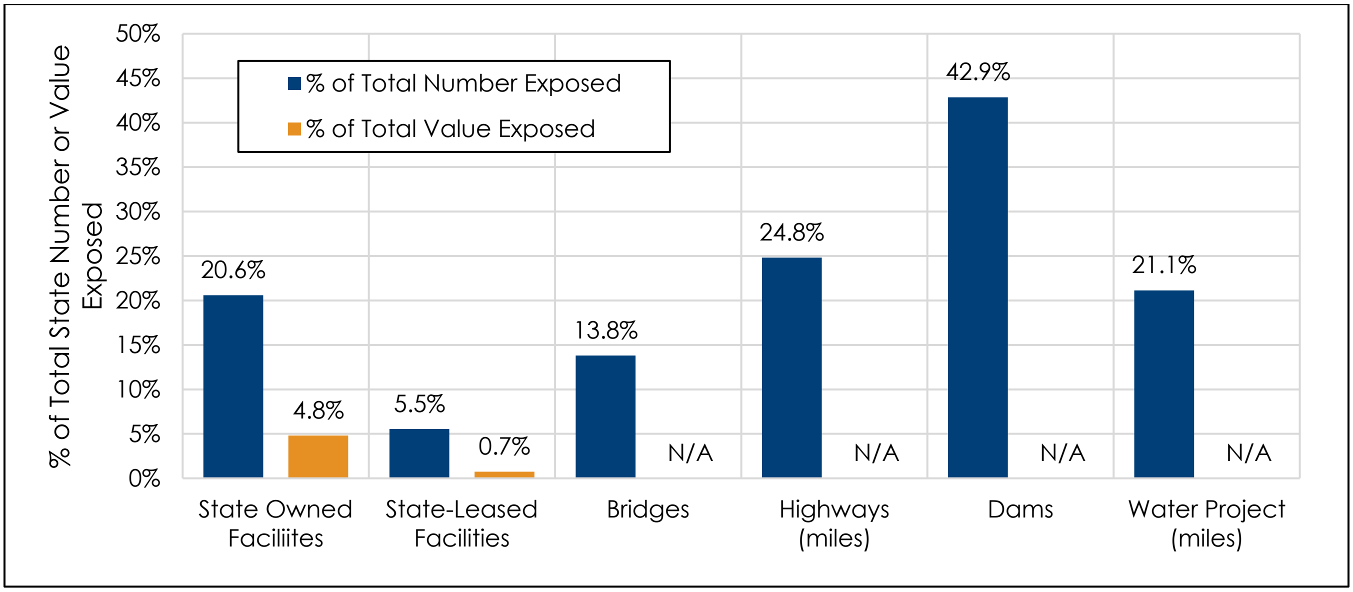
Type of Facility	Number of Structures	Total Area (sq. ft.)	Replacement Cost Value		
			Structure	Content	Total
State-Leased Facilities	105	—	$69,044,243	$70,725,927	$139,770,170
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	105	633,339	$38,317,982	$38,317,982	$76,635,964
Development Center	0	0	$0	$0	$0
Hospital	0	0	$0	$0	$0
Migrant Center	0	0	$0	$0	$0
Special School	0	0	$0	$0	$0
All Other Facilities	4,828	10,580,124	$831,982,506	$858,576,850	$1,690,559,356
Total State-Owned	***4,933***	***11,213,463***	***$870,300,488***	***$896,894,832***	***$1,767,195,320***
Total Facilities	**5,038**	**N/A***	**$939,344,732**	**$967,620,759**	**$1,906,965,490**

* The inventory of State assets does not include building area for State-leased facilities, so no total area for all State facilities is provided; the building area of vulnerable assets is shown for State-owned facilities only.

Table 9-7. State-Owned Infrastructure Exposed to High or Very High FHSZ

Type of Facility	State-Owned Infrastructure in the Mapped Hazard Area
Bridges	1,823
Highway (miles)	7,469.1
Dams	21
Water Project (miles)	151

Figure 9-11. State Assets in High or Very High Fire Hazard Severity Zones, as % of Statewide Total



N/A: Values not defined for bridges, highways, dams, and water project

9.6.3. Estimates of Loss

State assets can be damaged by wildfire, but there are no established damage curves or functions for estimating associated losses. Instead, loss estimates were developed representing 10 percent, 30 percent, and 50 percent of the replacement cost value of exposed State-owned facilities in the mapped wildfire hazard areas (see Table 9-8). This allows the State to select a range of potential economic impacts based on an estimate of the percentage of damage to these assets. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure.

Table 9-8. Loss Potential of State-Owned Assets for Wildfire

Type of Facility	Total Replacement Cost Value (contents only)	Estimated Loss Potential Based on % Damage		
		10% Damage	30% Damage	50% Damage
Facilities Housing Vulnerable Populations				
Correctional Facility	$76,635,964	$7,663,596	$22,990,789	$38,317,982
Development Center	$0	$0	$0	$0
Hospital	$0	$0	$0	$0
Migrant Center	$0	$0	$0	$0
Special School	$0	$0	$0	$0
All Other Facilities	**$1,690,559,356**	**$169,055,936**	**$507,167,807**	**$845,279,678**
Total	**$1,767,195,320**	**$176,719,532**	**$530,158,596**	**$883,597,660**

In addition to impacting State assets, wildfire events can have major economic impacts on a community from the initial loss of structures and subsequent economic losses.

9.6.4. Buildable Land

Of 11.7 million acres of land available for development statewide, 5.3 million acres (45.1percent) is located in the evaluated fire hazard severity zones. Appendix G provides a detailed assessment of exposed buildable lands by county. Any type of development in these areas will be susceptible to damage associated with wildfires.

9.6.5. Equity Priority Communities

Many communities and populations are especially vulnerable to wildfires, including low-income communities, migrant populations, populations whose primary language is not English, Indigenous, Black and Latina/e/o populations, communities of older adults, those with respiratory and other health concerns, and those with access or functional needs. Members of immigrant communities may be concerned about impacts to their immigration status and do not seek help. When a wildfire impacts an area with high rents where multiple families live in one structure, it may be difficult for those not listed on the lease to prove that they were affected by the fire. This could result in a lack of access to services.

Additionally, fires quickly increase housing prices and rent prices, further displacing people already affected by the fire and increasing the number of individuals experiencing homelessness. The underlying driver of housing affordability often means that the populations pushed into these peripheral regions are also the ones who can least afford the cost of wildfire damage and relocation, setting up social and economic complications to one-size-fits all solutions for wildfire resilience.

It can take days to translate information into languages other than English, hindering communication about evacuations and health and safety alerts. Indigenous populations may lose sacred sites; fisheries and hunting and gathering grounds may be degraded (National Academies Press 2020). Older adults do not have the mobility many others have, which can slow or prevent evacuation. More than one-third of the long-term care facilities in California are located in risky areas (Bénichou, Peterson and Pickoff-White 2020). WUI wildfire events can threaten economic security through loss of property, work, or life and disruption of food production. This can impact human health and increase stress, anxiety, depression, and mental health disorders for those within the equity priority communities who have greater risk of exposure and harm.

The risk analysis for wildfire found that 7.0 percent of people living in the fire hazard severity zones live in equity priority communities (253,461 people). A breakdown of exposed equity priority communities by county is included in Appendix I.

9.6.6. NRI Scores

According to the NRI, all of the State's counties have wildfire risk, rated from very low to very high. Table 9-9 shows scores for the six counties with the highest rating. See Section 4.1.3 for a description of the components of the NRI.

Table 9-9. NRI Scoring of Counties for Wildfire

County	Expected Annual Loss	Social Vulnerability Rating	Community Resilience Rating	Community Risk Factor	Risk Value	Score
San Diego	$381,629,724	Relatively High	Very Low	1.20	$445,037,091	100
Riverside	$319,123,716	Very High	Relatively Low	1.34	$398,534,350	99.97
San Bernardino	$134,371,346	Very High	Relatively Moderate	1.34	$147,460,270	99.94
Los Angeles	$108,835,472	Very High	Very Low	1.36	$110,453,363	99.90
Ventura	$48,353,567	Relatively High	Relatively Moderate	1.22	$53,155,787	99.81
Orange	$49,545,003	Relatively Moderate	Very Low	1.26	$45,718,477	99.78

9.7. MITIGATING THE HAZARD

9.7.1. Existing Measures for Mitigating the Hazard

Once thought of as a seasonal hazard, wildfires are an almost everyday occurrence in California today. However, much of the State's approach to dealing with wildfire is still seasonal in nature. Some past management practices have failed to address the full nature of the human/wildfire conflict and have exacerbated conditions that can lead to more damaging fires.

The State is improving its fire preparedness and mitigation efforts. The State has invested over $2.9 billion for wildfire prevention and forest resilience—first in the 2021-22 State budget and the Early Action Wildfire Package, and then in the passage of Senate Bill (SB) 155. The Early Action Wildfire Package includes $536 million in 2020-21 for roughly two dozen programs managed by 14 departments. SB 155 continuously appropriates $200 million from the Greenhouse Gas Reduction Fund annually until 2028-29 and provides more funding for research and incentives.

The State is also working toward long-term wildfire prevention and forest health through the implementation of vegetation management projects. In response to the Governor's Emergency Proclamation on March 22, 2019, CAL FIRE has identified 35 priority projects that can be implemented immediately to help reduce public safety risk for over 200 of California's most wildfire-vulnerable communities. Project examples include removal of hazardous dead trees, vegetation clearing, creation of fuel breaks and community defensible spaces, and creation of safer ingress and egress corridors.

Tools exist to predict and manage fire response. The Wildfire Forecast & Threat Intelligence Integration Center serves as California's integrated central organizing hub for wildfire forecasting, weather information, threat intelligence gathering, analysis, and dissemination. It provides information that government agencies can use to plan for upcoming fires. The Fire Integrated Real-time Intelligence System is a program that provides real-time intelligence data and analysis on emerging disaster incidents. Funding supports aircraft, a common operating picture, and near-real-time fire modeling that is available at the onset of emerging incidents. The goal of these programs is to provide fire crews and governing bodies with quick, real-time information for informed decision making.

General Wildfire Mitigation Approaches

Approaches to mitigate wildfires can include:

- An informed, educated public that takes responsibility for its own decisions relating to wildfire protection.
- Land use policies and standards that protect life, property, and natural resources.
- Building and fire codes that reduce structural ignitions from windblown embers and flame contact from WUI fires and impede or halt fire spread within the structure once ignited.
- Construction and property standards that provide defensible space.
- Forest management commitments to manage for more natural forest conditions.
- An effective regulatory mechanism for permitting an aggressive hazardous fuels management program.
- An effective wildfire suppression program.

Source: (FEMA 2013a)

9.7.2. Opportunities for Mitigating the Hazard

In addition to the work the State is already doing to mitigate wildfire risk, Table 9-10 provides a range of potential alternatives for mitigating the wildfire hazard. See Section 1.2.3 for a description of the different types of alternatives. Additional mitigation alternatives are available in the *Wildfire Smoke Considerations for California's Public Health Officials* (CDPH 2022k).

Table 9-10. Potential Opportunities to Mitigate the Wildfire Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ Clear potential fuels on property such as dry overgrown underbrush and diseased trees **Reduce exposure and vulnerability:** ▪ Create and maintain defensible space around structures ▪ Locate outside of hazard area ▪ Mow regularly ▪ Create and maintain defensible space around structures and provide water on site ▪ Use fire-resistant building materials ▪ Create defensible spaces around home ▪ Home hardening	**Manipulate the hazard:** ▪ Clear potential fuels on property such as dry underbrush and diseased trees **Reduce exposure and vulnerability:** ▪ Create and maintain defensible space around structures and infrastructure ▪ Locate outside of hazard area ▪ Create and maintain defensible space around structures and infrastructure and provide water on site ▪ Use fire-resistant building materials ▪ Use fire-resistant plantings in buffer areas of high wildfire threat	**Manipulate the hazard:** ▪ Clear potential fuels on property such as dry underbrush and diseased trees ▪ Remove invasive non-native hazardous fuels in riparian areas and restore native habitat ▪ Implement best management practices on public lands **Reduce exposure and vulnerability:** ▪ 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 ▪ Create and maintain defensible space around structures and infrastructure ▪ Use fire-resistant 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 ▪ Reintroduce fire (controlled or prescribed burns) to fire-prone ecosystems while also protecting critical native habitat resilience, such as chaparral and sage scrub ▪ Manage fuel load through thinning and brush removal ▪ Establish integrated performance standards for new development to harden homes ▪ Create and manage multi-benefit greenbelts for resilience (also known as wildfire risk reduction buffers zones), or other ecosystem-appropriate land use strategies, such as SOAR (Save Open Space & Agricultural Resources)-designated and wildlife corridors

<table>
<tr><th>Community-Scale</th><th>Organizational Scale</th><th>Government-Scale</th></tr>
<tr>
<td>Build local capacity:
▪ Employ techniques from the National Fire Protection Association’s Firewise USA program to safeguard home
▪ Identify alternative water supplies for fire fighting
▪ Install/replace roofing material with non-combustible roofing materials and implement other strategies to harden homes from embers and flame impingement</td>
<td>Build local capacity:
▪ Support Firewise USA community initiatives
▪ Create/establish stored water supplies to be utilized for firefighting</td>
<td>Build local capacity:
▪ More public outreach and education efforts, including an active Firewise USA program
▪ Possible weapons of mass destruction funds available to enhance fire capability in high-risk areas
▪ Identify fire response and alternative evacuation routes and establish where needed
▪ Seek alternative water supplies
▪ Become a Firewise USA community
▪ Use academia to study impacts/solutions to wildfire risk
▪ Establish/maintain mutual aid agreements between fire service agencies
▪ Develop, adopt, and implement integrated plans for mitigating wildfire impacts in wildland areas bordering on development
▪ Consider the probable impacts of climate change on the risk associated with the wildfire hazard in future land use decisions
▪ Establish a management program to track forest and rangeland health
▪ Provide incentives for existing structures to be hardened against wildfire
▪ Use tools to detect, forecast, and take action ahead of wildfire</td>
</tr>
<tr>
<td colspan="3">Nature-based opportunities
▪ Manage invasive species (e.g., lodgepole pines) that are susceptible to increased wildfire risk
▪ Create riparian corridors in wildfire hazard areas as fire breaks
▪ Incorporate nature-based wildfire risk reduction buffers into existing ecosystem-friendly land uses (e.g., green space, trails, or community parklands)
▪ Implement and fund ecological thinning and prescribed fire and cultural fire and, where appropriate, manage wildfire for resource benefit</td>
</tr>
</table>

9.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address the wildfire hazard:

- Action 2018-064: Legislation for Local Wildfire Hazard Planning: Incorporate wildfire hazards into development and land use planning as stated in California Government Code 65302.g.3 66474.02. and the California Environmental Quality Act (CEQA).
- Action 2018-065: Fire Hazard Severity Zones: Map areas of significant fire hazards based on fuels, terrain, weather, and other relevant factors to define the application of various mitigation strategies to reduce risk.
- Action 2018-068: Fire Safe Councils: Increase awareness, knowledge, and actions implemented by individuals and communities to reduce human loss and property damage from wildland fires, such as defensible space, fire risk reduction and fire safe building standards.
- Action 2018-070: Community Wildfire Protection Plans: Identify hazardous fuel reduction treatment priorities, recommend measures to reduce structural ignitability and address issues such as wildfire response, hazard mitigation, community preparedness and structure protection.

An Example Success Story for Wildfire Mitigation:

Wildfire Reduction at the Lick Observatory in Santa Clara County

The Lick Observatory is an active center for astronomical research founded in 1888. It is visited by approximately 35,000 people annually and serves as a resource for providing educational and cultural opportunities.

Problem: Wildfires pose an increasing threat to the Observatory, which is at the summit of Mount Hamilton and surrounded by forests.

Solution: UC Santa Cruz implemented a hazard mitigation project in 2007 to create defensible space around the observatory and remove combustible fuels. The work included vegetation management on 48 acres. The project brought the campus into compliance with California Public Resource Code, PRC 4291-Defensible Space, which requires 100 feet of reduced wildfire fuels around structures, along with treatments to reduce hazardous fuels.

Cost and Funding: The program, funded through FEMA Hazard Mitigation Assistance (HMA) grants, was completed in 2017 for a cost of $864,330.

Benefits: On August 16, 2020, a lightning storm in Santa Clara County led to one of the most destructive wildfires in California history, the Santa Clara Unit Lightning Complex Fire. The defensible space protected the Observatory structures and allowed CAL FIRE to safely remain at the observatory to protect the facility. The Observatory, valued at $77 million, experienced only $3.7 million in damage. CAL FIRE's suppression costs at the Observatory totaled $360,000.

Cal OES conducts loss avoidance studies after past mitigation projects are tested by the hazard they are meant to mitigate, in order to quantify the damage prevented by the projects. The following are key findings of the avoidance study for the Lick Observatory after the August 2020 fire:

- Without the mitigation action, the Observatory would have been completely lost by this fire
- Observatory Structure and Content Value: $77,152,670
- Observatory Structure and Content Damage: $3,769,707
- CAL FIRE Suppression Costs: $360,000
- Total Losses Avoided: $73,022,963

For the project cost of $864,330, this represents a return on investment of 8,448 percent.

Severe Wind, Weather, and Storms

Climate Impacts:
Increase in frequency and severity of severe weather events
Equity Impacts:
30.4% of exposed population (all persons in the State are exposed) identified as living in equity priority communities
State Facilities Exposed:
All facilities exposed
Community Lifelines Exposed:
All lifelines exposed

Impact Rating: High (36)

10. Severe Wind, Weather, and Storms

The severe wind, weather, and storm hazard has been identified as a high-impact natural hazard of interest based on the hazard impact rating protocol applied for this SHMP. Such events happen frequently in the State and all State-owned or -leased facilities and community lifelines are exposed to the hazard, although damage would be limited. All populations in the State could experience severe wind, weather, and storm events. These events are likely to impact equity priority communities more than the general populations due to many factors. Exposure to these events could increase if all buildable lands are developed, but the vulnerability of that exposure is considered low because it would be new development subject to codes and standards. The frequency and severity of severe wind, weather, and storm events is anticipated to increase over the next 30 years due to the impacts of climate change.

10.1. HAZARD OVERVIEW

Severe weather events in California are very common and can occur at any time of the year. For this SHMP, the severe weather profile includes coastal storms (including El Niño and La Niña), windstorms, hail, thunderstorms, tornadoes, and winter weather (including snow and ice storms).

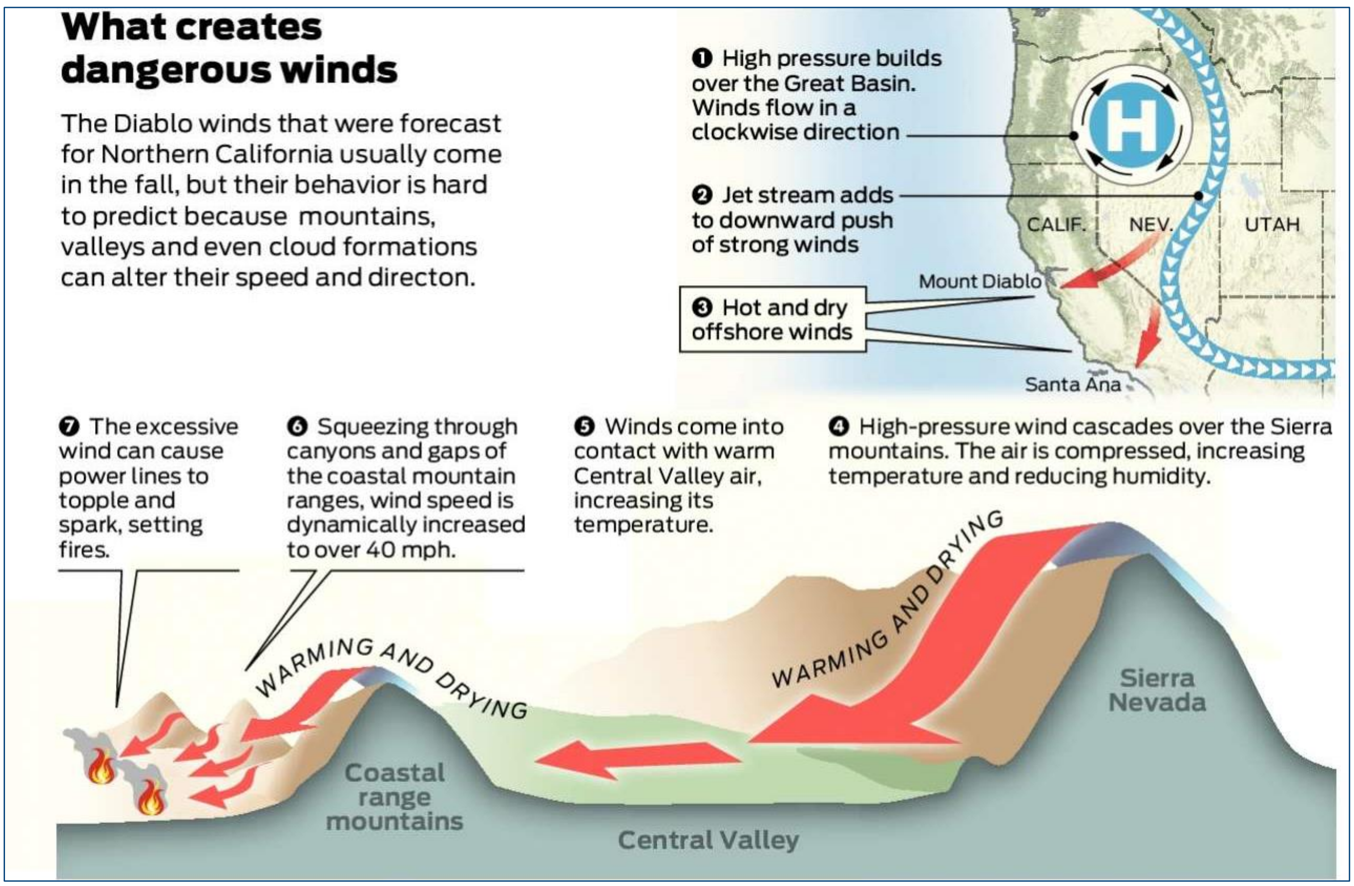
10.1.1. Windstorm

Wind occurs at all scales, from local breezes lasting a few minutes to global winds resulting from solar heating of the earth. High winds are often associated with other severe weather events such as thunderstorms, tornadoes, or tropical storms (NWS 2022h).

Santa Ana winds are warm, dry winds that blow during the Southern California cool season (October to March). They form when high pressure builds over the Great Basin—the geographic area bound by the Rocky Mountains to the east and the Sierra Nevada to the west—and when low pressure sits over the California coast. As air moves west from the Great Basin toward California, where pressure is lower (air flows from high to low pressure), it gains speed as it whips through mountain valleys and passes. The resulting airflow can reach speeds upwards of 30 mph, and gusts of more than twice this speed. The windstorms can last for several days at a time (Means 2021).

Diablo wind is a name that is sometimes used for hot, dry wind from the northeast that typically occurs in the San Francisco Bay Area during the spring and fall. The Diablo wind is created by the combination of strong inland high pressure at the surface, strongly sinking air aloft, and lower pressure off the California coast (see Figure 10-1. The air descending from aloft as well as from the Coast Ranges compresses as it sinks to sea level, where it warms as much as 20 °F and loses relative humidity.

Figure 10-1. Diablo Winds



Source: (San Francisco Chronicle 2020)

Because of the elevation of the coastal ranges in north-central California, the thermodynamic structure that occurs with the Diablo wind pattern favors the development of strong ridge-top and lee-side downslope winds associated with a phenomenon called the "hydraulic jump." While hydraulic jumps can occur with Santa Ana winds, the same thermodynamic structure that occurs with them typically favors "gap" flow more frequently. Santa Ana winds are gravity-driven winds draining air off the high deserts, while the Diablo wind originates mainly from strongly sinking air from aloft, pushed toward the coast by higher inland pressure. Thus, Santa Ana winds are the strongest in canyons, whereas a Diablo wind is first noted and blows strongest atop and on the western slopes of mountain peaks and ridges around the Bay Area.

10.1.2. Hail

Hail is a form of precipitation that occurs when updrafts in thunderstorms carry raindrops upward into extremely cold areas of the atmosphere, where they freeze into ice. Hail can damage aircrafts, homes, cars, and infrastructure, and can be deadly to livestock and people (NOAA National Severe Storms Laboratory 2022).

10.1.3. Thunderstorm

A thunderstorm is a local rainstorm produced by a cumulonimbus cloud and accompanied by lightning and thunder (NOAA n.d.-a). Such storms form from a combination of moisture, rapidly rising warm air, and a force capable of lifting air, such as a warm front, cold front, or mountain.

Although thunderstorms generally affect a small area, they have the potential to become dangerous due to their ability to generate tornadoes, hailstorms, strong winds, flash flooding, landslides, and lightning.

Roads may become impassable from flooding, downed trees or power lines, or a landslide. Downed power lines can lead to loss of utility services, such as water, phone, and electricity. Typical thunderstorms are 15 miles in diameter and last an average of 30 minutes.

Lighting is a flash of electrical energy produced by a thunderstorm. The resulting clap of thunder is the result of a shock wave created by the rapid heating and cooling of the air in the lightning channel. Lightning kills approximately 50 people in the United States each year and injures hundreds. Lightning can be cloud to air, cloud to cloud, or cloud to ground. Cloud to ground strikes can also be the cause of wildfires.

10.1.4. Tornadoes

A tornado is a rotating, funnel-shaped cloud that extends from a thunderstorm to the ground with whirling winds that can reach 250 mph or greater. Tornadoes typically move at speeds between 30 and 125 mph. Their damage paths can be more than a mile wide and 50 miles long. Tornadoes typically develop from either a severe thunderstorm or hurricane as cool air rapidly overrides a layer of warm air. The lifespan of a tornado rarely is longer than 30 minutes (FEMA 2022w); (NWS 2022). Tornadoes can occur at any time of the year, with peak seasons at different times for different states (NOAA National Severe Storms Laboratory 2022). According to the NWS, tornadoes in California occur mainly in the spring and fall, and their magnitudes usually do not exceed EF-3 strength, that is, 165 mph.

10.1.5. Winter Weather

Winter weather consists of storm events in which the main types of precipitation are snow, sleet, or freezing rain. California experiences its rainiest season during the winter, making winter precipitation more likely to occur (Kennedy 2022). For the purposes of this SHMP update, winter weather includes the following (NWS 2009):

- **Snowstorms—**Snow is precipitation in the form of ice crystals and forms directly from the freezing of water vapor in the air. Snowstorms are winter events that last several hours and see snow accumulation of more than 2 inches an hour.
- **Ice Storms—**An ice storm is a storm that results in the accumulation of at least 0.25 inches of ice on exposed surfaces. This creates hazardous driving and walking conditions. Tree branches and powerlines can easily snap under the weight of the ice.

10.1.6. El Niño and La Niña

El Niño is characterized by unusually warm water temperatures in the central and eastern portions of the topical Pacific Ocean. El Niño's impacts can affect the location of jet streams. Instead of coming ashore in the Pacific Northwest, the southern jet stream hits California with increased rainfall that is typically accompanied by floods, landslides, and coastal erosion. El Niño tends to make atmospheric rivers stronger.

La Niña is characterized by a cooling of the ocean surface in the central and eastern tropical Pacific Ocean. La Niña winters typically result in dry conditions, particularly for

Southern California. La Niña results in cold ocean water developing off the West coast of the Americas, which pushes the jet stream north. In a La Niña winter, the storm track tends to hit the Pacific Northwest with heavier rain and flooding, sometimes dipping into Northern California. The American Southwest, meanwhile, is left drier than normal (Water Education Foundation 2022).

10.2. HAZARD LOCATION

The entire State of California is susceptible to the severe weather hazard; however, some areas of the State are more susceptible to different types of severe weather than others:

- Coastal storms typically occur along the central and northern coasts of the State. Hurricanes are a rare occurrence because tropical storm winds generally blow from east to west, but when they do occur, they tend to impact the southern part of the State.
- Windstorms impact the entire State.
- Hailstorms impact the entire State.
- Thunderstorms impact the entire State.
- Tornadoes impact the entire State.
- Winter weather typically impacts the northern and central parts of the State between October and March.
- El Niño and La Niña can impact the entire State.

10.3. PREVIOUS HAZARD OCCURRENCES

Severe weather occurs frequently in the State of California and poses a threat to people and property.

10.3.1. Disaster and Emergency Declarations

The following disaster declarations or emergency proclamations related to severe weather have been issued for California (see Appendix F for details):

- Federal DR or EM declaration, 1953 – 2022: 17 events, classified as coastal storms, tornadoes, mudslides, flooding, severe winter storm, rain, snow, wind, high tides, or landslides
- California Emergency Proclamations, 1950 – 2022: 32 events, classified as monsoon, severe storm, snow, tornado, or windstorm
- USDA agricultural disaster declarations, 2012 – 2022: none

10.3.2. Event History

Table 10-1 lists significant severe weather events that impacted the State of California between 2018 and 2022. Due to the significant number of events, the table includes only events that caused at least $250,000 in property or crop damage. For events prior to 2018, please refer to Appendix K.

Table 10-1. Severe Weather Events in the State of California (2018 to 2022)

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties/Areas Impacted
March 15 – 17, 2018	Winter Storm	N/A	N/A	Shasta, Tehama
A series of cool storms brought travel impacts in the mountains from heavy snow. Thunderstorms in the Sacramento Valley had dime-sized hail. The event caused an estimated $300,000 in damages.				
July 13, 2018	Thunderstorm Wind	N/A	N/A	San Bernardino, Inyo
A substantial push of monsoon moisture helped trigger widespread thunderstorms across the Mojave Desert and southern Great Basin. Many storms produced severe weather and flash flooding. Thunderstorm winds derailed 15 train cars, blocking Highway 95. This event caused an estimated $666,000 in property damage.				
December 6, 2018	Winter Weather	N/A	N/A	Kern and Los Angeles
Several reports of 1-3 inches of snow were reported in the Kern County Mountains above 4,000 feet. The snow resulted in several roads being closed for a portion of the day including Interstate 5 from south of Grapevine in Kern County to Castaic in Los Angeles County after several vehicles became either stuck or were involved with accidents. This event caused approximately $250,000 in property damage.				

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties/Areas Impacted
January 17, 2019	Tornado	N/A	N/A	Mariposa, Kern, Tulare, Fresno
A strong low-pressure system with deep moisture fetch pushed into central California during the afternoon of January 16 and brought moderate to heavy precipitation along with strong winds to much of the area through the afternoon of January 17. Several reports of roadway flooding were received during the morning of January 17 when the heaviest precipitation occurred. Flash flooding and debris flows were reported in the Ferguson Fire burn area in Mariposa County and State Route 140 was closed for over 11 hours. One thunderstorm produced a tornado east of Clovis which was rated as EF-1 following a storm survey of the damage it produced. There were also several reports of post-frontal wind gusts exceeding 50 mph in the Kern County Mountains and Deserts while low-impact indicator sites had gusts exceeding 65 mph.				
February 2, 2019	Thunderstorm Wind	N/A	N/A	Mariposa, Fresno, Tulare, Kern
A strong upper low-pressure system approached the central California coast during the morning of February 2. Ahead of the low, strong southerly winds impacted the Grapevine area along Interstate 5 for much of the morning. By late morning, the strong winds spread northward into the Bakersfield area where there were numerous reports of downed trees and wind damage. As the main low moved inland during the day, moderate to heavy precipitation spread into the area and produced several instances of roadway and nuisance flooding. Scattered thunderstorms brought additional rainfall and small hail to the San Joaquin Valley and southern Sierra foothills during the late afternoon. One thunderstorm produced a brief small tornado south of Mariposa. $257,000 in property was damaged.				
February 14, 2019	Strong Wind	N/A	N/A	Santa Cruz Mountains
Strong wind gusts downed trees and caused power outages and structural damage. A tree fell on a car causing one fatality and one injury on Highway 17 while another tree caused a multi-car accident.				
February 17 – 18, 2019	Winter Storm	N/A	N/A	Kern City Mountains, S. Sierra Foothills
Interstate 5 was closed by California Highway Patrol (CHP) between Grapevine and Castaic for several hours between the early evening of February 17 to the late morning of February 18 due to refreezing of rain and wet snow which led to the formation of black ice on several roads in the Kern County Mountains. Several vehicles spun out or crashed due to the black ice on Interstate 5. $250,000 in property was damaged.				

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties/Areas Impacted
February 24 – March 1, 2019	Severe Winter Storms and Flooding	DR-4434	N/A	Amador, Butte, Calaveras, Colusa, Colusa, Del Norte, El Dorado, Glenn, Humboldt, Lake, Marin, Marin, Mariposa, Mendocino, Modoc, Monterey, Napa, Riverside, Santa Barbara, Shasta, Sonoma, Tehama, Trinity, Tuolumne, and Yolo
A series of heavy precipitation, snow, flooding, and winds impacted northern California. Numerous downed trees were reported, causing power outages and closed roadways. Property damage was estimated at over $1 million.				
May 19, 2019	Hail	N/A	N/A	Fresno
A strong upper-level low pressure system moved into central California during the afternoon of May 18. A cold front associated with this system pushed across the area overnight bringing periods of moderate to locally heavy precipitation to the area with much of the area picking up between 0.75 and 2 inches of liquid precipitation. There were several reports of small hail and locally heavy rainfall from areas impacted by these thunderstorms. One strong cell produced a small EF0 tornado near Huron as well as some wind damage. $75,000 in property damage and $16 million in crop damage resulted from this event.				
July 23 – 24, 2019	Thunderstorm Wind	N/A	N/A	Riverside, San Bernardino, San Diego
Strong thunderstorms led to microbursts in Riverside County, downing 20 utility poles and causing power outages. The winds also damaged cars, buildings, and infrastructure. Approximately $8 million in property damages was reported for this event.				
September 16-18, 2019	Severe Storms/ Winter Weather	N/A	N/A	Yuba, Tehama, Butte, Nevada
A series of cold, upper-level disturbances tracked across northern California, bringing showers, thunderstorms, and snow to higher elevations. Flooding and wind damage were the main impacts from this storm. Approximately $4 million in property damage and $2.5 million in crop damage resulted from this event.				

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties/Areas Impacted
August 22, 2020	Hail	N/A	N/A	San Bernardino
Thunderstorms developed over the Mojave Desert causing isolated flash flooding and hail damages. In San Bernardino, golf ball sized hail accumulated on I-15 at Mountain Pass and damaged vehicles. Approximately $250,000 in property damage was reported.				
January 18-19, 2021	High Wind	N/A	N/A	Sierra
A series of high wind events impacted the southern portion of the State, bringing strong winds over the Sierra Nevada and adjacent foothills. Wind gusts exceeded 60 mph for an 8-to-12-hour period. The strong winds downed power lines and caused extended power outages. Estimated 100 mph gusts near Yosemite Valley toppled several trees knocking out power to nearly all of Yosemite Park for several days. In addition, several structures were damaged by the winds and the park was closed for several days. Damages were estimated at $200 million.				
January 27, 2021	High Wind/Heavy Rain	N/A	N/A	Bakersfield
Heavy rain fell over northern and central California, causing flooding and wind damage. Wind gusts of up to 60 mph were measured. Rainfall totals ranged from 1-7 inches. Heavy snow fell in the Sierra Nevada as well. The storm led to extensive tree damage and approximately $250,000 in property damage.				
August 31, 2021	Thunderstorm Wind	N/A	N/A	Imperial
Rainfall occurred in northeast Imperial County along SR 78, where nearly 7 inches of rain was estimated to have fallen within a 5-hour period. An unbridged crossing along SR 78 at Milpitas Wash became flooded with swiftly flowing water due to the heavy rainfall. A vehicle attempting to cross through the flooded portion of the highway was swept off the roadway before overturning in the wash. Both occupants perished in the flash flood. Strong to severe thunderstorms across the Imperial Valley led to damaging wind gusts that resulted in numerous downed power poles. According to the Imperial Irrigation District, extensive damage sustained to the power infrastructure on both the 30th and 31st would cost the district more than $8 million.				

While California has tornadoes, such storms represent a relatively low risk for most areas, compared to states in the Midwestern and Southern United States where risk exposure is severe, and many lives and millions of dollars are lost annually due to this hazard. On average, the State of California experiences 11 tornadoes a year (The Weather Channel 2022).

El Niño events in 1982-1983 and 1997-1998 drenched the West Coast with record rain. The last El Niño, a weak one, occurred in 2018-2019 (Water Education Foundation 2022).

10.4. PROBABILITY OF FUTURE HAZARD EVENTS

10.4.1. Overall Probability

According to FEMA, NOAA, and the 2018 SHMP, the State of California experienced over 2,500 severe weather events between 1950 and 2022, as summarized in Table 10-2. This equates to an average of 35 severe weather events each year. Overall, the State can expect to experience at least a similar average frequency of these events in the future, with the possibility of an increase in frequency due to the impacts from climate change.

Table 10-2. Probability of Future Severe Weather Events in California

Hazard Type	Events Between 1950 and 2022	Average Frequency
Coastal Storms and Hurricanes	10	About 1 per 7 years
Windstorm	>500	More than 7 per year
Hailstorm	>500	More than 7 per year
Thunderstorm and Lightning	>500	More than 7 per year
Tornado	466	About 7 per year
Winter Weather (snow and ice)	>500	More than 7 per year

Source: (FEMA 2022o), (NCEI 2022b), and (Cal OES 2018)

10.4.2. Climate Change Impacts

A key theme in the California Climate Adaptation Strategy is the likelihood of more extreme weather-related events. Because the science is new, however, little is yet known about some of the potential effects of climate change on weather. For example, the California Adaptation Strategy does not include an in-depth assessment of the possibility of increasing numbers and intensities of windstorms.

While a specific event is difficult to project for a particular location, planners should be familiar with local weather patterns and be able to identify which events meet or go beyond the historically observed range that would pose the greatest risk to a community. This could be intense rainfall, wind, heat, powerful hurricanes, or any other climate change-influenced event. Communities should include the potential for these events in their planning process. For example, severe coastal storms may increase in frequency and severity. This potential should be incorporated into coastal community plans for land use and emergency response.

10.5. IMPACT ANALYSIS

10.5.1. Severity

Coastal Storms

Only two tropical storms have had a landfall in California. The first was on September 24, 1939. This storm approached the Los Angeles area but lost hurricane strength just before making landfall at San Pedro as a tropical storm (Sistek 2022). The second was Tropical Storm Kay, in September 2022 (State of California 2022m).

Windstorms

Table 10-3 provides the description of winds used by the NWS during wind-producing events.

Table 10-3. NWS Wind Descriptions

Description	Sustained Wind Speed (mph)
Strong, dangerous, or damaging	≥40
Very Windy	30-40
Windy	20-30
Breezy, brisk, or blustery	15-25
None	5-15 or 10-20
Light or light and variable wind	0-5

Source: (NWS 2022a)

One of the first scales to estimate wind speeds and effects was created by Sir Francis Beaufort (1774-1857). He developed a scale in 1805 to help sailors estimate winds via visual observations. The scale starts with 0 and goes to a force of 12. The Beaufort scale is still used today to estimate wind strengths. Table 10-4 shows the Beaufort Wind Scale ratings.

Hailstorms

Hail size is often estimated by comparing it to a known object, as shown in Figure 10-2. Most hailstorms are made up of a mix of different sizes, and only the very largest hail stones pose serious risk to people caught in the open (NWS 2022g).

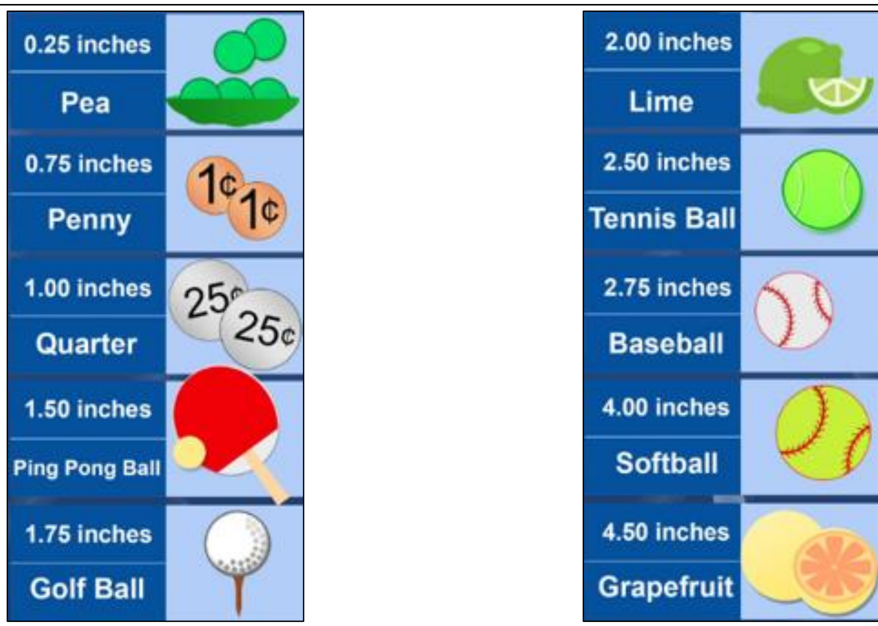
Table 10-4. Beaufort Wind Scale

	Speed			Specifications for use at sea
Force	**(mph)**	**(knots)**	**Description**	**Specifications for use on land**
0	0-1	0-1	Calm	Sea like a mirror.
				Calm: smoke rises vertically.
1	1-3	1-3	Light Air	Ripples with the appearance of scales are formed, but without foam crests.
				Direction of wind shown by smoke drift, but not by wind vanes.
2	4-7	4-6	Light Breeze	Small wavelets, still short, but more pronounced. Crests have a glassy appearance and do not break.
				Wind felt on face; leaves rustle; ordinary vanes moved by wind.
3	8-12	7-10	Gentle Breeze	Large wavelets. Crests begin to break. Foam of glassy appearance. Perhaps scattered white horses.
				Leaves and small twigs in constant motion; wind extends light flag.
4	13-18	11-16	Moderate Breeze	Small waves, becoming larger; frequent white horses.
				Raises dust and loose paper; small branches are moved.
5	19-24	17-21	Fresh Breeze	Moderate waves, taking a more pronounced long form; many white horses are formed.
				Small trees in leaf begin to sway; crested wavelets form on inland waters.
6	25-31	22-27	Strong Breeze	Large waves begin to form; the white foam crests are more extensive everywhere.
				Large branches in motion; whistling heard in telegraph wires; umbrellas used with difficulty.
7	32-38	28-33	Near Gale	Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind.
				Whole trees in motion; inconvenience felt when walking against the wind.
8	39-46	34-40	Gale	Moderately high waves of greater length; edges of crests begin to break into spindrift. The foam is blown in well-marked streaks along the direction of the wind.
				Breaks twigs off trees; generally, impedes progress.
9	47-54	41-47	Severe Gale	High waves. Dense streaks of foam along the direction of the wind. Crests of waves begin to topple, tumble, and roll over. Spray may affect visibility
				Slight structural damage occurs (chimney pots and slates removed)

Force	Speed (mph)	Speed (knots)	Description	Specifications for use at sea / Specifications for use on land
10	55-63	48-55	Storm	Very high waves with long overhanging crests. The resulting foam, in great patches, is blown in dense white streaks along the direction of the wind. Overall, the surface of the sea takes on a white appearance. The tumbling of the sea becomes heavy and shock-like. Visibility affected.
				Seldom experienced inland; trees uprooted; considerable structural damage occurs.
11	64-72	56-63	Violent Storm	Exceptionally high waves (small and medium-size ships might be for a time lost to view behind the waves). The sea is completely covered with long white patches of foam lying in the direction of the wind. Everywhere the edges of the wave crests are blown into froth. Visibility affected.
				Very rarely experienced; accompanied by wide-spread damage.
12	72-83	64-71	Hurricane	The air is filled with foam and spray. Sea completely white with driving spray; visibility very seriously affected.
				See Saffir-Simpson Hurricane Scale

Source: (NWS n.d.-a)

Figure 10-2. Hail Size Chart



Source: (NWS 2020)

Thunderstorms

The National Weather Service Storm Prediction Center (SPC) issues severe thunderstorm risk maps based on the likelihood of different severities of thunderstorms. Figure 10-3 shows the SPC's severe thunderstorm risk categories (SPC 2020).

Figure 10-3. Severe Thunderstorm Risk Categories

THUNDERSTORMS (no label)	1 - MARGINAL (MRGL)	2 - SLIGHT (SLGT)	3 - ENHANCED (ENH)	4 - MODERATE (MDT)	5 - HIGH (HIGH)
No severe* thunderstorms expected	**Isolated severe thunderstorms possible**	**Scattered severe storms possible**	**Numerous severe storms possible**	**Widespread severe storms likely**	**Widespread severe storms expected**
Lightning/flooding threats exist with all thunderstorms	Limited in duration and/or coverage and/or intensity	Short-lived and/or not widespread, isolated intense storms possible	More persistent and/or widespread, a few intense	Long-lived, widespread and intense	Long-lived, very widespread and particularly intense

Source: (SPC 2020)

Lightning severity is determined by the frequency of lightning strikes during a storm. Multiple devices are available to track and monitor the frequency of lightning, including NOAA's nowCOAST weather tracking tool (NOAA 2023).

Tornadoes

The severity of a tornado is categorized using the Enhanced Fujita Tornado Intensity Scale (EF Scale), which compares wind speed and actual damage. Figure 10-4 illustrates the relationship between EF ratings, wind speed, and expected tornado damage.

Figure 10-4. Explanation of EF-Scale Ratings

EF Rating	Wind Speeds	Expected Damage
EF-0	65-85 mph	'Minor' damage: shingles blown off or parts of a roof peeled off, damage to gutters/siding, branches broken off trees, shallow rooted trees toppled.
EF-1	86-110 mph	'Moderate' damage: more significant roof damage, windows broken, exterior doors damaged or lost, mobile homes overturned or badly damaged.
EF-2	111-135 mph	'Considerable' damage: roofs torn off well constructed homes, homes shifted off their foundation, mobile homes completely destroyed, large trees snapped or uprooted, cars can be tossed.
EF-3	136-165 mph	'Severe' damage: entire stories of well constructed homes destroyed, significant damage done to large buildings, homes with weak foundations can be blown away, trees begin to lose their bark.
EF-4	166-200 mph	'Extreme' damage: Well constructed homes are leveled, cars are thrown significant distances, top story exterior walls of masonry buildings would likely collapse.
EF-5	> 200 mph	'Massive/incredible' damage: Well constructed homes are swept away, steel-reinforced concrete structures are critically damaged, high-rise buildings sustain severe structural damage, trees are usually completely debarked, stripped of branches and snapped.

Source: (NWS n.d.-e)

Winter Weather

The Sperry-Piltz Ice Accumulation (SPIA) Index predicts the projected footprint, total ice accumulation, and resulting potential damage from incoming ice storms. The SPIA Index, shown in Figure 10-5, is based on three parameters: storm total rainfall, converted to ice accumulation; wind; and temperatures during the event period (SPIA Index n.d.).

Figure 10-5. Sperry-Piltz Ice Accumulation

Ice Damage Index	Damage and Impact Descriptions
0	Minimal risk of damage to exposed utility systems; no alerts or advisories needed for crews, few outages.
1	Some isolated or localized utility interruptions are possible, typically lasting only a few hours. Roads and bridges may become slick and hazardous.
2	Scattered utility interruptions expected, typically lasting 12 to 24 hours. Roads and travel conditions may be extremely hazardous due to ice accumulation.
3	Numerous utility interruptions with some damage to main feeder lines and equipment expected. Tree limb damage is excessive. Outages lasting 1 – 5 days.
4	Prolonged & widespread utility interruptions with extensive damage to main distribution feeder lines and some high voltage transmission lines/structures. Outages lasting 5 – 10 days.
5	Catastrophic damage to entire exposed utility systems, including both distribution and transmission networks. Outages could last several weeks in some areas. Shelter needed.

Source: (SPIA Index n.d.)

10.5.2. Warning Time

Coastal Storms

The Coastal Storm Modeling System (CoSMoS) provides emergency responders and coastal planners with critical storm-hazard information such as flood extent, flood depth, duration of flooding, wave height, and currents that can be used to increase public safety, mitigate physical damages, and more effectively manage complex coastal settings. The Coastal and Marine Hazards and Resources Program initially developed CoSMoS in collaboration with Deltares, and later in partnership with the National Oceanic and Atmospheric Administration, the National Park Service, and non-governmental organizations (NGOs) (USGS 2019e).

Windstorms

NWS issues advisories and warnings for winds, which are normally site-specific. High wind advisories, watches, and warnings are issued by the NWS when wind speeds may pose a hazard or may be life threatening. The criteria for each of these varies from state to state.

Thunderstorms

Severe thunderstorm watches and warnings are issued by the local NWS office and the SPC. A severe thunderstorm warning is issued when thunderstorms are producing hail equal to or greater than 1 inch in diameter or wind gusts of at least 58 mph are occurring or imminent. The local NWS office and the SPC update watches and warnings and notify the public when they are no longer in effect.

10.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with severe wind, weather, and storms:

- The most significant cascading hazards associated with severe local storms are floods, mudslides, landslides, sinkholes, and power failures.
- PSPS events associated with severe weather events.
- Rapidly melting snow combined with heavy rain can overwhelm both natural and constructed drainage systems, causing overflow and property destruction.
- Landslides occur when the soil on slopes becomes oversaturated and fails.
- Lightning can start wildfires.
- Road closures caused by weather can restrict the movement of people and goods.

10.5.4. Environmental Impacts

Severe weather that creates long periods of rainfall can erode natural banks along waterways and degrade soil stability for terrestrial species. Tornadoes can tear apart habitats, causing fragmentation across ecosystems. Researchers believe that a greater number of diseases can spread across ecosystems because of impacts that severe weather and climate change have on water supplies (CDC 2022b). The residual impacts of a community’s methods to maintain its infrastructure through winter weather (such as road salting) may also have an impact on the environment. Reduced snowpack in the mountainous regions can worsen both drought and wildfire (National Integrated Drought Information System n.d.).

10.5.5. Local Hazard Impacts

LHMP Rankings

County hazard mitigation plans often identify "severe weather" as a hazard of concern without separating specific weather types from each other. Of the 58 counties in California, four assessed tornado as a hazard of concern. All four ranked it as low risk. Severe weather was assessed as a hazard of concern in 54 counties' hazard mitigation plans. The following 31 counties listed severe weather as a high-risk hazard:

- Alpine
- Amador
- Butte
- Calaveras
- El Dorado
- Humboldt
- Imperial
- Inyo
- Kern
- Lake
- Madera
- Mendocino
- Merced
- Modoc
- Mono
- Monterey
- Napa
- Nevada
- Placer
- San Benito
- San Diego
- San Joaquin
- Santa Barbara
- Santa Clara
- Shasta
- Siskiyou
- Solano
- Stanislaus
- Trinity
- Tulare
- Yolo

LHMP Estimates of Potential Loss

A review of the LHMPs in the counties (as called for in FEMA's Standard State Mitigation Planning Requirement S6.b) found no quantitative risk analysis that identifies population or structures exposed to this hazard. This can be attributed to the lack of extent and location hazard mapping to use for such an analysis. Therefore, no summary of risk for local plan reviews is provided for this hazard.

10.6. VULNERABILITY ANALYSIS

To understand risk, the assets exposed to hazards must be identified. For severe weather, the entire State of California is exposed. However, certain areas are more vulnerable to specific severe weather events than others due to geographic location and local weather patterns.

10.6.1. Exposure of State-Owned or -Leased Facilities

All State-owned or -leased assets, as listed in Table 4-1 and Table 4-2, are exposed to severe weather and storms. This includes 23,961 State-owned facilities, and 1,893 State-leased facilities.

10.6.2. Exposure of Critical Facilities and Community Lifelines

All 755 State critical facilities and community lifelines, as listed in Table 4-3, are exposed to the severe weather hazard. Loss of utilities and closed roadways are the most common issue with severe weather events. Impacts on transportation lifelines affect both short-term (e.g., evacuation activities) and long-term (e.g., day-to-day commuting and goods transport) transportation needs. The utility infrastructure can also suffer damage, resulting in widespread power outages. The interruption of power, water, wastewater, hospital services, and other emergency services has cascading impacts on the State's population and all forms of economic activity.

Critical facilities and community lifelines that are exposed to severe wind, weather, and storms are likely to experience functional downtime associated with loss of power following these events, which could increase the net impact of these events. Additionally, the impacts of road closures during severe storm events can cause functional downtime due to inaccessibility of locations and/or ability of employees to come to work.

10.6.3. Estimates of Loss

Depending on the severity and duration of the severe weather event, damage to State assets can include roof damage from wind, structural damage from downed trees, and power outages. State infrastructure can be impacted by debris and downed trees/power lines, causing road closures, power outages, and limiting access to emergency personnel.

Loss estimations for the severe weather hazards profiled in this assessment 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 cost value of all State-owned facilities (see Table 10-5). This allows the State to select a range of potential economic impacts based on an estimate of the percentage of damage to these assets. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure.

Table 10-5. Loss Potential of State-Owned Facilities for Severe Wind, Weather, and Storms

Type of Facility	Total Replacement Cost Value	Estimated Loss Potential Based on % Damage		
		10% Damage	30% Damage	50% Damage
Facilities Housing Vulnerable Populations				
Correctional Facility	$5,673,743,477	$567,374,348	$1,702,123,043	$2,836,871,738
Development Center	$696,669,418	$69,666,942	$209,000,825	$348,334,709
Hospital	$837,461,197	$83,746,120	$251,238,359	$418,730,598
Migrant Center	$996,980,976	$99,698,098	$299,094,293	$498,490,488
Special School	$128,610,363	$12,861,036	$38,583,109	$64,305,182
All Other Facilities	**$28,392,185,985**	**$2,839,218,598**	**$8,517,655,796**	**$14,196,092,992**
Total	**$36,725,651,416**	**$3,672,565,142**	**$11,017,695,425**	**$18,362,825,708**

10.6.4. Buildable Land

An estimated 11.7 million acres of land is available for development in California. Because the entire State is vulnerable to severe weather, any type of development of any of this land will be susceptible to damage and impacts from this hazard.

10.6.5. Equity Priority Communities

Because the entire population of the State of California is exposed and vulnerable to severe weather, the exposed population in equity priority communities is equal to the statewide percentage: 30.4 percent of the total population (12 million people).

Priority populations include older adults, people with disabilities, people with low income or linguistically isolated populations, people with chronic conditions and life-threatening illnesses, individuals experiencing homelessness, and residents living in areas that are isolated from major roads. Power outages can be life-threatening to those dependent on electricity for assistive technology and life-sustaining medical devices and is a significant concern. These populations face isolation and exposure during severe weather events and are likely to suffer more secondary effects of the hazard.

10.6.6. NRI Scores

Strong Wind

According to the NRI, all of the State's counties have strong wind risk, rated from very low to very high. Table 10-6 shows scores for the six counties with the highest rating. See Section 4.1.3 for a description of the components of the NRI.

Table 10-6. NRI Scoring of Counties for Strong Wind

County	Expected Annual Loss	Social Vulnerability Rating	Community Resilience Rating	Community Risk Factor	Risk Value	Score
Los Angeles	$569,654	Very High	Very Low	1.36	$795,169	73.46
Riverside	$260,521	Very High	Relatively Low	1.34	$342,928	46.2
San Diego	$275,332	Relatively High	Very Low	1.20	$334,902	45.53
San Bernardino	$233,745	Very High	Relatively Moderate	1.34	$314,175	43.46
Imperial	$156,546	Very High	Very Low	1.70	$253,897	36.84
Orange	$201,184	Relatively Moderate	Very Low	1.26	$251,692	36.68

Hail

According to the NRI, all of the State's counties have hail risk, rated from very low to relatively moderate. Table 10-7 shows scores for the six counties with the highest rating. See Section 4.1.3 for a description of the components of the NRI.

Table 10-7. NRI Scoring of Counties for Hail

County	Expected Annual Loss	Social Vulnerability Rating	Community Resilience Rating	Community Risk Factor	Risk Value	Score
Fresno	$1,341,822	Very High	Relatively Low	1.53	$2,045,009	94.65
Tulare	$624,358	Very High	Very Low	1.55	$993,965	88.51
Kern	$292,913	Very High	Very Low	1.41	$431,559	77.63
Madera	$197,348	Very High	Very Low	1.41	$292,345	70.44
San Bernardino	$131,055	Very High	Relatively Moderate	1.34	$171,618	61.06
San Joaquin	$114,293	Very High	Relatively High	1.32	$151,064	57.08

Thunderstorm

According to the NRI, all of the State's counties have thunderstorm risk, rated from very low to relatively high. Table 10-8 shows scores for the six counties with the highest rating. See Section 4.1.3 for a description of the components of the NRI.

Table 10-8. NRI Scoring of Counties for Thunderstorm

County	Expected Annual Loss	Social Vulnerability Rating	Community Resilience Rating	Community Risk Factor	Risk Value	Score
Los Angeles	$774,547	Very High	Very Low	1.36	$1,104,747	95.01
Contra Costa	$552,279	Relatively Moderate	Relatively High	1.11	$630,520	89.32
Stanislaus	$370,800	Very High	Relatively Moderate	1.43	$519,711	87.00
Kern	$367,329	Very High	Very Low	1.41	$515,940	86.81
Butte	$254,470	Very High	Relatively High	1.25	$329,057	79.89
San Joaquin	$237,850	Very High	Relatively High	1.32	$320,007	79.50

Tornado

According to the NRI, all of the State's counties have tornado risk, rated from very low to relatively high. Table 10-9 shows scores for the six counties with the highest rating. See Section 4.1.3 for a description of the components of the NRI.

Table 10-9. NRI Scoring of Counties for Tornado

County	Expected Annual Loss	Social Vulnerability Rating	Community Resilience Rating	Community Risk Factor	Risk Value	Score
Los Angeles	$16,313,687	Very High	Very Low	1.36	$21,880,211	97.61
Riverside	$5,237,380	Very High	Relatively Low	1.34	$6,816,650	89.47
Orange	$4,799,429	Relatively Moderate	Very Low	1.26	$5,847,332	87.40
San Bernardino	$3,398,026	Relatively Moderate	Very Low	1.34	$4,548,618	83.17
San Diego	$2,054,719	Relatively High	Very Low	1.20	$2,466,557	70.73
Alameda	$2,198,340	Relatively Moderate	Very High	1.13	$2,408,097	70.12

Winter Weather

According to the NRI, 52 of the State's counties have winter weather risk, rated from very low to relatively high. Table 10-10 shows scores for the six counties with the highest rating. See Section 4.1.3 for a description of the components of the NRI.

Table 10-10. NRI Scoring of Counties for Winter Weather

County	Expected Annual Loss	Social Vulnerability Rating	Community Resilience Rating	Community Risk Factor	Risk Value	Score
Mono	$317,625	Relatively Moderate	Relatively High	1.17	$370,412	88.51
Alpine	$106,849	Relatively Moderate	Relatively Moderate	1.35	$144,225	72.96
El Dorado	$103,764	Relatively Low	Relatively High	1.02	$112,264	66.59
Nevada	$79,943	Relatively Low	Relatively High	0.98	$78,097	57.14
Tuolumne	$58,693	Relatively Moderate	Relatively Moderate	1.16	$62,138	50.72
Los Angeles	$46,516	Very High	Very Low	1.36	$56,395	48.55

10.7. MITIGATING THE HAZARD

10.7.1. Existing Measures to Mitigate the Hazard

Storm-related mitigation activities that occur during storm season in California include clearing culverts, marshaling heavy equipment, training crews in flood-fighting techniques, and sharing weather-related information with the public.

10.7.2. Opportunities for Mitigating the Hazard

Planners should be familiar with local weather patterns and be able to identify which events meet or go beyond the historically observed range that would pose the greatest risk to a community. This could be any climate change-influenced event. Communities should include the potential for these events in their planning process. For example, severe coastal storms may increase in frequency and severity. This potential should be incorporated into coastal community plans for land use and emergency response. A range of alternatives by scale to mitigate the severe wind, weather, and storms hazards is provided in Table 10-11.

Table 10-11. Potential Opportunities to Mitigate the Severe Weather Hazards

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ None **Reduce exposure and vulnerability:** ▪ Insulate residential and non-residential structures ▪ Provide redundant heat and power ▪ Plant appropriate trees near home and power lines ("Right tree, right place" National Arbor Day Foundation Program) **Build local capacity:** ▪ 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 and vulnerability:** ▪ Relocate critical infrastructure (such as power lines) underground ▪ Reinforce or relocate critical infrastructure such as power lines to meet performance expectations ▪ Install tree wire **Build local capacity:** ▪ 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 and vulnerability:** ▪ Harden infrastructure such as locating utilities underground ▪ Trim trees back from power lines ▪ Designate snow routes and strengthen critical roads and bridges ▪ Use the best available technology to enhance the warning systems for all severe weather events **Build local capacity:** ▪ Support programs such as "Tree Watch" that proactively manage problem areas through the use of selective removal of hazardous trees, tree replacement, etc. ▪ Establish and enforce building codes that require all roofs to withstand snow loads ▪ Increase communication alternatives ▪ Enhance public awareness campaigns to address actions to take during severe weather events ▪ Coordinate severe weather warning capabilities and the dissemination of warning among agencies with the most capability ▪ 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 ▪ Consider the probable impacts of climate change on risk associated with the severe weather hazard ▪ Evaluate and revise, as needed, building codes to address severe weather impacts on residents
Nature-based opportunities ▪ No nature-based solutions have been identified to mitigate severe wind, weather, and storms.		

10.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address severe weather:

- Action 2018-001: Support Legislative Efforts that Formalize California's Comprehensive Mitigation Program.
- Action 2018-006: Enhance Collaboration on the Development and Sharing of Data Systems and GIS modeling.
- Action 2018-008: Develop a database containing a description of the specific natural hazard event for which each project was designed to mitigate.

SEA-LEVEL RISE, COASTAL FLOODING, AND EROSION

Climate Impacts:
Shoreline erosion, coastal flooding, water pollution, degraded or disturbed coastal ecosystems, and impacts to human-made structures

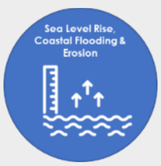
Equity Impacts:
Sea-Level Rise – 11.4% of population living in the 6-foot sea-level rise hazard area identified as living in equity priority communities
Coastal Flooding – 3% of population living in the 1% annual chance coastal flood hazard area identified as living in equity priority communities

State Facilities Exposed:
Sea-Level Rise – 42 facilities in the 6-foot hazard area
Coastal Flooding – 81 facilities in the 1% percent chance flood hazard areas (coastal)

Community Lifelines Exposed:
Sea-Level Rise – 1 lifeline in the 6-foot hazard area
Coastal Flooding – 4 lifelines in the 1% annual chance flood hazard areas (coastal)

Impact Rating: High (33)

11. SEA-LEVEL RISE, COASTAL FLOODING, AND EROSION



The sea-level rise, coastal flooding, and erosion hazard has been identified as a high-impact natural hazard of interest based on the hazard impact rating protocol applied for this SHMP. Events associated with this hazard happen frequently in the State. About 14 percent of State-owned or -leased facilities and community lifelines are exposed to the hazard. Approximately 5 percent of the State's population is exposed to these hazards, and over 30 percent of that population has been identified as living in equity priority communities. About 7 percent of the identified buildable lands in the State intersect mapped sea-level rise, coastal flood, and erosion hazard areas. The frequency and severity of this hazard is anticipated to increase over the next 30 years due to the impacts of climate change.

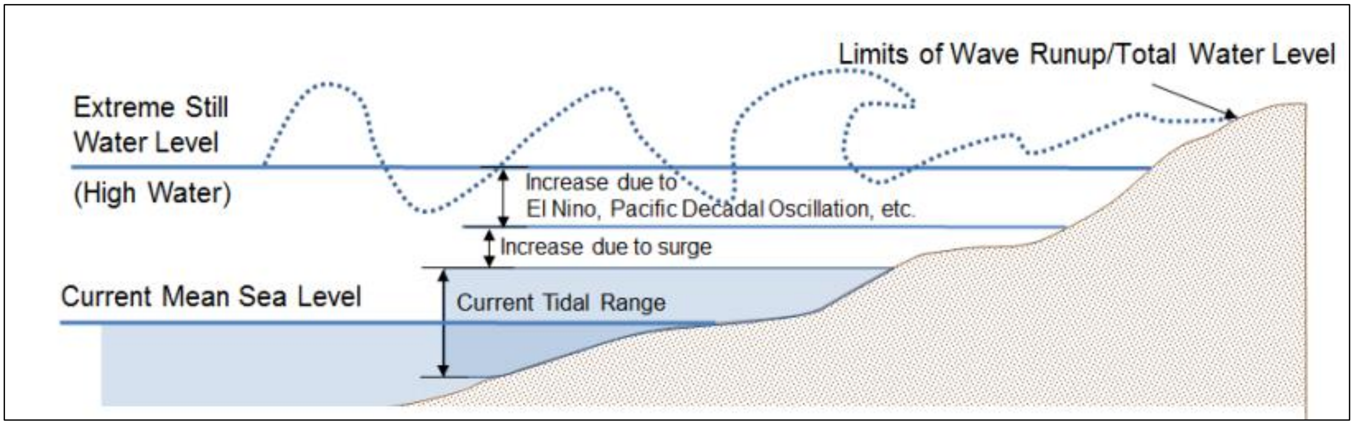
11.1. HAZARD OVERVIEW

California has more than 1,100 miles of outer coast featuring bluffs, beaches, and wetlands, in addition to bay shorelines and the Sacramento-San Joaquin River Delta. The San Francisco Bay shoreline alone is approximately 300 miles, not including the Delta. The coast supports varying levels of development and land use, including recreational, agricultural, industrial, commercial, and residential uses. These coastal areas are exposed to coastal flooding and erosion. Changes to sea level will increase the occurrence and severity of coastal flooding and erosion events (Cal OES 2018a).

11.1.1. Sea-Level Rise

Sea-level rise is an increase in the average level of the ocean. Generally, sea-level rise progressively worsens the impact of high tides and wind-driven waves associated with severe storms. Coupled with increased frequency, severity, and duration of high tide and storm events related to climate change, sea-level rise will exacerbate these extreme events along the coast. El Niño events exacerbate storms and coastal inundation above that already occurring due to sea-level rise and normal coastal weather and tidal patterns (Barnard 2017). The additive effects of high tides, storm surge, atmospheric patterns (e.g., El Niño) and sea-level rise are shown in Figure 11-1.

Figure 11-1. Additive Effects of Sea-Level Rise



Source: (California Coastal Commission 2018)

Increases in global sea level result from three primary causes: ocean expansion caused by warming water; the melting of land-based ice, including mountain glaciers, ice caps, and the polar ice sheets of Greenland and Antarctica; and land-water storage changes. Since 2006, the melting of land ice from glaciers and ice sheets has become the most important contributor to sea-level rise, with mountain glaciers contributing 20 percent and ice sheets 33 percent (IPCC 2019). If the current rate of loss for these ice sheets continues, their contribution will become the dominant source of sea-level rise (OPC 2017).

While global mean sea level is rising, it is relative sea level—the local difference in elevation between the height of the sea surface and the height of the land surface at any particular location—that affects coastal communities and ecosystems at risk from coastal flooding.

Future changes in relative sea level will vary along the length of the California coastline and can be influenced by factors such as the following:

- Fluctuating ocean and atmospheric patterns (e.g., El Niño, which usually causes regional sea level to rise along the California coast for several months)
- Vertical land movement from tectonic forces, sediment compaction, or extraction of water or hydrocarbon

- Changes in river flows that affect runoff
- Weather such as storm surge and wave runup during severe storm conditions

11.1.2. Coastal Flooding

Coastal flooding is the rising of tidally influenced waters due to high astronomical tides or storm surge. Most locations in California experience two high and two low tides daily. Storm surge is the abnormal rise in seawater level during a storm, measured as the height of the water above the normal predicted astronomical tide. The surge is caused primarily by a storm's winds pushing water onshore. The amplitude of the storm surge at any given location depends on the orientation of the coastline relative to the storm track; the intensity, size, and speed of the storm; and the local underwater topography (NOAA 2022a). When astronomical high tides and storm surge occur at the same time, the risk for coastal flooding is much greater.

High-tide flooding, often referred to as "nuisance" or "sunny day" flooding, is increasingly common due to years of relative sea-level increases. It occurs when tides reach anywhere from 1.75 to 2 feet above the daily average high tide and start spilling onto streets or bubbling up from storm drains. Overall, coastal flooding is more likely during El Niño conditions than it is during La Niña conditions (C. f. NOAA 2021c).

11.1.3. Erosion

Coastal flooding usually coincides with storm events that have significant wave action. During coastal flooding, waves are able to reach higher up the beach face, resulting in greater rates of erosion. This can result in loss of beach volume and slumping and collapse of sections of coastal bluffs and cliffs.

Coastal erosion is a natural, ongoing sediment redistribution process that continually changes beaches, dunes, and bluffs. Waves, tides, currents, wind-driven water, ice, rainwater runoff, groundwater seepage, and rising sea levels all move sand, sediment, and water along the coastline (Giang 2011), resulting in the transfer of sediment from one location to another. Coastal erosion may also be exacerbated by human activities, such as boat wakes, shoreline hardening, and dredging (FEMA 1996).

The addition of sediment is referred to as accretion. Accretion can be beneficial if it strengthens a shoreline, leading to wider beaches and more material for dune building. However, it can also narrow channels and inlets, leading to an increase of coastal flooding or lack of safe water access for boats and ships (Galgano 2009).

Coastal erosion is one of the primary hazards leading to loss of lives or damage to property and infrastructure in coastal areas. It is typically discussed as a sporadic event associated with other types of natural hazards, such as winter weather, but also occurs constantly at a lower rate.

11.2. HAZARD LOCATION

11.2.1. Sea-Level Rise

No single sea-level rise inundation area dataset for the entire California coastline was available at the time this SHMP was prepared. A comprehensive data set is in the process of being developed under the "Our Coast, Our Future" program sponsored by the USGS, but it is not complete. Therefore, this assessment used two data sets that look at two timeframes for sea-level rise projections.

- The USGS "Our Coast, Our Future" data set that provides coverage from San Diego County to the Marin County/Mendocino County border.
- The NOAA Office for Coastal Management's Sea-Level Rise Viewer, a national data set that provided coverage from Mendocino County to Del Norte County.

Both data sets define inundation area for sea-level rise intervals that align with the State's sea-level rise projections for 2050 and 2100. However, the models use different approaches and therefore show different sea-level rise impacts. The differences in the models are summarized as follows:

- The Our Coast, Our Future data was modeled using the USGS Coastal Storm Modeling System. This system allows predictions of coastal flooding due to both future sea-level rise and storms integrated with long-term coastal evolution. The 100 cm (3.3 feet) of sea-level rise and 200 cm (6.6 feet) of sea-level rise intervals were chosen to align with the 2050 and 2100 projections, respectively.
- The NOAA data is often referred to as the "bathtub" model, showing a static rise over mean higher high water. The 3 feet of sea-level rise and 6 feet of sea-level rise intervals were chosen to align with the State's 2050 and 2100 projections, respectively.

Two aggregate data sets were developed to assess the risk from sea-level rise. Figure 11-2 and Figure 11-3 show the extent and location for the two projections.

Figure 11-2. Projected Sea-Level Rise Extents for 2050

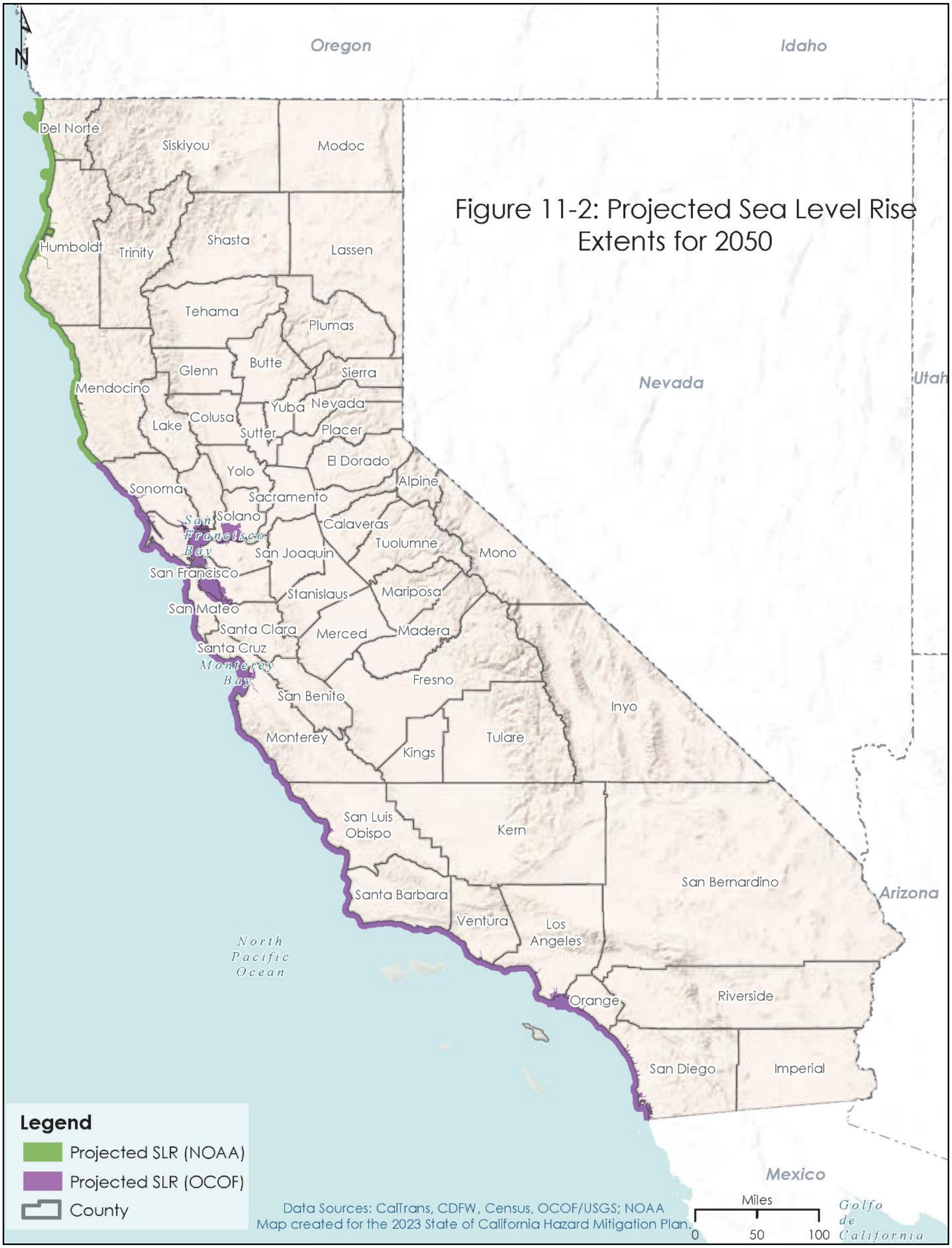


Figure 11-3. Projected Sea-Level Rise Extents for 2100

11.2.2. Coastal Flooding

Low-lying coastal areas in California are vulnerable to coastal flooding and can be impacted during high-water caused by storms, astronomical conditions, and significant wave action. Certain areas along the coast may have higher risk of experiencing structural damage caused by wave action or high-velocity water during the 1% annual-chance flood. These areas are identified on FIRMs as Coastal High-Hazard Areas (FEMA 2021b).

Storm surge modeling computes the maximum potential storm surges based on storm movement in different directions and strengths in combination with topography and tides (National Hurricane Center n.d.). Figure 11-4 shows the mapped coastal flood zones for the State of California.

11.2.3. Erosion

Coastal erosion, of varying degree, is possible at all locations along the California coastline. Erosional rates are dependent on numerous factors including sediment type, erosional forces, and sediment supply (A. Young 2021). There is no validated statewide dataset for mapping the extent and location of the coastal erosion hazard. Therefore, the assessment of coastal erosion risk in this plan is qualitative. If local mitigation planning efforts have good data on extent and location of the coastal erosion hazard, they are encouraged to use that data for more quantitative assessment of risk.

11.3. PREVIOUS HAZARD OCCURRENCES

11.3.1. Disaster and Emergency Declarations

The following disaster declarations or emergency proclamations related to flood-related events in coastal counties have been issued for California (see Appendix F for details):

- Federal DR or EM declaration, 1953 – 2022: 30 events, classified as flood, coastal storm, or hurricane (FEMA 2022d)
- California Emergency Proclamations, 1950 – 2022: 4, classified as flood/high tides
- USDA agricultural disaster declarations, 2012 – 2022: None

Figure 11-4. FEMA Mapped Coastal Flood Hazard Zones

11.3.2. Event History

Table 11-1 lists coastal flooding and severe episodic erosion events that have impacted California between 2018 and 2022. As shown in Figure 11-5, changes in sea level have been occurring for at least the last 100 years and are projected to continue. The rate of sea-level rise is increasing, and this trend is projected to continue.

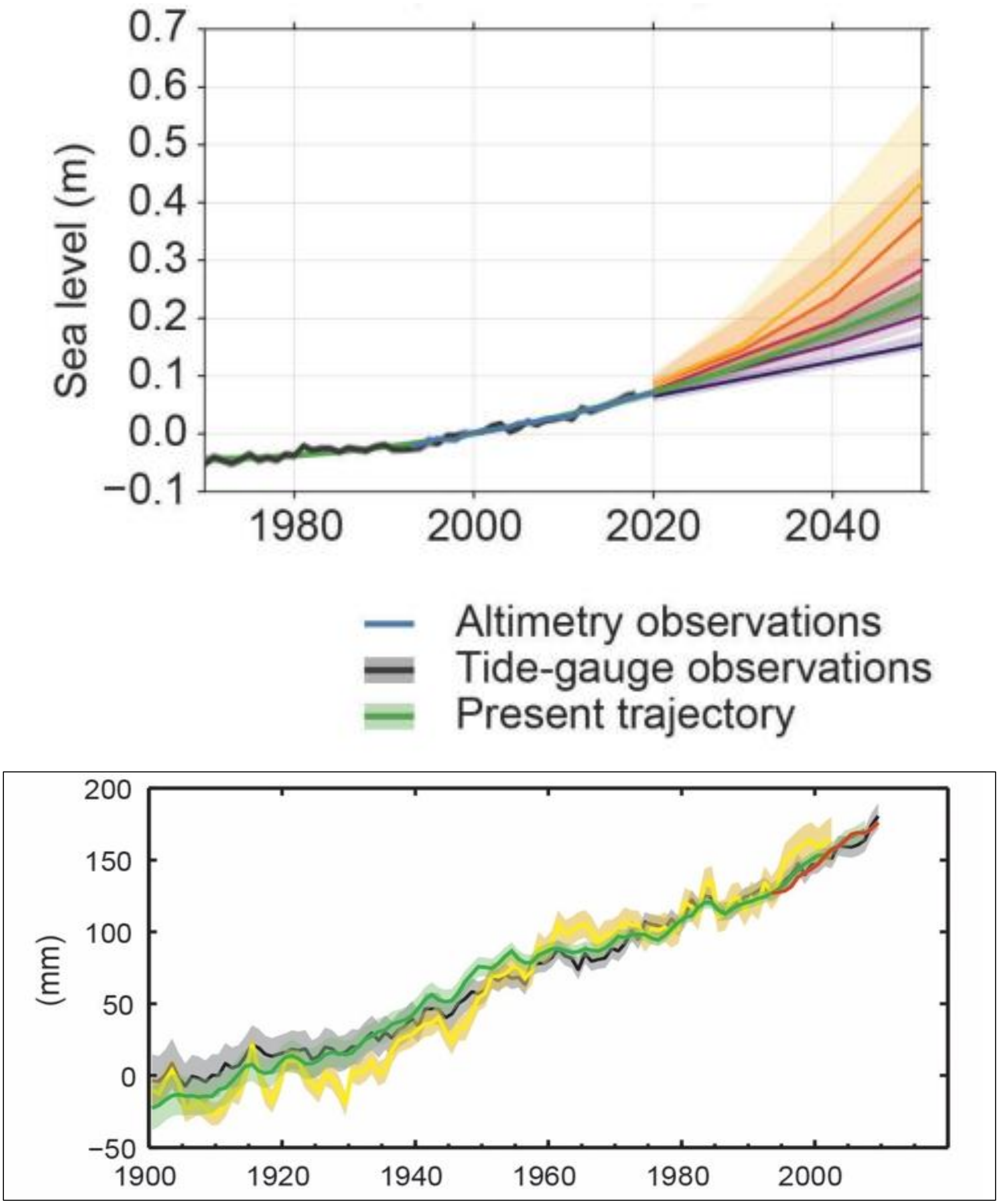
Table 11-1. Coastal Flooding and Erosion Events in California (2018 to 2022)

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties Impacted
January 16-20, 2018	Coastal Flood, High Surf	N/A	N/A	Orange, San Diego, San Francisco, Santa Cruz
Two rounds of large, long period northwest swells arrived at the beaches. High surf warnings were issued. Significant beach erosion was reported along with isolated coastal flooding.				
July 11, 2018	Coastal Flood	N/A	N/A	Orange
Minor coastal flooding occurred at high tide in Orange County. No damage to homes was reported.				
November 28-December 1, 2018	Erosion	N/A	N/A	Orange
A long period west-northwest swell brought high surf to Southern California beaches. Surf of 6-10 feet with sets to 12 feet were reported. Minor coastal flooding occurred. Beach erosion was reported during high surf, causing damage to the Boardwalk at Capistrano Beach in Dana Point. A walkway was severely damaged, palm trees were uprooted, and old buried cars were exposed.				
December 22-25, 2018	Coastal Flood	N/A	N/A	Marin, Humboldt
King tides impacted the coast. Low-lying areas and roadways were flooded. The Park and Ride lot in Manzanita Park in Mill Valley was closed. Portions of Shoreline Highway off 101 were closed by Caltrans.				
January 5, 2019	Coastal Flooding	N/A	N/A	San Francisco
Shallow thunderstorms developed over the coastal waters, some of which contained rotating cells. High tides and strong winds cause flooding on the Embarcadero in San Francisco causing officials to close it for a time.				

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties Impacted
January 16-20, 2019	Coastal Flooding	N/A	N/A	San Diego, Orange, San Francisco, Mendocino, Marin
High tides and surf brought large waves and coastal flooding to Southern California. Areas of the San Diego County coastline observed sets as high as 15 feet and significant coastal flooding. Orange County received significant coastal flooding. Many water rescues occurred due to the high surf and rip currents, and the Ocean Beach Pier in San Diego County saw extensive damage. High waves that coincided with high tides caused flooding on the Embarcadero where Pier 14 and one lane were shut down. High surf moved a large rock sea barrier in Mendocino County farther inland. Coastal flooding was reported in La Jolla Shores. King Tides flooded parking lots and roads in Sausalito and Mill Valley.				
November 15, 2020	Coastal Flooding	N/A	N/A	Humboldt, Marin
High tide at San Francisco reached 6.9 feet above sea level. Minor roadway flooding was observed in Sausalito. These high tides also brought rough seas to the coast. A person fell into the surf near Sutro Baths and drowned. Rough ocean conditions and the unusually high tide made for difficult search conditions. Minor roadway flooding occurred on Gate 5 Road in Sausalito. A parking lot on Shoreline Highway in Mill Valley experienced flooding				
December 13-15, 2020	Coastal Flooding	N/A	N/A	San Francisco, Marin, Monterey, San Diego
King Tides coincided with increased northwest swell. High tide at San Francisco exceeded 7 feet. The combination of these events led to minor flooding of low-lying coastal areas. Minor flooding occurred along the Embarcadero in San Francisco. The bike path between Sausalito and Mill Valley was flooded with seawater. Seawater flooded the walking patch at Salinas River State Beach near Moss Landing. The San Francisco Bay Trail north of the Oyster Point Marina was flooded. Moderate parking lot flooding was reported at Imperial Beach and Cardiff due to high King Tides.				
January 10-12, 2021	Coastal Flooding	N/A	N/A	Humboldt, San Francisco, Marin, Monterey
A large, long period swell produced large breaking surf along the coast and vulnerable coastal roads of northwest California. The large waves coincided with a high astronomical tide resulting in some minor coastal flooding. Flooding was reported in numerous locations, including Bucks Landing parking lot in Las Gallinas Creek, a parking lot at Lowrie Yacht Harbor, Manzanita Park and Ride near Sausalito, and Pier 14 in San Francisco.				

Source: (NOAA 2023a); (FEMA 2022u); (USDA 2022)

Figure 11-5. Global Sea-Level Rise Average



Source: (NOAA 2022)

11.4. PROBABILITY OF FUTURE HAZARD EVENTS

11.4.1. Overall Probability

The State is highly likely to experience some coastal flooding, erosion, and sea-level rise at least annually. California experienced 47 coastal flood events between 1996 and 2022—an average of nearly two events per year. Such events are likely to continue with at least that frequency in the future. Sea-level rise and erosion are ongoing long-term hazards and are expecting to continue their ongoing occurrence.

11.4.2. Climate Change Impacts

Coastal areas may be impacted by climate change in different ways. A warmer atmosphere means storms have the potential to be more intense and occur more often. Climate change also will result in sea-level rise. These changes will exacerbate coastal flooding and erosion and will have severe impacts along the California coast.

Coastal Flooding

The additive effects of high tides, storm surge, atmospheric patterns and large waves will be exacerbated by impacts from sea-level rise. This will likely increase the frequency of these events over time. The continued rise in sea level increases the risk of inundation in low coastal areas. Under sea-level rise scenarios, development adjacent to shoreline areas will be at increased risk of damage from everyday tidal conditions as well as storm events (Se-Hyeon Cheon 2016).

As sea-level rise continues, damaging floods that decades ago happened only during a storm will happen more regularly, such as during a full-moon tide or with a change in prevailing winds or currents (C. f. NOAA 2021c). In 2020, high tide flooding only occurred in the northern areas of the State. However, NOAA forecasts an increase in annual coastal flooding frequencies in the northern and southern ends of the State's coastal areas. By 2030, the national high-tide flood frequency is likely to be about 2 to 3 times greater than today without additional flood-management efforts. By 2050, it is likely to be 5 to 15 times higher, and potentially in some locations reaching nearly 180 days per year, effectively becoming the new high tide.

Erosion

According to the California Climate Adaptation Strategy, rising water levels and increased storm activity will increase coastal erosion, impacting beaches and cliffs throughout the State. Near-shore wave heights and wave energy will increase, intensifying the potential for storm damage, beach erosion, and bluff retreat. For example, a projected 31 to 67 percent of Southern California beaches are projected to be lost by the end of the century if adaptation actions are not implemented.

Sea-Level Rise

Sea-level rise is driven by climate change. As the planet warms, land ice melts and flows into the ocean. Ocean temperatures rise and thermal expansion takes place. Figure 11-6 shows sea-level rise projections by decade from the California Sea-Level Rise Guidance 2018 Update, based on various GHG emissions scenarios.

Figure 11-6. Projected Decadal Sea-Level Rise (in Feet) for San Francisco

		Probabilistic Projections (in feet) (based on Kopp et al. 2014)						H++ scenario (Sweet et al. 2017) *Single scenario
		MEDIAN	LIKELY RANGE			1-IN-20 CHANCE	1-IN-200 CHANCE	
		50% probability sea-level rise meets or exceeds...	66% probability sea-level rise is between...			5% probability sea-level rise meets or exceeds...	0.5% probability sea-level rise meets or exceeds...	
					Low Risk Aversion		Medium - High Risk Aversion	Extreme Risk Aversion
High emissions	2030	0.4	0.3	-	0.5	0.6	0.8	1.0
	2040	0.6	0.5	-	0.8	1.0	1.3	1.8
	2050	0.9	0.6	-	1.1	1.4	1.9	2.7
Low emissions	2060	1.0	0.6	-	1.3	1.6	2.4	
High emissions	2060	1.1	0.8	-	1.5	1.8	2.6	3.9
Low emissions	2070	1.1	0.8	-	1.5	1.9	3.1	
High emissions	2070	1.4	1.0	-	1.9	2.4	3.5	5.2
Low emissions	2080	1.3	0.9	-	1.8	2.3	3.9	
High emissions	2080	1.7	1.2	-	2.4	3.0	4.5	6.6
Low emissions	2090	1.4	1.0	-	2.1	2.8	4.7	
High emissions	2090	2.1	1.4	-	2.9	3.6	5.6	8.3
Low emissions	2100	1.6	1.0	-	2.4	3.2	5.7	
High emissions	2100	2.5	1.6	-	3.4	4.4	6.9	10.2
Low emissions	2110*	1.7	1.2	-	2.5	3.4	6.3	
High emissions	2110*	2.6	1.9	-	3.5	4.5	7.3	11.9
Low emissions	2120	1.9	1.2	-	2.8	3.9	7.4	
High emissions	2120	3	2.2	-	4.1	5.2	8.6	14.2
Low emissions	2130	2.1	1.3	-	3.1	4.4	8.5	
High emissions	2130	3.3	2.4	-	4.6	6.0	10.0	16.6
Low emissions	2140	2.2	1.3	-	3.4	4.9	9.7	
High emissions	2140	3.7	2.6	-	5.2	6.8	11.4	19.1
Low emissions	2150	2.4	1.3	-	3.8	5.5	11.0	
High emissions	2150	4.1	2.8	-	5.8	5.7	13.0	21.9

Source: (CNRA, OPC 2018)

An extreme scenario, labeled as H++, is included, based on rapid ice melt on Antarctica. The H++ rapid loss scenario projects a 10.2-foot increase by 2100 and a 21.9-foot increase by 2150. The California Sea-Level Rise Guidance 2018 Update also shows the probability of sea level meeting or exceeding particular heights for each decade from 2030 to 2150. An example for San Francisco is shown in Figure 11-7.

Figure 11-7. Probability that San Francisco Sea-Level Rise Will Meet or Exceed a Particular Height

SAN FRANCISCO - High emissions (RCP 8.5)

	Probability that sea-level rise will meet or exceed... (excludes H++)									
	1 FT.	2 FT.	3 FT.	4 FT.	5 FT.	6 FT.	7 FT.	8 FT.	9 FT.	10 FT.
2030	0.1%									
2040	3.3%									
2050	31%	0.4%								
2060	65%	3%	0.2%	0.1%						
2070	84%	13%	1.2%	0.2%	0.1%					
2080	93%	34%	5%	0.9%	0.3%	0.1%	0.1%			
2090	96%	55%	14%	3%	0.9%	0.3%	0.2%	0.1%	0.1%	
2100	96%	70%	28%	8%	3%	1%	0.5%	0.3%	0.2%	0.1%
2150	100%	96%	79%	52%	28%	15%	8%	4%	3%	2%

SAN FRANCISCO - Low emissions (RCP 2.6)

	Probability that sea-level rise will meet or exceed... (excludes H++)									
	1 FT.	2 FT.	3 FT.	4 FT.	5 FT.	6 FT.	7 FT.	8 FT.	9 FT.	10 FT.
2060	43%	1.4%	0.2%							
2070	62%	4%	0.6%	0.2%	0%					
2080	74%	11%	2%	0.4%	0.2%	0.1%				
2090	80%	20%	3%	1.0%	0.4%	0.2%	0.1%	0.1%		
2100	84%	31%	7%	2%	0.8%	0.4%	0.2%	0.1%	0.1%	
2150	93%	62%	31%	14%	7%	4%	2%	2%	1%	1%

Source: (CNRA, OPC 2018)

11.5. IMPACT ANALYSIS

11.5.1. Severity

As indicated by the descriptions in Table 11-1 of nine coastal flooding events between 2018 and 2021, coastal flooding in California has significant potential for harm to people and damage to property. High surf has been reported with wave sets up to 15 feet. Roads and private properties have been damaged by the flooding. At least one person caught in high surf has drowned, and several have required rescue.

Coastal erosion can result in significant economic loss through the destruction of buildings, roads, infrastructure, natural resources, and wildlife habitats. Damage often results from an episodic event with the combination of severe storm waves and dune or bluff erosion. Collapses of coastal bluffs and cliffs present significant dangers to beachgoers that may be injured or killed by falling sediment and rock. Development at the top of the bluff or cliff may be lost or require abandonment as coastal bluff and cliff erosion takes place (State of California 2022a).

A September 2006 USGS coastal beach erosion study for California (*Historical Shoreline Change and Associated Coastal Land Loss Along Sandy Shorelines of the California Coast*) concludes that, based on the net shoreline changes in the short-term (25 to 40 years), 66 percent of California´s beaches are eroding. Central California, which covers the area from Point Reyes to just north of Santa Barbara, shows the highest percentage of erosion. Long-term coastal shoreline change (using data gathered over the last 120 years) shows a trend of expansion, which is likely attributable to large scale coastal engineering and beach fill projects in Southern California and to a high influx of sediments from coastal rivers in Northern California. This study identified the statewide average net shoreline change rates for the long and short term as 0.2 meters per year and -0.2 meters per year, respectively (USGS 2006).

The severity of the sea-level rise hazard can be assessed by projected future levels of rise, with the most extreme scenario indicting more than 10 feet of sea-level rise by 2100. During the 20th century, average sea level rose only about 7 inches along most of California's coastline.

11.5.2. Warning Time

Coastal Flooding and Erosion

Coastal flooding and erosion events typically coincide with coastal storm events. These events are usually well forecast by NWS with up to several days of confident warning time.

Sea-Level Rise

Sea-level rise projections provide communities the ability to identify priorities for the most vulnerable locations and populations, keeping in mind that sea-level rise affects other coastal hazards such as erosion and flooding, as well as processes located a distance inland.

Sea-level rise forecasts extend out many decades but are dependent on the rate at which the planet warms, land ice masses collapse, and changes occur in land-water storage. Climate science evolves rapidly, and communities developing strategies to address sea-level rise should choose projections based on best available science at the time. The following are California's key sea-level rise guidance documents:

- California Sea-Level Rise Guidance 2018 Update (CNRA, OPC 2018) (a newer update is underway as of this SHMP update)
- 2017 Rising Seas in California: Update on Sea-Level Rise Science (OPC 2017)
- The California Coastal Commission's Sea-Level Rise Policy Guidance (California Coastal Commission 2018)

The California Sea-Level Rise Guidance recommends that decision makers use projections that assign a likelihood of occurrence to various sea-level rise heights and rates. Such projections are based on a range of scenarios for emissions of the GHGs that cause climate change and therefore sea-level rise. Because these projections may underestimate the likelihood of extreme sea-level rise (as would result, for example, from loss of the West Antarctic ice sheet), planning should include an extreme scenario for consideration for high stakes, long-term decisions.

11.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with sea-level rise, coastal flooding, and erosion:

- Loss of wetlands from erosion and wetland migration due to sea-level rise can reduce the natural filtration provided by wetland plants, increasing the likelihood of water quality issues.
- Healthy coastal ecosystems support fisheries, tourism, human health, and public safety. Many of these ecosystems are being transformed, degraded, or lost due in part to climate change, particularly sea-level rise and higher numbers of extreme weather events.
- As sea level continues to rise, repeated disruptions by coastal flooding will aggravate existing impacts on infrastructure, initiate cascading impacts on the larger economy, and burden people.
- Indirect economic costs (such as lost business) and adverse socio-psychological impacts have the potential to negatively affect people and their communities.
- Individuals exposed to weather- or climate-related disasters have been shown to experience negative mental health impacts. Among those most likely to suffer these impacts are some of society's most vulnerable populations, including older adults, people who are economically or transportation disadvantaged, or experiencing homelessness.
- Saltwater intrusion into drinking water sources can result in the need for water utilities to increase treatment, relocate water intakes, or develop alternate sources of fresh water. Saltwater intrusion, through surface water or groundwater sources, may diminish the availability or quality of source waters for drinking water utilities.
- Sea-level rise and associated coastal flooding could impact at least 400 hazardous facilities. These facilities, which include power plants, refineries, industrial facilities, and hazardous waste sites, have the potential to release hazardous pollutants into floodwater and nearby communities during a flood event. This could lead to adverse health impacts for residents exposed to hazardous pollutants. Coastal communities with more low-income residents and communities of color are disproportionately located near facilities at risk of spilling hazardous materials during a coastal flooding event (Rattini 2022).

11.5.4. Environmental Impacts

Most ecosystems that could be impacted by coastal flooding are able to quickly recover from a coastal flooding event with minor impacts. Examples of these ecosystems include wetlands and beaches.

Sea-level rise and long-term erosion can result in migration of ecosystems inland. If beaches, wetlands, and other coastal habitats are unable to migrate inland as sea levels rise—because of sediment availability, shoreline armoring, or other development that blocks natural migration—they can be lost to permanent inundation or degraded by saltwater intrusion. This can have resulting impacts related to land subsidence, loss of habitat for fish and wildlife, and loss of aesthetic, recreational, and commercial uses. Such loss would also mean the loss of important ecosystem services. For example, intact wetlands serve as a buffer to flooding events by increasing flood capacity, recharging groundwater, protecting water quality, and providing water supply reliability.

When wetlands are able to migrate inland, it can help to preserve wetland acreage, but it comes at the expense of the former inland habitats that the wetlands replace.

11.5.5. Local Hazard Impacts

LHMP Rankings

Twenty of the hazard mitigation plans prepared for California's 58 counties list climate change as a hazard of concern, and 11 counties rank coastal hazards as a hazard of concern. The following counties rank these hazards as high impact hazards:

- Counties ranking climate change as a high impact hazard:
  - Alameda
  - Colusa
  - Los Angeles
  - Madera
  - Mariposa
  - Napa
  - Nevada
  - Santa Cruz
  - Tulare
  - Yolo

- Counties ranking coastal hazards as a high impact hazard:
  - San Mateo
  - Santa Barbara
  - Santa Cruz

LHMP Estimates of Potential Loss

Table 11-2 summarizes potential losses to vulnerable structures based on estimates from the local risk assessments (as called for in FEMA's Standard State Mitigation Planning Requirement S6.b). Due to variances in approaches to assessing risk at the local level as well as the hazards assessed and the age of each assessment reviewed, this data is considered approximate.

Table 11-2. Coastal Flood Risk Exposure Analysis for LHMP Reviews

Estimated Total Population Exposed	262,461
Estimated Number of Structures at Risk	54,607
Estimated Value of Structures at Risk	$13.67 billion

11.6. VULNERABILITY ANALYSIS

The vulnerability of State assets was based on the exposure of facilities and infrastructure to three spatial hazard data sets: coastal flooding; 2050 sea-level rise (SLR 2050); and 2100 sea-level rise (SLR 2100).

11.6.1. Exposure of State-Owned or -Leased Facilities

The statewide exposures of State-owned or -leased facilities and infrastructure to the coastal flooding, 2050 sea-level rise, and 2100 sea-level rise hazards are summarized in Table 11-3, and Table 11-4. Figure 11-8, Figure 11-9, and Figure 11-10 summarize the exposed assets as a percentage of total assets statewide. Appendix I provides detailed results by county.

Table 11-3. State-Owned or -Leased Facilities Exposed to Sea-Level Rise and Coastal Flooding

Type of Facility	Number of Structures	Total Area (sq. ft.)	Replacement Cost Value		
			Structure	Content	Total
State Facilities in the Mapped Coastal Flood Zone					
State-Leased Facilities	5	—	$5,680,089	$6,126,168	$11,806,257
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	0	0	0	0	0
Development Center	0	0	0	0	0
Hospital	0	0	0	0	0
Migrant Center	0	0	0	0	0
Special School	0	0	0	0	0
All Other Facilities	76	60,175	$4,435,116	$3,307,192	$7,742,308
Total State-Owned	***76***	***60,175***	*$4,435,116*	*$3,307,192*	*$7,742,308*
Total Facilities	**81**	**N/A***	**$10,115,205**	**$9,433,360**	**$19,548,565**
State Facilities in the Mapped 2050 Sea-Level Rise Inundation Zone					
State-Leased Facilities	19	--	$63,392,405	$63,161,399	$126,553,804
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	0	0	$0	$0	$0
Development Center	0	0	$0	$0	$0
Hospital	0	0	$0	$0	$0
Migrant Center	0	0	$0	$0	$0
Special School	0	0	$0	$0	$0
All Other Facilities	112	209,946	$23,580,238	$26,378,504	$49,958,742
Total State-Owned	*112*	*209,946*	*$23,580,238*	*$26,378,504*	*$49,958,742*
Total Facilities	**131**	**N/A***	**$86,972,643**	**$89,539,903**	**$176,512,546**

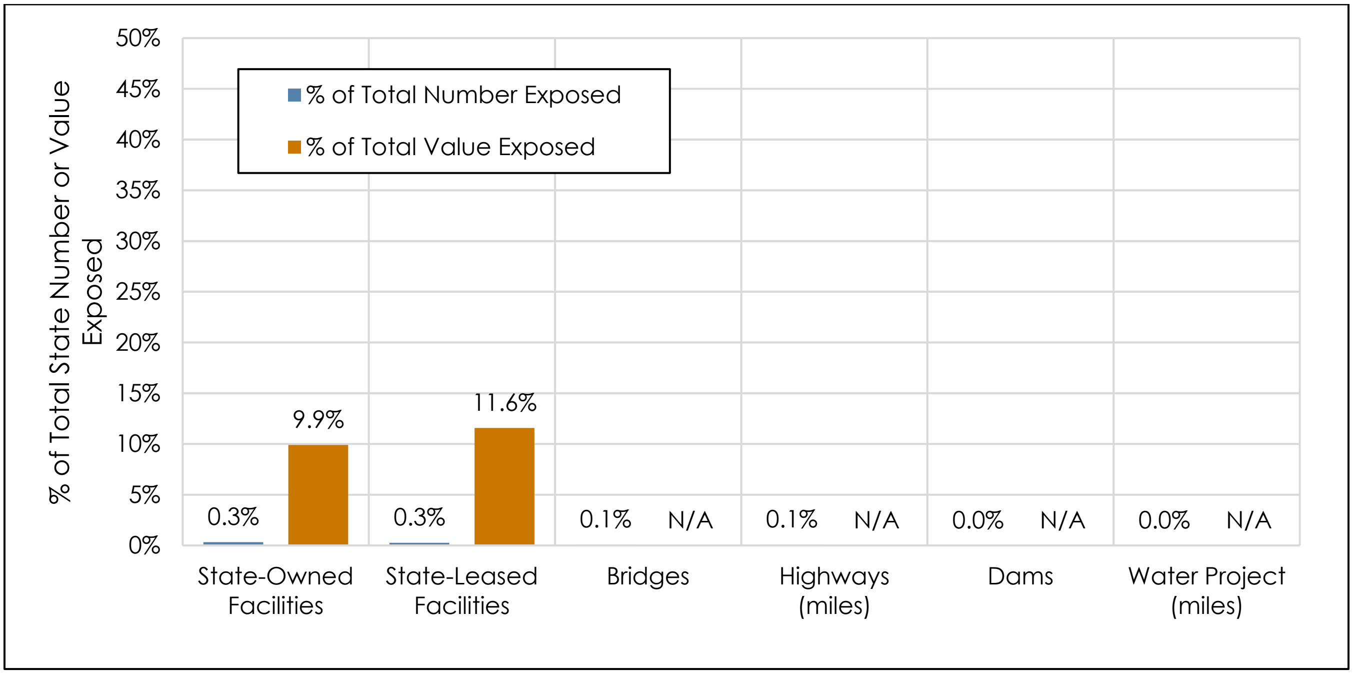
Type of Facility	Number of Structures	Total Area (sq. ft.)	Replacement Cost Value		
			Structure	Content	Total
State Facilities in the Mapped 2100 Sea-Level Rise Inundation Zone					
State-Leased Facilities	21	--	$38,705,790	$40,044,025	$78,749,815
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	0	0	$0	$0	$0
Development Center	0	0	$0	$0	$0
Hospital	0	0	$0	$0	$0
Migrant Center	0	0	$0	$0	$0
Special School	0	0	$0	$0	$0
All Other Facilities	387	1,434,595	$464,965,753	$444,391,423	$909,357,177
Total State-Owned	*387*	*1,434,595*	*$464,965,753*	*$444,391,423*	*$909,357,177*
Total Facilities	**408**	**N/A***	**$503,671,543**	**$484,435,448**	**$988,106,991**

* The inventory of State assets does not include building area for State-leased facilities, so no total area for all State facilities is provided; the building area of vulnerable assets is shown for State-owned facilities only.

Table 11-4. State-Owned Infrastructure Exposed to Sea-Level Rise and Coastal Flooding

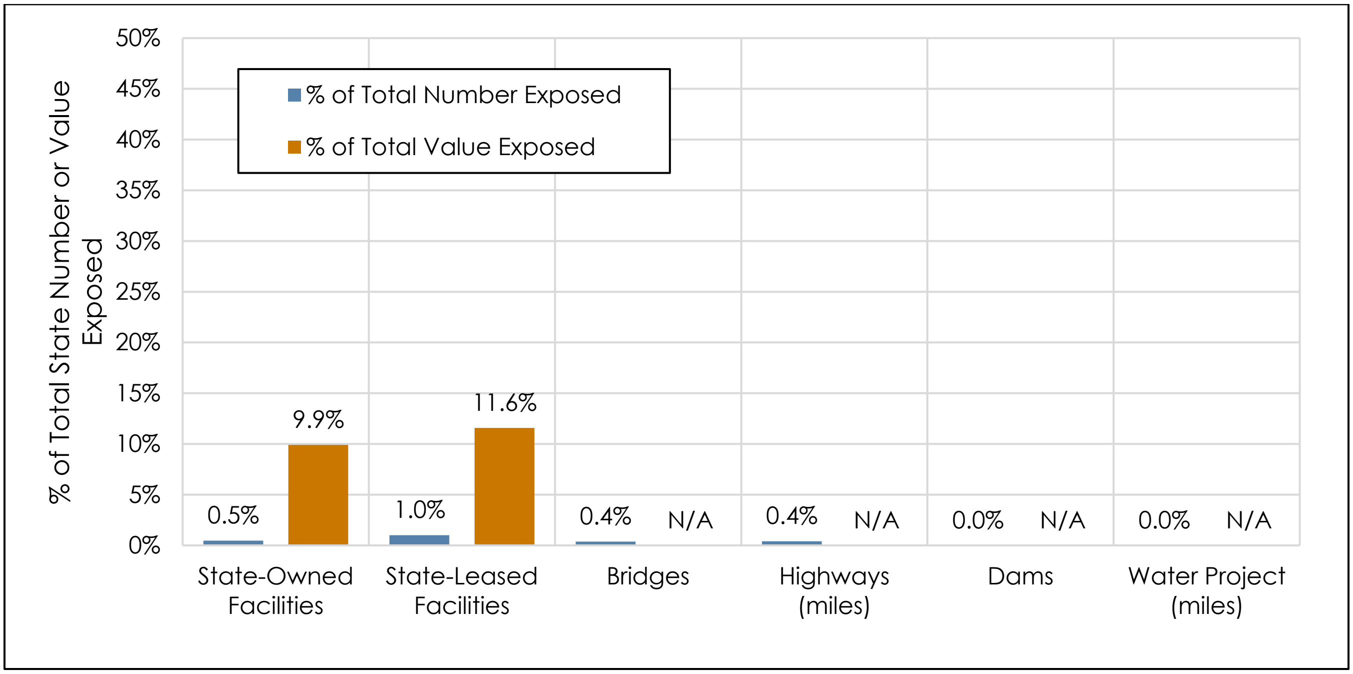
Type of Facility	State-Owned Infrastructure in the Mapped Hazard Area		
	Coastal Flood	2050 Sea-Level Rise	2100 Sea-Level Rise
Bridges	10	50	114
Highway (miles)	19.8	123	274.5
Dams	0	0	0
Water Project (miles)	0	0	0

Figure 11-8. State Assets Exposed to Coastal Flood, as % of Statewide Total



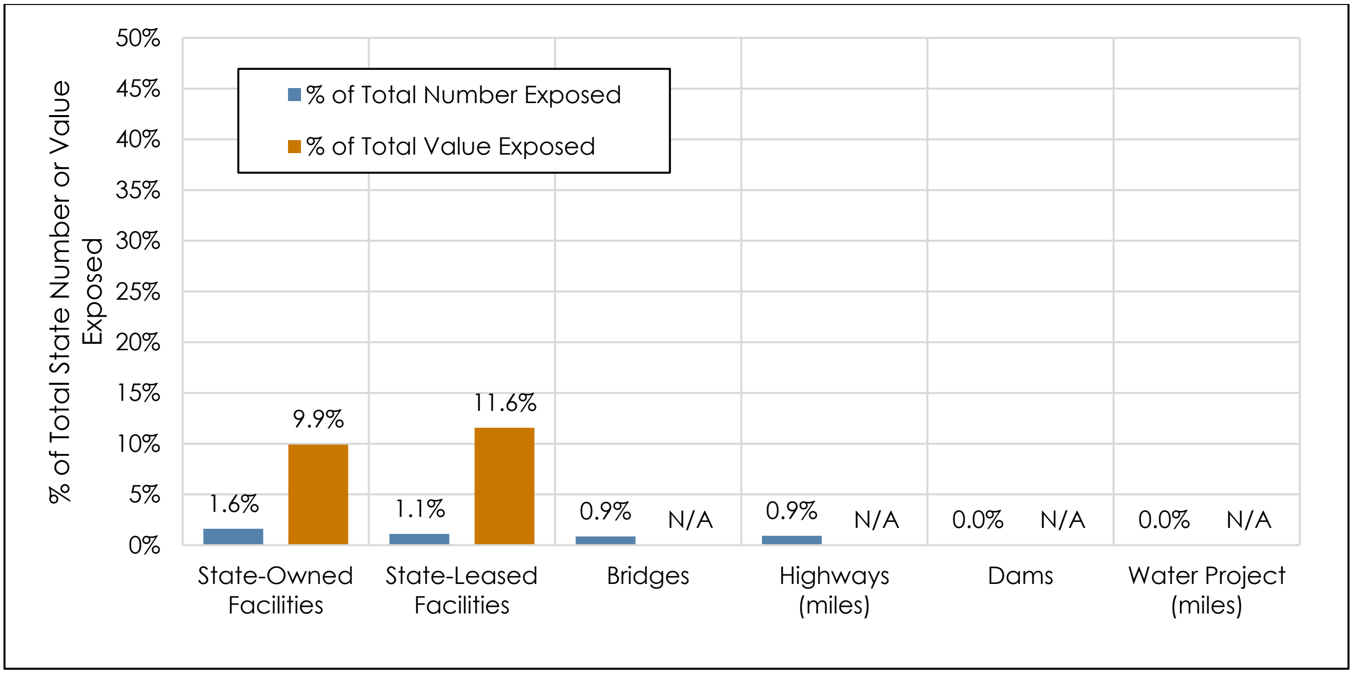
N/A: Values not defined for bridges, highways, dams, and water project

Figure 11-9. State Assets Exposed to Projected 2050 Sea-Level Rise, as % of Statewide Total



N/A: Values not defined for bridges, highways, dams, and water project

Figure 11-10. State Assets Exposed to Projected 2100 Sea-Level Rise, as % of Statewide Total



N/A: Values not defined for bridges, highways, dams, and water project

The following are significant results of the analysis of State-owned assets in mapped coastal flooding and sea-level rise inundation areas:

- For facilities that the State owns within the coastal flood zone, the average building area is 792 square feet, with an average replacement cost value of $101,872 (for both structure and contents).
- For facilities that the State owns within the SLR 2050 hazard zone, the average building area is 2,738 square feet, with an average replacement cost value of $505,600 (for both structure and contents).
- For facilities that the State owns within the SLR 2100 hazard zone, the average building area is 2,928 square feet, with an average replacement cost value of $1.3 million (for both structure and contents).
- The average replacement cost value for State-leased facilities within the coastal flood zone is $2.4 million (for both structure and contents).
- The average replacement cost value for State-leased facilities within the SLR 2050 hazard zone is $6.7 million (for both structure and contents).
- The average replacement cost value for State-leased facilities within the SLR 2100 Hazard zone is $5.3 million (for both structure and contents).
- The State agency with the most State-owned or -leased facilities within the coastal flood zone is State Parks (78).
- The State agencies with the most State-owned or -leased facilities within the SLR 2050 hazard zone are CDFW (66), State Parks (29) and Caltrans (13).
- The State agencies with the most State-owned or -leased facilities within the SLR 2100 hazard zone are the District Agricultural Associations (150). State Parks (134), C (74), Caltrans (23) and CHP (4).
- The State agency with the highest total replacement cost for State-owned or -leased facilities within the coastal flood zone is CDFW at $10.8 million.
- The State agency with the highest total replacement cost for State-owned or -leased facilities within the SLR 2050 zone is CDFW at $42.1 million.
- The State agency with the highest total replacement cost for State-owned or -leased facilities within the SLR 2100 zone is the District Agricultural Associations at $761 million.

11.6.2. Exposure of Critical Facilities and Community Lifelines

The Risk Assessment identified four critical facility and community lifelines within the coastal flood hazard zone, all of them under the "transportation" category. The facilities include one each in Humboldt, San Diego, San Francisco, and San Mateo counties.

The Risk Assessment identified 114 critical facility and community lifelines within the SLR 2050 hazard zone. The "transportation" lifeline category accounts for 67 percent of these, and "food, water, and shelter" accounts for 21 percent. The County with the largest percentage of these facilities is San Mateo (26.3 percent,) followed by Alameda (15.7 percent) and San Diego (15.7 percent).

The Risk Assessment identified 200 critical facility and community lifelines within the SLR 2100 hazard zone. The "transportation" lifeline category accounts for 65 percent of these, "food, water, and shelter" accounts for 16 percent, and "energy" accounts for 8 percent. The County with the largest percentage of these facilities is Alameda (24 percent,) followed by San Francisco (18 percent) and San Mateo (18 percent).

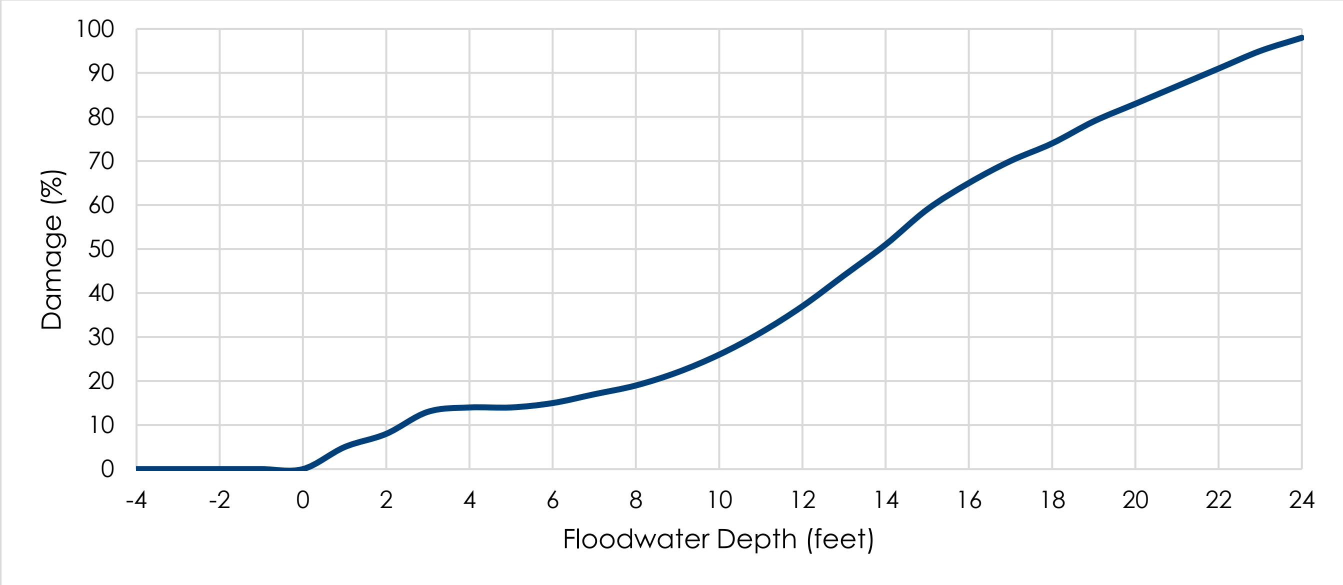
For a detailed breakdown of facility counts by County see Appendix I.

Critical facilities and community lifelines that are exposed to the sea-level rise, coastal flooding, and erosion hazards are likely to experience functional downtime following these events, which could increase the net impact of these events. Hazus estimates damage and functional downtime for flooding scenarios. Local governments are encouraged to use tools such as Hazus when creating or updating their LHMPs.

11.6.3. Estimates of Loss

Loss estimations for hazard events that cause flooding typically use an approach that correlates damage to the depth of flood water impacting a structure and the time of inundation. USACE has established depth/damage correlations based on analysis of the impacts historical flood events have had on the built environment. The assessment of potential loss associated with riverine flooding for this SHMP used the USACE depth-damage curve for facilities with "average government function" (see Figure 11-11).

Figure 11-11. Depth/Damage Curve for "Average Government Function" Occupancy



Source: Data exported from Hazus model

Table 11-5 shows the resulting estimates of potential damage to State-owned or -leased facilities in the SLR 2050 hazard zone per foot of flood depth, up to the flood depth that would trigger substantial damage (50 percent of replacement cost value).

Table 11-5. Estimates of Flood Loss for Facilities in the SLR 2050 Hazard Zone

Flood Depth (feet)	Estimates of Flood Loss*		
	State-Owned	State-Leased	Total
1	$23,248,288	$1,935,290	**$25,183,579**
2	$36,397,260	$3,096,463	**$39,493,725**
3	$60,445,548	$5,031,753	**$65,477,304**
4	$65,095,205	$5,418,811	**$70,514,020**
5	$65,095,205	$5,418,811	**$70,514,021**
6	$69,744,863	$5,805,869	**$75,550,738**
7	$79,044,178	$6,579,984	**$85,624,169**
8	$88,343,493	$7,354,100	**$95,697,601**
9	$102,292,466	$8,515,274	**$110,807,749**
10	$120,891,096	$10,063,505	**$130,954,611**
11	$144,139,383	$11,998,795	**$156,138,189**
12	$172,037,329	$14,321,142	**$186,358,483**
13	$204,584,931	$17,030,548	**$221,615,492**
14	$237,132,534	$19,229,953	**$256,362,501**

* Structure Losses only. Does not include contents or inventory losses.

Sea-level rise threatens many aspects of the coastal economy and California's broader economy, including coastal-related tourism, beach and ocean recreational activities, transfer of goods and services through ports and transportation networks, coastal agriculture, and commercial fishing and aquaculture. Sea-level rise will create difficulties for ports and harbors by affecting cargo transfer capability as ships ride higher along docks and by affecting transfer between roads or railways and docks.

11.6.4. Buildable Lands

Of the 11.7 million acres of land available for development in California, 0.05-percent (5,773 acres) is within the coastal flood hazard zone, 0.2-percent (24,014 acres) is in the SLR 2050 hazard area, and 0.29-percent (34,715 acres) is in the SLR 2100 hazard zone.

Any type of development in these areas will be susceptible to damage associated with coastal flood and sea-level rise. The combination of these two impacts will also impact the frequency and severity of areas along the California coast susceptible to coastal erosion. As a strong growth management state as well as strong participation in the NFIP, the State is well equipped with regulatory oversight of new development that may occur within these buildable lands.

11.6.5. Equity Priority Communities

The cost of interventions to protect properties from coastal flooding and erosion risk may financially stress lower- or middle-income residents. Relocating may be difficult because of the expenses and the availability of accessible housing or the time needed to make housing accessible. Tribal Nations and indigenous populations along the coast are at risk of losing access to culturally significant sites or plants and animals that hold cultural significance as a source of traditional medicine, ceremony, or subsistence (OPC 2022, OEHHA 2022c). Additionally, Tribal Nations may not have access to the resources or funds to relocate Tribal Nation members.

The population over the age of 65 is more vulnerable and, physically, may have more difficulty evacuating during severe coastal flooding and erosion events. They may require extra time or outside assistance during evacuations and are more likely to seek or need medical attention, which may not be available due to isolation during a flood event (U.S. EPA 2021).

The risk analysis for sea-level rise, coastal flooding and coastal erosion found the following vulnerability of equity priority communities (a breakdown of by county is included in Appendix I):

- 3 percent of people living in the coastal flood hazard zone live in equity priority communities (226 people)
- 8.5 percent of people living in the SLR 2050 hazard zone live in equity priority communities (16,465 people)
- 10.9 percent of people living in the SLR 2100 hazard zone live in equity priority communities (228,484 people)

11.6.6. NRI Scores

According to the NRI, 19 of the State's counties have coastal flooding risk, rated from very low to relatively moderate. Table 11-6 shows scores for the six counties with the highest rating. See Section 4.1.3 for a description of the components of the NRI.

Table 11-6. NRI Scoring of Counties for Coastal Flooding

County	Expected Annual Loss	Social Vulnerability Rating	Community Resilience Rating	Community Risk Factor	Risk Value	Score
Humboldt	$4,308,641	Very High	Relatively Moderate	1.36	$6,478,232	93.96
Marin	$3,801,318	Relatively Low	Very Haigh	1.02	$4,161,749	89.54
San Mateo	$1,626,573	Relatively Low	Very High	1.05	$1,858,026	79.88
Santa Clara	$1,001,237	Relatively Low	Relatively High	1.11	$1,119,806	74.04
Solano	$680,780	Relatively High	Very High	1.18	$1,002,823	72.64
Alameda	$875,558	Relatively Moderate	Very High	1.13	$977,693	72.23

11.7. MITIGATING THE HAZARD

11.7.1. Opportunities for Mitigating the Hazard

A range of potential opportunities for mitigating the sea-level rise, coastal flooding and erosion hazard is provided in Table 11-7. See Section 1.2.3 for a description of the different types of alternatives.

Table 11-7. Potential Opportunities to Mitigate the Sea-Level Rise, Coastal Flood, and Erosion Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ Barriers (sea wall), only when no nature-based alternative is feasible ▪ Pumps ▪ Protect, preserve, and restore beaches and dunes **Reduce exposure and vulnerability:** ▪ Voluntary retreat ▪ Elevate on fill above sea-level rise elevation ▪ Elevate utilities above base flood elevation ▪ Use low-impact development ▪ Elevate ▪ Floodproof **Build local capacity:** ▪ Buy flood insurance	**Manipulate the hazard:** ▪ Barriers (sea wall), only when no nature-based alternative is feasible ▪ Pump stations ▪ Protect, preserve, and restore wetlands ▪ Protect, preserve, and restore beaches and dunes **Reduce exposure and vulnerability:** ▪ Relocate out hazard zone ▪ Elevate on fill above sea-level rise elevation ▪ Locate critical facilities or functions outside hazard area ▪ Use low-impact development techniques ▪ Build redundancy for critical functions or retrofit critical buildings ▪ Maintain drainage facilities that service your property	**Manipulate the hazard:** ▪ Barriers (sea wall), only when no nature-based alternative is feasible ▪ Pump Stations ▪ Protect, preserve, and restore wetlands ▪ Protect, preserve, and restore beaches and dunes **Reduce exposure and vulnerability:** ▪ Buyout/Relocation Program ▪ 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 ▪ Acquire vacant land or promote open space uses in developing watersheds to control increases in runoff ▪ Harden infrastructure ▪ Provide redundancy for critical infrastructure nodes and systems ▪ Higher regulatory standards in sea-level rise zones ▪ Facilitate managed retreat from, or upgrade of, the most at-risk areas ▪ Implement tree management programs ▪ Elevate roads that are vital/critical to evacuation and local community operations ▪ Include nature-based elements in infrastructure adaptation projects (e.g., roads) such as living shorelines, ecotone levees, and habitat restoration to increase resilience ▪ Design or enhance existing drainage systems for higher design storms to provide increased capacity of the drainage system

Community-Scale	Organizational Scale	Government-Scale
▪ Develop household plan, such as retrofit savings, 72-hour self-sufficiency during and after an event	▪ Provide flood-proofing when new critical infrastructure must be located in floodplains **Build local capacity:** ▪ Be informed and understand future impacts of sea-level rise on your business ▪ Develop a Continuity of Operations Plan	▪ Maintain the drainage infrastructure to levels that equal or exceed their design specifications ▪ Require accounting of sea-level rise in all applications for new development in shoreline areas **Build local capacity:** ▪ Provide technical information and guidance ▪ Promote the purchase of flood insurance ▪ Enact tools to help manage development in hazard areas (stronger controls, tax incentives, information) ▪ Incorporate retrofitting or replacement of critical system elements in capital improvement plan ▪ Develop strategy to take advantage of post-disaster opportunities ▪ Provide incentives to guide development away from hazard areas or to retrofit in place ▪ Provide residents with sea-level rise inundation maps
Nature-based opportunities ▪ Restore wetlands, marshes, mudflats, oyster reefs, dunes, beaches, eelgrass, kelp forests, living shorelines and other coastal habitats to enhance resilience and reduce wave impacts during storms ▪ Preserve/restore tidal marshes to enhance resilience and provide multiple benefits, including absorbing floodwaters and reducing wave impacts during storms ▪ Conserve and protect coastal habitat and non-habitat areas suitable for habitat restoration ▪ Establish living shorelines (natural elements including plants, reefs, and oyster beds) to prevent erosion ▪ Incentivize voluntary retreat from coastal hazard areas		

11.7.2. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address sea-level rise, coastal flooding, or coastal erosion:

- Action 2018-006: Enhance Collaboration on the Development and Sharing of Data Systems and GIS Modeling.
- Action 2018-008: Develop a database containing a description of the specific natural hazard event for which each project was designed to mitigate.
- Action 2018-050: Sea-Level Rise Guidance: Provide guidance on factors to consider in projecting sea- level rise, potential impacts, and adaptation strategies.
- Action 2018-051: State Agency Adaptation Planning: Assess vulnerability of State assets to sea-level rise and develop adaptation strategies to address potential impacts.

Landslide, Debris Flow and Other Mass Movements

Climate Impacts:
More intense rainfall events can increase landslide frequency

Equity Impacts:
2.7% of the exposed population (those living in mapped landslide hazard areas) identified as living in equity priority communities

State Facilities Exposed:
3,626 facilities in high landslide hazard areas; 85 facilities in very high landslide hazard areas; 30 facilities in landslide hazard zones

Community Lifelines Exposed:
Four lifelines in landslide hazard zones based on the data used for this assessment.

Impact Rating: High (30)

12. Landslide, Debris Flow, & Other Mass Movements

The landslide, debris flow, and other mass movements hazard has been identified as a high-impact natural hazard of interest based on the hazard impact rating protocol applied for this SHMP. Events associated with this hazard happen frequently in the State and about 14 percent of State-owned or -leased facilities and community lifelines are exposed. Approximately 1.57 percent of the State's population is exposed, and more than 2.7 percent of that population has been identified as living in equity priority communities. Over 5 percent of identified buildable lands in the State intersect mapped landslide, debris flow and other mass movement hazard areas. These values represent minimum values because landslide, debris flow, and other mass movement hazards have not been mapped for the entire State. The frequency and severity of this hazard is anticipated to increase over the next 30 years due to the impacts from climate change.

12.1. HAZARD OVERVIEW

A landslide is the downslope movement of a mass of rock, debris, or earth down a slope under the direct influence of gravity (Cruden and Varnes 1996). Landslides can travel at speeds ranging from fractions of an inch per year to tens of miles per hour depending on the slope steepness and the rock and soil mass's water content. Landslides range from the size of an automobile to a mile or more in length and width. Due to their sheer weight and speed, they can cause serious damage and loss of life.

More than one-third of California is hilly and mountainous terrain that runs parallel to the coast, forming a barrier that captures moisture from offshore storms. Moderate to steep topography, weak rocks, heavy winter rains, wildfires, and earthquakes all lead to slope failures more frequently than would otherwise occur under gravity alone.

12.1.1. Deep-Seated Landslides

Deep-seated landslides (greater than 10 to 15 feet deep) tend to be triggered by deep infiltration of rainfall over a period of weeks to months, earthquake shaking, or the combination of both rainfall and earthquakes (Wieczorek 1996). Some deep-seated landslides move very slowly, though others can move quickly and with little notice. These landslides generally cause extensive property damage and major impacts on the State's infrastructure.

General Landslide Types

The California Department of Conservation (DOC) categorizes landslides into the following types:

- **Earth Flows**—Landslides made mostly of fine-grained, cohesive silt or clay that commonly occur on moderately steep slopes (10 to 30 percent grade), often triggered by prolonged rainfall. Earth flows move as slow as several centimeters or millimeters per day over a period of days to weeks.
- **Debris Flows**—Landslides made mostly of coarse-grained, non-cohesive fine sand to boulder-sized particles, triggered by intense rainfall after a dry period or by rapid snow melt. Debris flows are often small, and vegetation tends to grow back over their path rapidly.
- **Debris Slides**—Landslides made mostly of coarse-grained sandy or gravelly soil, usually occurring after heavy rainstorms on very steep slopes (60 to 70 percent grade) in areas where the base of a slope is undercut by erosion. Debris slides form steep scars that are likely to remain un-vegetated for years.
- **Rockslides**—Bedrock that largely stays intact for at least part of the landslide event. Rockslides occur in a variety of sizes on a variety of gradients (35 to 70 percent grade).
- **Rock Falls**—A landslide where a mass of rock detaches from a steep slope and descends mainly by falling, rolling, or bouncing through the air. Rock falls can be triggered by heavy rain, earthquakes, or freeze-thaw events, and tend occur on steep slopes. Scarring from a rock fall may not be visually distinct from the intact rock surrounding it, and the rubble it leaves at the bottom of a slope can dissipate by erosion.

Source: (DOC 2019)

12.1.2. Alluvial Fans and Debris Flows

Alluvial fans are geologic features built by runoff spreading out on a broad fan-like surface (see Figure 12-1) as successive debris-laden floods or debris flows are deposited (Harvey 2018). They range from small features on the order of an acre, to massive landforms that are visible from space. The processes that form these landforms become increasingly active with the occurrence of earthquakes, wildfires, and strong winter weather.

Figure 12-1. Debris Flows Spread Out on an Alluvial Fan in the Santa Rosa Mountains

Source: Jeremy Lancaster, California Geological Survey

As residential and business land uses have expanded onto mountain-front alluvial fan areas, more lives and property are at risk from debris-laden floods and debris flows in alluvial fan areas (see Figure 12-2).

Debris Flows Related to Shallow Landslides

The first type of debris flow occurs on hillslope due to soil failure in which soil liquefies and runs downhill. This type of debris flow generally results from a shallow landslide (less than 10 to 15 feet deep) and has a discrete initiation zone and depositional area.

Figure 12-2. A Santa Clara County Debris Flow Triggered by Storms Following the Loma Fire, 2017

Source: Brian Swanson, California Geological Survey

Shallow landslides tend to occur in winter but are most likely after prolonged periods of heavy rainfall when soil materials are saturated. Debris flows are typically more dangerous because they are fast moving, causing both property damage and loss of life.

According to the USGS, about 10 inches of seasonal rain is necessary for ground saturation in Southern California, and once the ground is saturated, as little as 0.2 inches of rain per hour can trigger a debris flow that deposits material on an alluvial fan (USGS 1975).

Post-Wildfire Debris Flows

The second type of debris flow is a result of post-fire conditions, where burned soil surfaces enhance rainfall runoff that concentrates and picks up debris as it moves. A post-fire debris flow has a less discrete initiation zone but is similar to a debris flow derived from hillslopes, in that it may result in a fast-moving flow, inundation, and a detrimental impact on lives and property within its zone of runout and deposition. It is also often the case that waves of muddy water follow the initial debris flow surges, causing additional flooding downstream.

Debris flows often start in areas that experienced wildfires during the previous fire season (California Water Science Center 2018). Research by the USGS in the western United States has refined the understanding of debris flows generated from recently burned watersheds (NOAA-USGS Debris Flow Task Force 2005). Post-fire debris flow hazards assessments prepared by the USGS can be found at the USGS debris flow website (USGS 2022j).

12.1.3. Earthquakes and Landslides

Although less frequent, the most devastating landslides worldwide have been triggered by earthquakes. Strong ground shaking can create the additional forces necessary to weaken slopes and cause those already distressed by gravity to fail. One of the most significant earthquake-related landslide disasters in history occurred in 1920 in central China, where an estimated magnitude 8.5 earthquake caused weak slopes to collapse into a densely populated valley, killing an estimated 180,000 people.

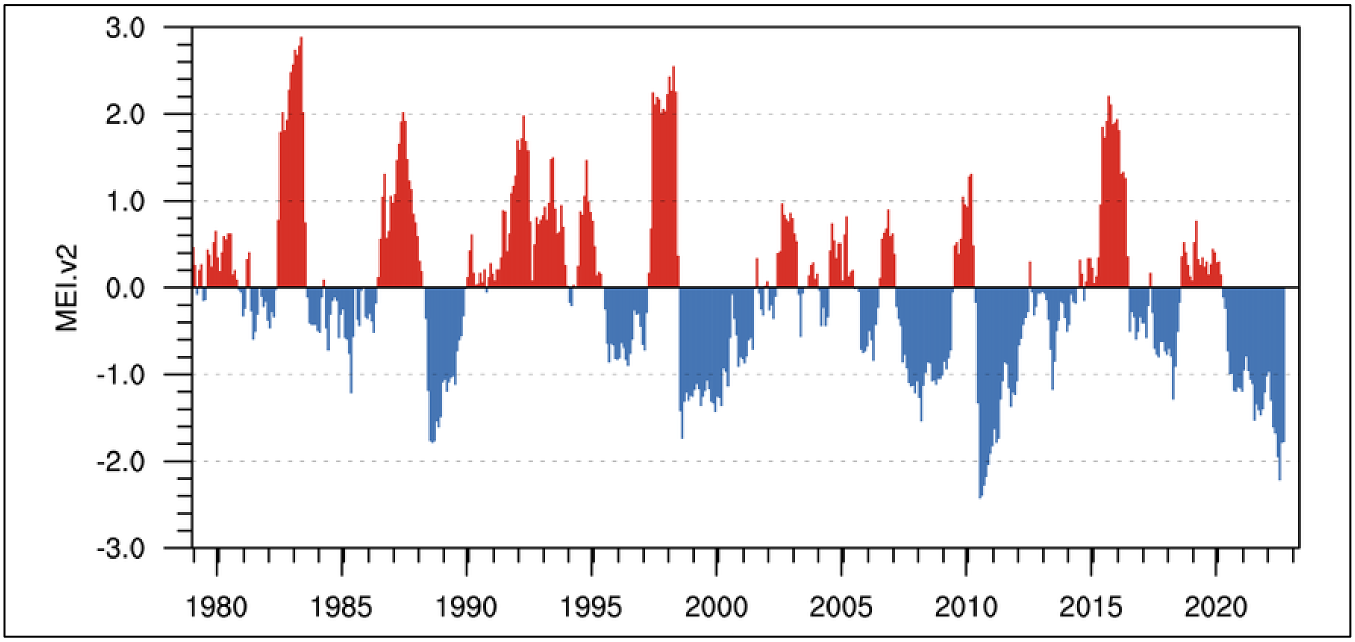
Earthquake shaking can also rapidly weaken loose water-saturated sediments via liquefaction, which can greatly increase ground deformation and sliding, even on gentle slopes. This happened during the 1971 San Fernando Earthquake, when the soil beneath two earth-fill dams partially liquefied and shifted, causing partial collapse of both facilities. Those events resulted in over a half-billion dollars in damage and the temporary evacuation of 80,000 people below the dam.

12.1.4. Rainfall and Landslides

A statewide pattern of landslide occurrences repeats itself during heavy winter seasons, which may coincide with numerous atmospheric rivers making landfall. This can occur during both El Niño Southern Oscillation and La Niña settings in the Pacific Ocean. (California Coastal Commission 2019). (L'Heureux 2014).

Figure 12-3 shows a history of El Niño occurrences using the Multivariate El Niño-Southern Oscillation index (v2). The red regions (above the 0.0 line) correspond to warmer sea surface temperatures, which bring unusually moist air into the north Pacific, producing wetter winters and more intense landslide and debris flow activity in California.

Figure 12-3. Multivariate El Niño Southern Oscillation Index



Source: (NOAA Physical Sciences Laboratory n.d.)

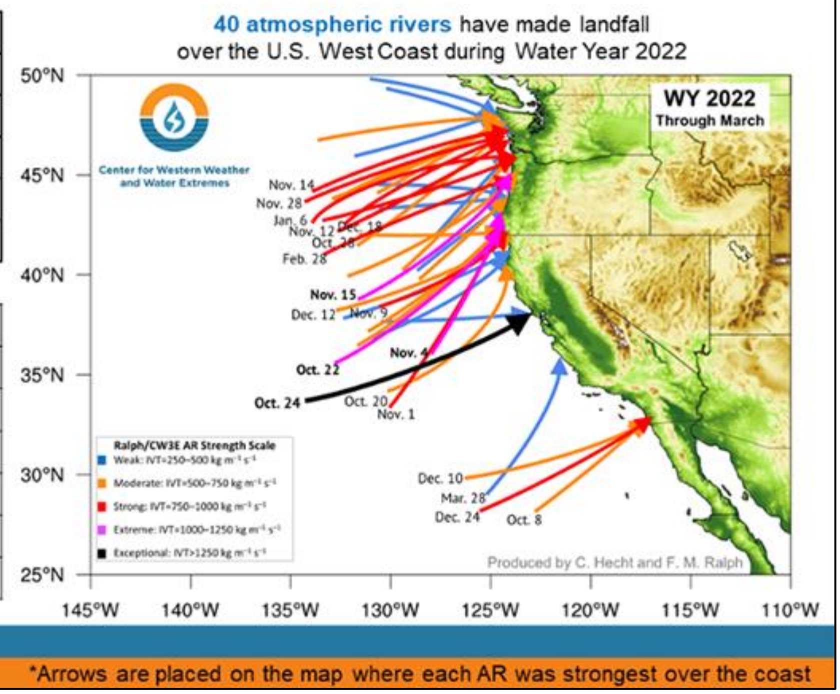
While El Niño is a condition that can result in high total rainfalls, there are other conditions that may result in record levels of rainfall, even in a non-El Niño year. The October 2021 severe storms were an example of an instance where record-breaking rainfall occurred during an exceptional atmospheric river event. As shown, these events are becoming less frequent. The blue regions (below the 0.0 line) correspond to the cooler sea surface temperatures of the drier La Niña events. Figure 12-4 summarizes incidents of atmospheric rivers that made landfall along the west coast of the U.S. from late 2021 through early 2022. Several landings in California brought an increased risk of landslide occurrence.

According to the USGS, variations in long-term precipitation may influence rainfall/debris-flow threshold values along the U.S. Pacific coast, where the mean annual precipitation and the number of rainfall days are influenced by topography, distance from the coastline, and geographic latitude. Studies have been performed using data from storms that triggered significant debris-flow activity in southern California, the San Francisco Bay region, and the Pacific Northwest (Mechanics, Prediction, and Assessment, 1997 1st International Conference on Debris-Flow Hazards Mitigation 1997)).

Figure 12-4. Landfalling Atmospheric Rivers, Water Year 2022 October Through March

AR Strength	AR Count
Weak	11
Moderate	15
Strong	10
Extreme	3
Exceptional	1

Regions Impacted by Each AR	
State/Region	AR Conditions
Washington	36
Oregon	36
Northern CA	26
Central CA	15
Southern CA	11



Source: (Center for Western Weather and Water Extremes 2022)

El Niño years and other high rainfall winter seasons that have strong atmospheric river storm events reveal similar patterns of landslide occurrences across the State. During heavy rainfall conditions, the added weight of rain-saturated slopes and weakened slopes from the pressure the groundwater exerts on porous hillside materials can trigger slope failure.

Figure 12-5 shows the statewide distribution of landslide damage reports that CGS investigated during the 2023 atmospheric river emergency response.

12.1.5. Post-Wildfire Landslides

Wildfires make the landscape more susceptible to landslides. When rainstorms pass through, the water liquefies unstable, dry soil and burned vegetation. Post-fire landslide hazards include fast-moving, highly destructive debris flows that can occur in response to high intensity rainfall events in the years immediately after wildfires, as well as flows generated over longer time periods accompanied by root decay and loss of soil strength. Post-fire debris flows are particularly hazardous because they can occur with little warning, exert great impulsive loads on objects in their paths, strip vegetation, block drainage ways, damage structures, and endanger human life.

Figure 12-5. 2023 Atmospheric River Response

Wildfires could result in the destabilization of pre-existing deep-seated landslides over long periods. Recent research shows California's wildfire season is getting longer, and the rainy season is getting shorter and more intense. This suggests Californians face a higher risk of wildfires and post-wildfire landslides that can damage property and endanger people's lives.

When Cal OES determines that post-fire watershed impacts pose a significant threat to life, safety, and property, the State will activate the Watershed/Debris Flow Task Force to coordinate with appropriate State, federal, Tribal Nation, and local stakeholders to mitigate against the identified hazards.

The task force works closely with State (Watershed Emergency Response Team [WERT]) and federal (Burned Area Emergency Response) post-fire assessment teams to identify "values at risk" that have potential to be impacted by post-fire flash floods or debris flows. Values at risk can include critical infrastructure, residences, or any physical asset at risk of impacts from debris flows. The task force communicates the WERT-identified risks to counties and provides technical assistance during values-at-risk mitigation efforts.

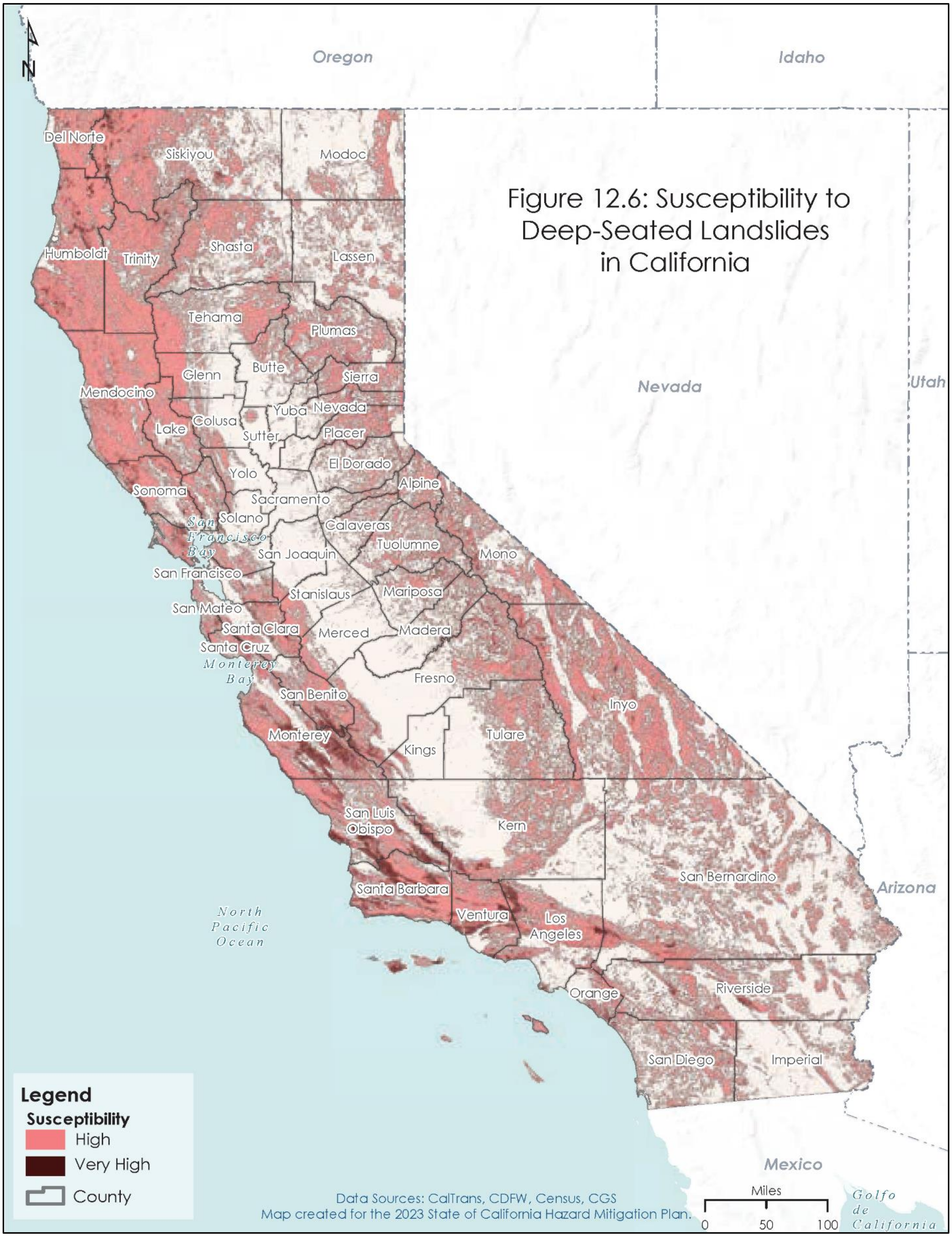
12.2. HAZARD LOCATION

Landslide hazards are present in many regions of California. Landslide probability of occurrence is notably high in the coastal regions of California, which are home to much of the State's population, industry, and infrastructure (DOC 2015).

General landslide susceptibility in California can be estimated from the distribution of weak rocks and steep slopes as shown in Figure 12-6. High and moderate landslide susceptibility, combined with high rainfall or high earthquake potential, leads to high landslide hazard in coastal California. The Franciscan Formation, which makes up much of the Northern California Coast Ranges, has weak rock that is both easily eroded and landslide prone.

Over the decades, development has spread into mountainous terrain where hazard exposure is high. Most reported landslide losses occur in these regions. An interactive map of deep-seated landslide susceptibility and landslide inventory mapping is publicly available on the CGS website (DOC 2022a).

Figure 12-6. Susceptibility to Deep-Seated Landslides in California



The concern for debris flows following wildfires is particularly acute wherever urban areas encroach upon alluvial fans. Figure 12-7 shows areas at moderate or high risk for post-fire debris flows. The areas of high or very high risk occur over burn scars, which can take several years to recover (Cotton 2021).

Since the 1970s, CGS has produced numerous maps that show landslide features and delineate potential slope-stability problem areas. Preparation of these maps has been episodic, often driven by landslide disasters and subsequent legislative mandates. Many CGS landslide maps and related products have been produced for local or State agencies in response to their specific needs.

(CGS 2022a)

12.3. PREVIOUS HAZARD OCCURRENCES

12.3.1. Disaster and Emergency Declarations

Figure 12-8 is a compilation of federal disasters declared due to landslides and flooding declarations where landslides occurred as a secondary factor to flooding. Also included are federal earthquake disasters that triggered significant damaging landslides, debris flows, rock falls and similar mass wasting movements. Many recently declared disasters include, as part of their description, "landslide" or "debris flow." Earlier disasters, such as the 1955 floods or the 1964 storms, do not include "landslides" as part of their description, but it is reasonable to expect that many damaging slides occurred. Similarly, earthquake disasters often have damaging landslides or rockfalls although not specifically mentioned in the disaster declaration. For this map, historical records and publications by Caltrans, USACE, California Department of Water Resources (DWR), the USGS, CGS and others were reviewed to determine whether damaging landslides occurred as part of the disaster. Consideration of the geology and general topographic relief of various counties assisted in the assessment. Data prior to 1953 was not reviewed, as this was the approximate year when federal disasters began being declared.

For counties in the Central Valley, if significant portions of the county are within an area of high relief and had a historical incident of damaging landslides, then that county was included with a particular disaster. For example, in Merced County, the hills around San Luis Reservoir and Highway 152 are relatively susceptible to landslides.

Figure 12-7. Post Fire Debris Flow Combined Hazard

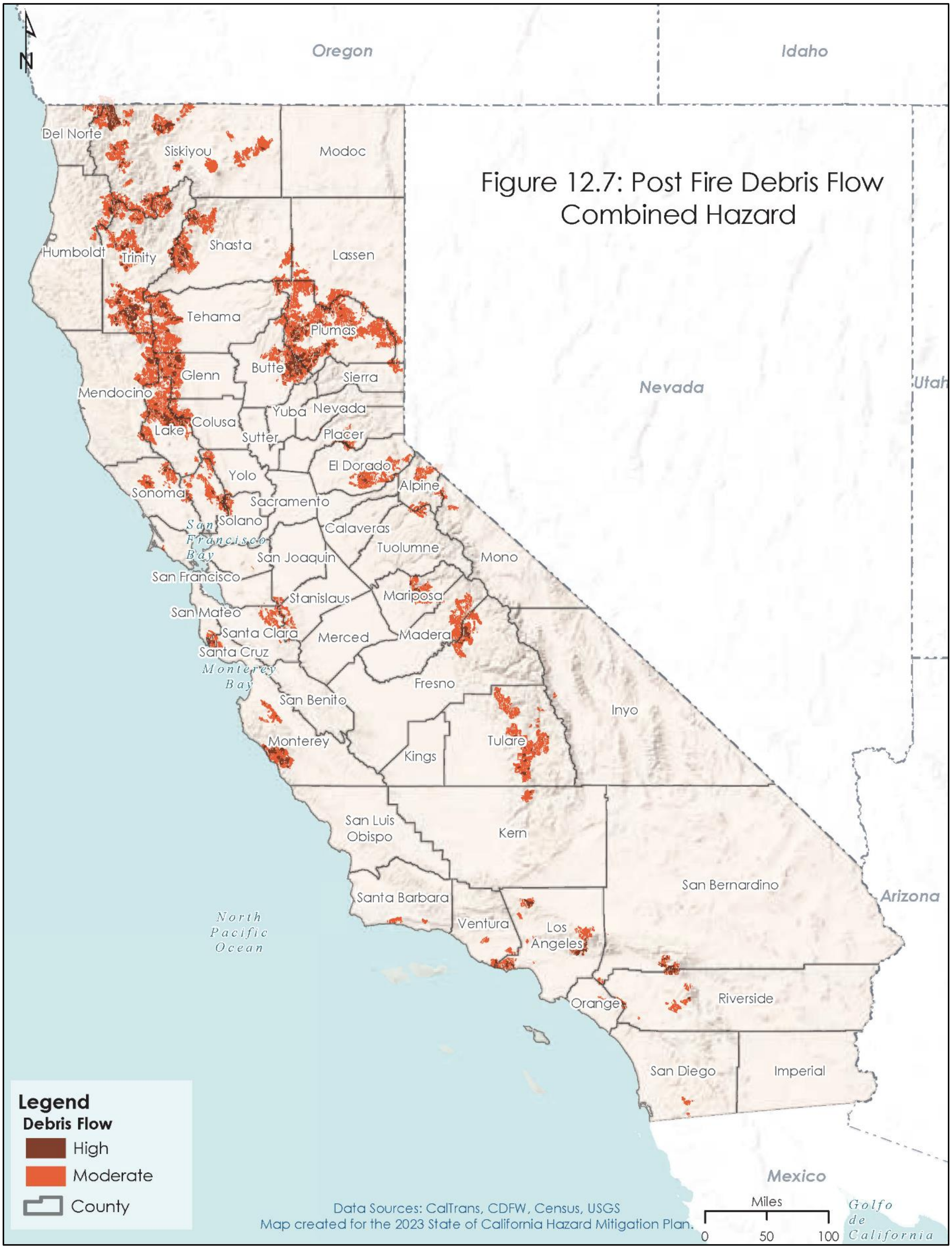
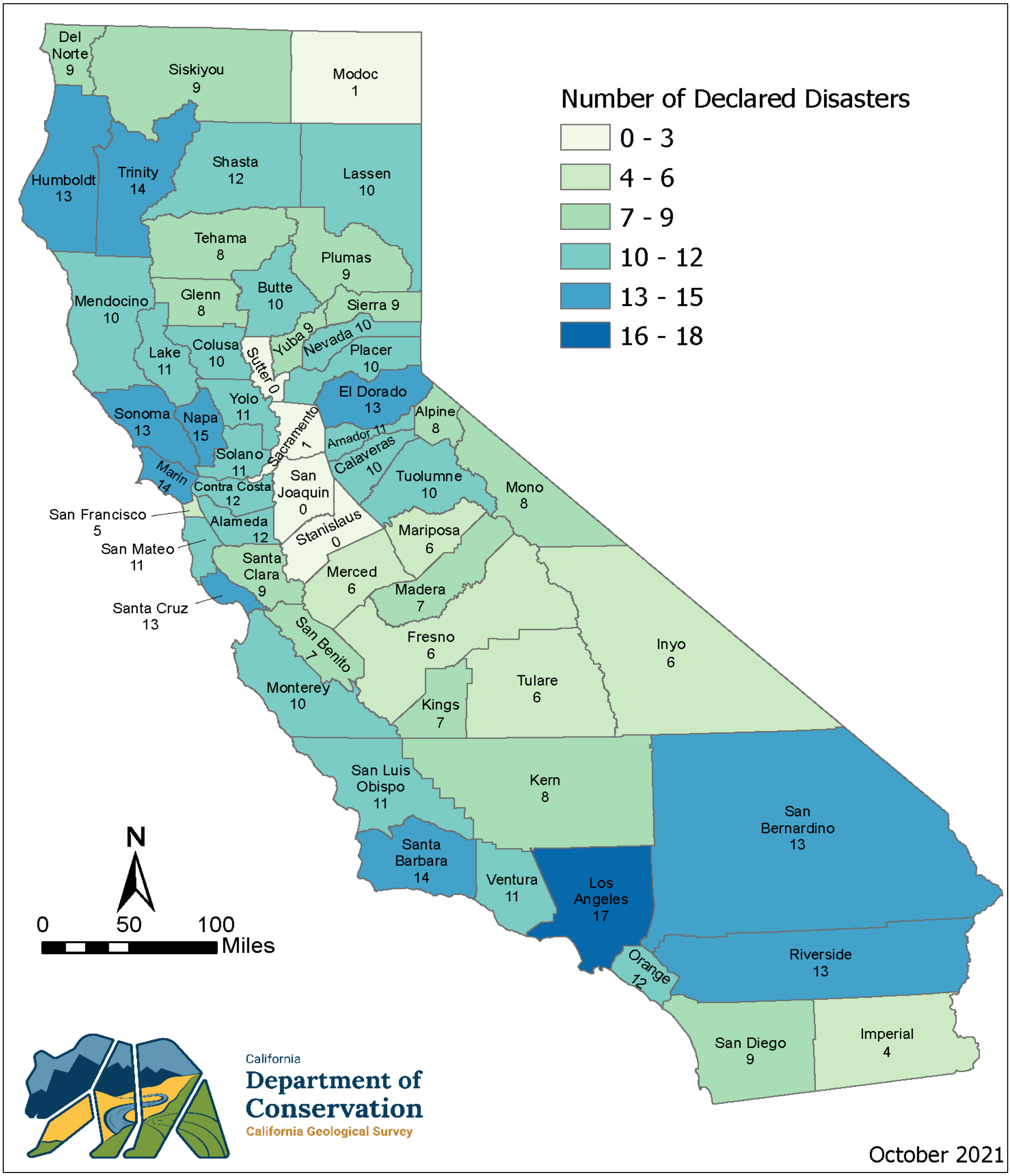


Figure 12-8. Federally Declared Landslide Disasters by County, 1953 – 2019



An investigation to identify any documented slides there for the 1955 flood disaster did not identify any; however, there are documented incidents of damaging landslides throughout the Coast Ranges (where the western portion of Merced County is) and it is reasonable to assume that damaging landslides occurred in Merced County even though verification is available.

12.3.2. Event History

Many large landslides are complex, being a combination of more than one landslide type. This is well illustrated by the La Conchita landslide that lies along the coastal bluffs in Ventura County. Historically active since the turn of the 19th century, it was reactivated as a slow-moving rotation slide during the 1995 winter rains that destroyed six homes in the subdivision below. The slow movement allowed homeowners to evacuate safely, resulting in no injuries during the event.

A portion of the same landslide moved again during the 2005 heavy winter rains as a fast-moving debris flow, which destroyed 30 more homes and caused 10 fatalities as the occupants had no time to escape (USGS 2006a).

More recently, a series of debris flows occurred in Southern California in early January 2018, particularly affecting areas northwest of Montecito in Santa Barbara County. The incident was responsible for 23 deaths, although the body of one of the victims has never been found. About 800 people were rescued, and about 160 people were hospitalized with injuries, including four in critical condition. The disaster occurred one month after a series of major wildfires. The fires scorched steep slopes, which caused loss of vegetation and destabilization of the soil and greatly facilitated subsequent mudflows. Over 500 structures were damaged or destroyed, with more than 40 swept of their foundations, all resulting in over $1 billion in direct and indirect economic losses.

Landslides triggered during the February 2017 severe storms caused damage across a large portion of the State, with a Major Disaster Declaration issued for 44 California counties and one Tribal Nation.

Many of the landslide events in the State have occurred during spring and winter when precipitation is high, causing slope instability and land movement. Table 12-1 lists landslide events that have occurred between 2018 and 2022.

Table 12-1. Landslide-Related Events in the State of California (2018 to 2022)

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties Impacted
March 10, 2021	Debris Flow	N/A	N/A	Orange
The debris flow brought areas of mud and debris over roads and into homes.				
January 27, 2021	Heavy Rain	N/A	N/A	Stanislaus
Rockslides caused by heavy rain.				
January 27, 2021	High Wind	N/A	N/A	Bakersfield
Mudslides and debris flows were reported in the West Side Hills near the Mineral Fire burn area.				
January 27, 2021	Debris Flow	N/A	N/A	San Benito
Mudslide on Panoche Rd.				
April 10, 2020	Debris Flow	N/A	N/A	San Diego
Interstate 8 landslide and debris on highway caused closure.				
April 9, 2020	Debris Flow	N/A	N/A	San Diego
Mudslide under a home spilled onto Black Mountain Road in Rancho Peñasquitos.				
December 26, 2019	Debris Flow	N/A	N/A	Kern
Caused by heavy rain.				
February 2019	Landslides, Mudslides	DR-4422	N/A	La Jolla Reservation
Heavy rains caused landslides on the 8,541-acre reservation. Facilities were damaged and destroyed.				
February and March 2019	Landslides, Mudslides	DR-4434	N/A	Amador, Butte, Colusa, Del Norte, El Dorado, Glenn, Humboldt, Lake, Marin, Mariposa, Mendocino, Monterey, Napa, Sonoma, Tehama, Trinity, Tuolumne, Yolo
An atmospheric river with extremely heavy rain caused flooding and mudslides throughout the State.				

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties Impacted
February 2019	Landslides, Mudslides	DR-4431	N/A	Calaveras, Colusa, Marin, Mariposa, Mendocino, Modoc, Napa, Riverside, Santa Barbara, Shasta, Trinity
An atmospheric river with extremely heavy rain caused flooding and mudslides throughout the State.				
November 29, 2018	Debris Flow	N/A	N/A	Butte
Caused by heavy rain/burn area.				
November 28, 2018	Debris Flow	N/A	N/A	Butte
Caused by heavy rain/burn area.				
July 11, 2018	Debris Flow	N/A	N/A	San Bernardino
Caused by heavy rain.				
March 22, 2018	Debris Flow	N/A	N/A	Mariposa
Caused by heavy rain/burn area.				
March 22, 2018	Debris Flow	N/A	N/A	Mariposa
Caused by heavy rain/burn area.				
March 22, 2018	Debris Flow	N/A	N/A	Mariposa
Caused by heavy rain/burn area.				
March 22, 2018	Debris Flow	N/A	N/A	Mariposa
Caused by heavy rain/burn area.				
March 22, 2018	Flash Flood	N/A	N/A	Tuolumne
Heavy rain led to significant erosion and at least one landslide.				
March 22, 2018	Flash Flood	N/A	N/A	Mariposa
Heavy rain caused rockslides and debris flows, closing several roads.				
March 21, 2018	Flood	N/A	N/A	El Dorado
Closed lanes on Highway 50 at Latrobe Rd/El Dorado Hills due to rockslide.				
January 2018	Mudslides	DR-4353	N/A	Santa Barbara
Post-Thomas Fire debris flows in Montecito. 129 homes destroyed, 307 homes damaged, 21 fatalities.				

Sources: (FEMA 2022u) (Climate Signals n.d.) (Nguyen 2019)
Note: Includes landslide events resulting in deaths, injuries, or damage of over $25,000.

12.4. PROBABILITY OF FUTURE HAZARD EVENTS

12.4.1. Overall Probability

Based on historical events in the State, California has a high probability of future landslide events. According to FEMA and NOAA reports, the State experienced 151 landslide events between 2018 and 2022 that caused enough damage to trigger federal disaster declarations. Based on this, California can expect at least 30 landslide events every year that may cause damage to property and infrastructure.

12.4.2. Climate Change Impacts

Landslides can result from intense rainfall and runoff events. Projected climate change-associated variance in rainfall events may result in more high-intensity events, which may increase landslide frequency (due to wetter wet periods and drier dry periods). While total average annual rainfall may decrease, rainfall is predicted to occur in fewer, more intense precipitation events (Ehlers 2022).

The combination of a generally drier climate in the future, which will increase the chance of drought and wildfires, and the occasional extreme downpour is likely to cause more mudslides and landslides. Climate change will also influence coastal areas, including both increased erosion and sea-level rise. Climate modeling will be a key component of understanding future landslide risks.

Increased wildfire occurrence associated with climate change escalates the risk of landslide and debris flows in the period following a fire, when slopes lack vegetation to stabilize soils and burned soil surfaces create more rainfall runoff. As climate change affects the length of the wildfire season, it is possible that a higher frequency of large fires may occur in late fall, when conditions remain dry, and then be followed immediately by intense rains early in the winter, as occurred with the Thomas Fire in December 2017 and subsequent Montecito and Carpinteria debris flows in January 2018.

12.5. IMPACT ANALYSIS

12.5.1. Severity

Landslides destroy property and infrastructure and can take the lives of people. According to the USGS, slope failures in the United States result in an average of 25 to 50 lives lost per year and an annual cost to society of about $1.5 billion. When landslides occur, 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 severity of a landslide will depend on the type and the size of the landslide.

12.5.2. Warning Time

Landslides can occur suddenly or slowly. The velocity may be a slow creep of inches per year for large, deep-seated landslides, while the runout from debris flows and post-fire debris flows may be many feet per second. Earthquake-induced landslides, including rock avalanche, may be almost instantaneous.

The warning time for landslides depends on awareness of the hazard as well as monitoring and alert systems. Assessments of pre-existing landsliding and areas that may be prone to landsliding helps to develop awareness of the hazard and planning for potential slope movement, depending on slope angle, material, and water content. Some methods used to monitor landslides 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, amount of predicted precipitation, and potential earthquake ground motions can help in these assessments.

For landslides or debris flows that may be triggered by rainfall, improved forecasting of El Niño events or other potentially high rainfall years can provide some advanced warning. Rainfall forecasting allows for better preparation and response to potential slope failures and flood events.

High-intensity, short-duration rainfall rates are the primary cause of debris flows. The USGS computes thresholds for post-burn areas based on statistical occurrences of debris flows and associated rainfall rates (burn areas less than two years old). For post-burn areas assessed by the WERT, USGS-generated thresholds are refined further using inputs from erosion modeling to field validated soil burn severity. In addition, those thresholds are adjusted on a continuous basis with input from local jurisdictions to reflect the revegetation of a post-burn area. Depending on conditions, some post-burn areas may take five years to recover. The WERT works with the USGS, the NWS, and Cal OES to develop thresholds as guidance for watches and warnings of possible flash flooding and debris flows.

Warning time for earthquake-induced landslide may be gained as the California Earthquake Early Warning System is developed. The California Earthquake Early Warning System may be able to provide the public with time for situational awareness of rapid earth movement.

Some large, deep-seated landslides can be instrumented with surficial and/or subsurface monitoring devices. This kind of monitoring is used when landslides may impact infrastructure or housing. The monitoring can provide alerts if movement begins or accelerates. This information can assist with evacuation alerts and provide data for protection and repair of infrastructure.

12.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with landslides:

- Landslides can collapse into water bodies, causing tsunamis or seiches. In 1958, a magnitude 8 earthquake collapsed a hillside into Lituya Bay, Alaska, causing a water splash wave that reached 1,720 feet up a mountain slope, stripping all vegetation. A massive landslide into the Vaiont Reservoir in Italy in 1963 caused a water splash wave that swept 800 feet over the top of a dam, causing a major flood that killed an estimated 2,600 people below.
- Landslides can relocate river channels, as occurred during the Oso mudslide in Washington State in March 2014.
- Landslides and debris flows can impact water quality and the storage capacity of surface water reservoirs used to store potable water.
- Landslides can act as dams, creating unplanned reservoirs, which in turn can create new hazards.
- Landslides can result in rapid water and debris blocking transportation routes or preventing key services for first responders.

12.5.4. Environmental Impacts

A landslide alters the landscape. In addition to changes in topography, vegetation and wildlife habitats may be damaged or destroyed. Soil and sediment runoff will accumulate downslope, potentially blocking waterways and roadways and impairing the quality of streams and other water bodies. Landslides that fall into streams may impact fish and wildlife habitat, as well as affecting water quality. Hillsides that provide wildlife habitat can be lost for prolonged periods due to landslides.

12.5.5. Local Hazard Impacts

LHMP Rankings

Forty-one of the hazard mitigation plans prepared for California's 58 counties list landslide as a hazard of concern, and 15 counties rank it as a high-impact hazard:

- Amador
- Butte
- Contra Costa
- Los Angeles
- Madera
- Marin
- Modoc
- Napa
- Nevada
- San Luis Obispo
- San Mateo
- Santa Barbara
- Santa Cruz
- Sonoma
- Ventura

An additional 18 counties identified landslide as a medium-impact hazard.

LHMP Estimates of Potential Loss

Table 12-2 summarizes potential losses to vulnerable structures based on estimates from the local risk assessments (as called for in FEMA's Standard State Mitigation Planning Requirement S6.b). Due to variances in approaches to assessing risk at the local level as well as the hazards assessed and the age of each assessment reviewed, this data is considered approximate.

Table 12-2. Landslide, Debris Flow and Other Mass Movements Risk Exposure Analysis for LHMP Reviews

Estimated Total Population Exposed	832,305
Estimated Number of Structures at Risk	385,036
Estimated Value of Structures at Risk	$325.9

12.6. VULNERABILITY ANALYSIS

A statewide assessment of landslide susceptibility was conducted using the following data provided by CGS:

Deep Seated landslide susceptibility mapping describes the relative likelihood of future landslides based solely on prior failure (from a landslide inventory), rock or soil strength, and steepness of slope. This analysis used the areas mapped having high or very high susceptibility to landslides (see Figure 12-6).

- **Landslide zone** mapping depicts areas with a higher probability of earthquake-induced landslides, within which specific actions are mandated by California law prior to any development. These maps do not show varying degrees of risk—a site is either in or out of the zone—and are designed for use as planning tools by non-scientists. Zone maps incorporate expected future earthquake shaking, existing landslide features, slope gradient, and strength of hillslope materials (see Figure 12-9). To date, CGS has evaluated and mapped only about 5 percent of the State for earthquake-induced landslide hazards.

12.6.1. Exposure of State-Owned or -Leased Facilities

Table 12-3, and Table 12-4 summarize the number and replacement cost value of State assets located in high landslide susceptibility areas, very high landslide susceptibility areas, landslide zones, and post-wildfire debris flow zones. Figure 12-10, Figure 12-11, Figure 12-12, and Figure 12-13 summarize the exposed assets as a percentage of total assets statewide. These quantities are based on a partial evaluation of landslide hazards in the State and therefore represent minimum values. Appendix I provides detailed results by county.

Figure 12-9. Earthquake-Induced Landslide Zones

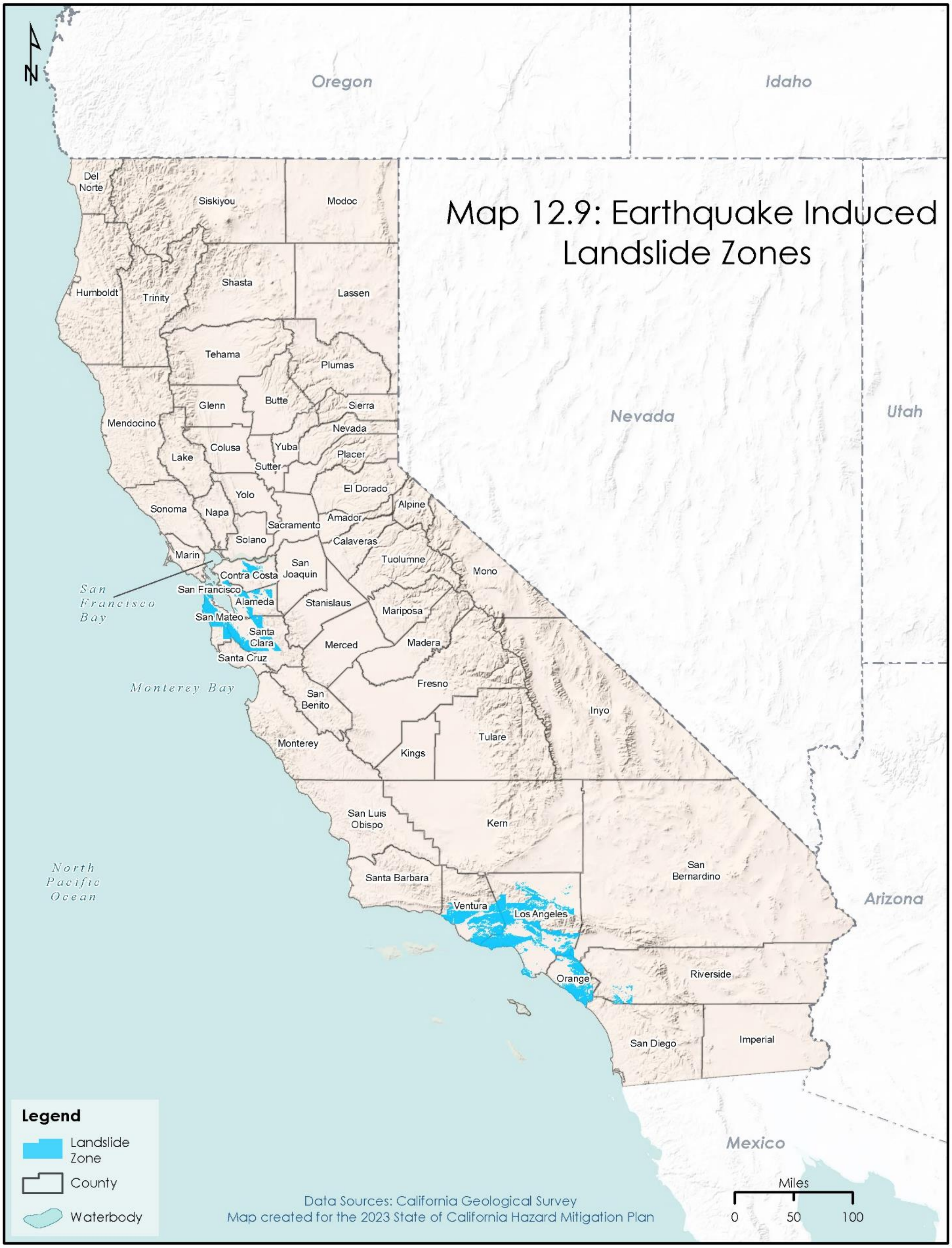


Table 12-3. State-Owned or -Leased Facilities Exposed to Landslide Hazards

Type of Facility	Number of Structures	Total Area (sq. ft.)	Replacement Cost Value		
			Structure	Content	Total
State Facilities in High Landslide Susceptibility Areas					
State-Leased Facilities	103	—	$856,634,521	$859,203,955	$1,715,838,476
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	0	0	$0	$0	$0
Development Center	0	0	$0	$0	$0
Hospital	2	580	$31,043	$35,917	$66,960
Migrant Center	0	0	$0	$0	$0
Special School	0	0	$0	$0	$0
All Other Facilities	3,521	22,610,858	$1,594,469,379	$1,466,134,975	$3,060,604,354
Total State-Owned	***3,523***	***22,611,438***	***$1,594,500,422***	***$1,466,170,892***	***$3,060,671,314***
Total Facilities	**3,626**	**N/A***	**$2,451,134,943**	**$2,325,374,847**	**$4,776,509,790**
State Facilities in Very High Landslide Susceptibility Areas					
State-Leased Facilities	14	--	$13,419,205	$12,119,020	$25,538,225
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	0	0	$0	$0	$0
Development Center	0	0	$0	$0	$0
Hospital	0	0	$0	$0	$0
Migrant Center	0	0	$0	$0	$0
Special School	0	0	$0	$0	$0
All Other Facilities	71	205,683	$3,578,775	$1,979,238	$5,558,013
Total State-Owned	***71***	***205,683***	***$3,578,775***	***$1,979,238***	***$5,558,013***
Total Facilities	**85**	**N/A***	**$16,997,980**	**$14,098,258**	**$31,096,238**

Type of Facility	Number of Structures	Total Area (sq. ft.)	Replacement Cost Value		
			Structure	Content	Total
State Facilities in Landslide Zones					
State-Leased Facilities	15	—	$59,425,049	$58,124,863	$117,549,912
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	0	0	$0	$0	$0
Development Center	0	0	$0	$0	$0
Hospital	0	0	$0	$0	$0
Migrant Center	0	0	$0	$0	$0
Special School	0	0	$0	$0	$0
All Other Facilities	15	26,432	$487,087	$243,543	$730,630
Total State-Owned	***15***	***26,432***	***$487,087***	***$243,543***	***$730,630***
Total Facilities	**30**	**N/A***	**$59,912,136**	**$58,368,406**	**$118,280,542**
State Facilities in Post-Wildfire Debris Flow Zones					
State-Leased Facilities	7	—	$1,691,190	$2,410,051	$4,101,242
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	0	0	$0	$0	$0
Development Center	0	0	$0	$0	$0
Hospital	0	0	$0	$0	$0
Migrant Center	0	0	$0	$0	$0
Special School	0	0	$0	$0	$0
All Other Facilities	180	306,495	$54,312,323	$42,042,407	$96,354,730
Total State-Owned	***180***	***306,495***	***$54,312,323***	***$42,042,407***	***$96,354,730***
Total Facilities	**187**	**N/A***	**$56,003,513**	**$44,452,459**	**$100,455,972**

* The inventory of State assets does not include building area for State-leased facilities, so no total area for all State facilities is provided; the building area of vulnerable assets is shown for State-owned facilities only.

Table 12-4. State-Owned or -Leased Infrastructure Exposed to Landslide Hazards

Type of Facility	State-Owned Infrastructure in the Mapped Hazard Area			
	High Landslide Susceptibility Areas	Very High Landslide Susceptibility Areas	Landslide Zones	Post-Wildfire Debris Flow Zones
Bridges	2,815	306	112	14
Highway (miles)	—	—	140.9	359.2
Dams	21	3	2	3
Water Project (miles)	—	—	9.6	0

Figure 12-10. State Assets in High Landslide Susceptibility Areas as % of Statewide Total

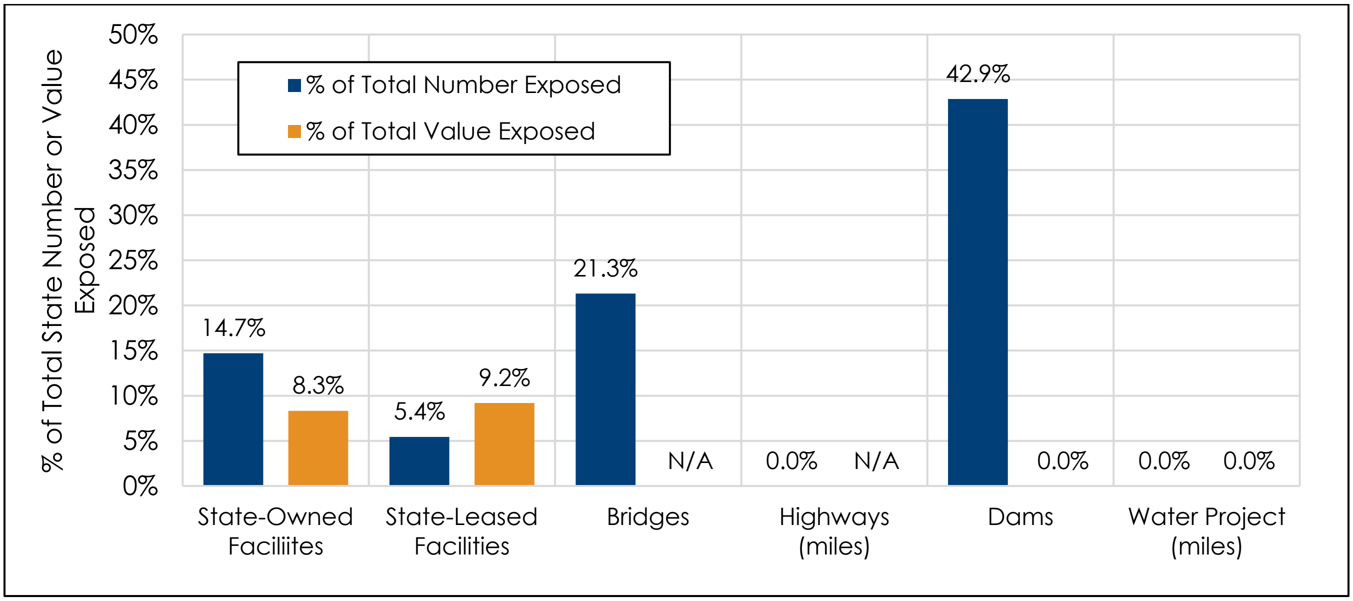


Figure 12-11. State Assets in Very High Landslide Susceptibility Areas as % of Statewide Total

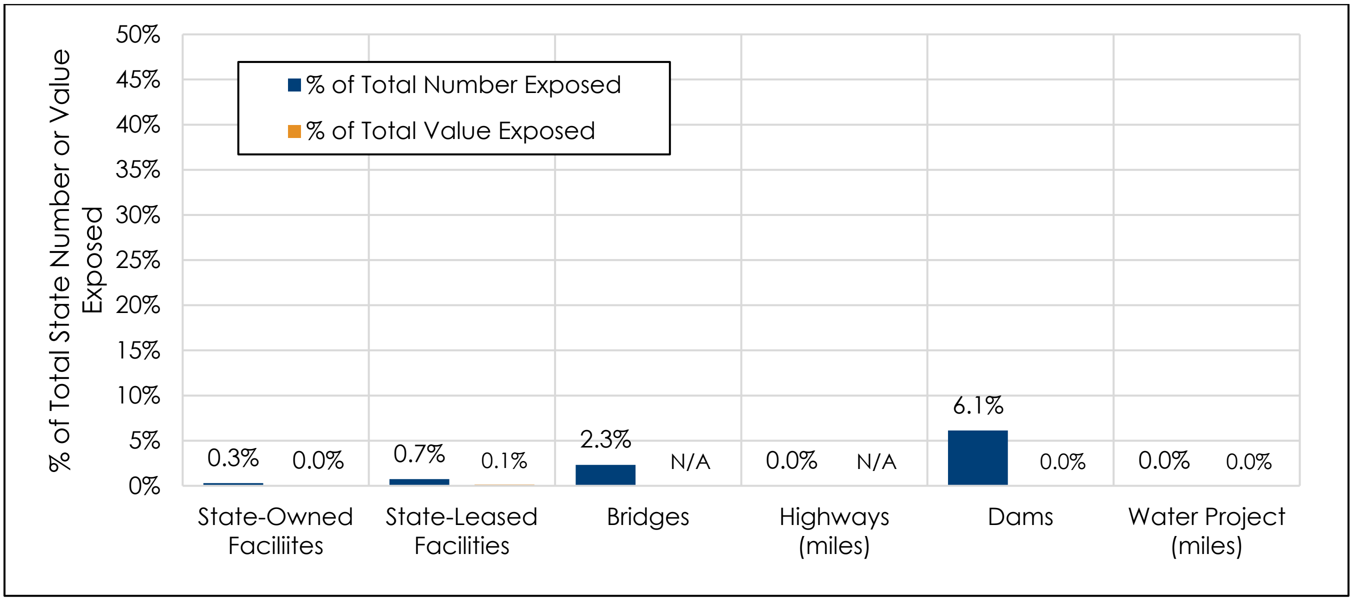


Figure 12-12. State Assets in Landslide Zones as % of Statewide Total

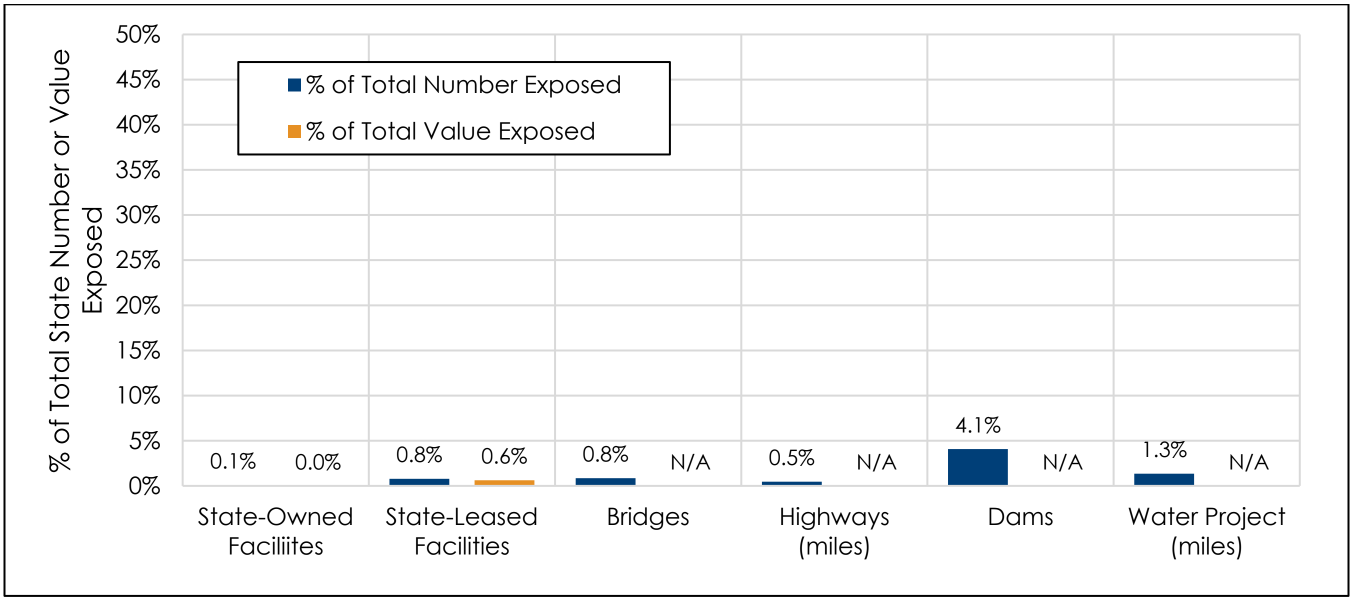
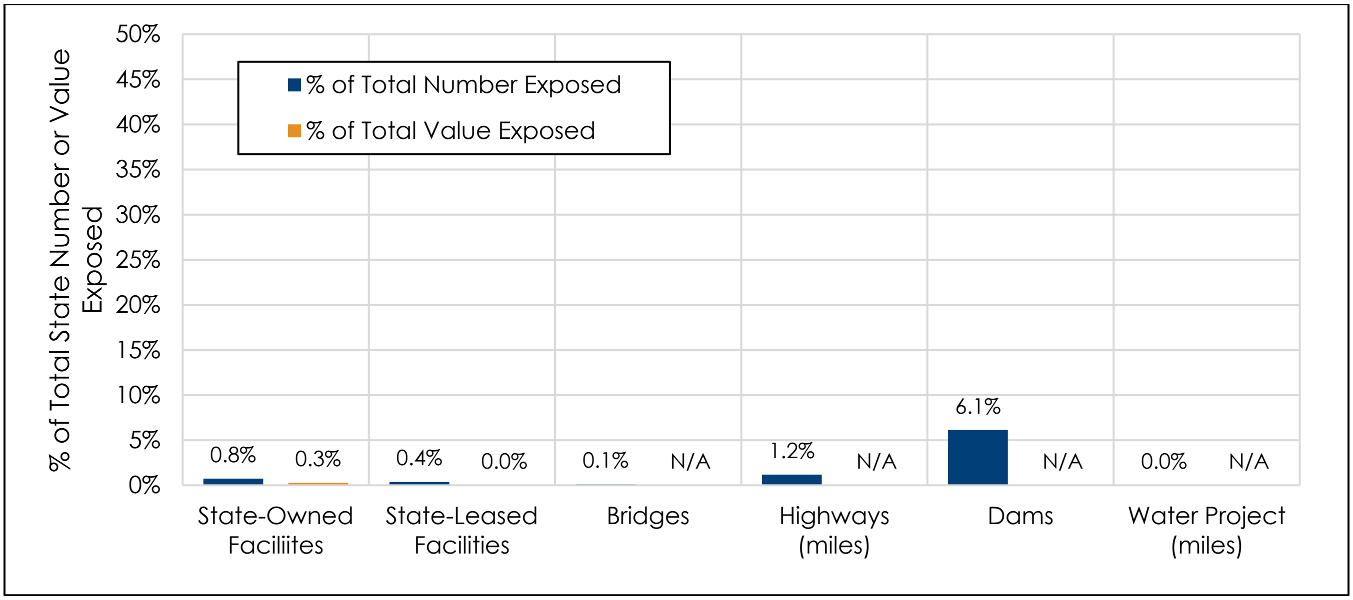


Figure 12-13. State Assets in Post-Wildfire Debris Flow Zones as % of Statewide Total



12.6.2. Exposure of Critical Facilities and Community Lifelines

Four critical facilities and lifelines are in landslide zones, and one is in a post-fire debris flow zone, as shown in Table 12-5. There are no critical facilities or community lifelines in the high or very high landslide susceptibility areas. These quantities are based on a partial evaluation of landslide hazards in the State and therefore represent minimum values.

Table 12-5. Critical Facilities and Community Lifelines in Landslide Zones

	Total Number of Facilities	Number of Facilities in Hazard Area				% of Total Facilities			
		High	Very High	Zone	Post-Fire Debris Flow	High	Very High	Zone	Post-Fire Debris Flow
Communications	42	—	—	0	0	—	—	0	0
Energy	176	—	—	0	1	—	—	0	0.6
Food, Water, Shelter	257	—	—	2	0	—	—	0.8	0
Hazardous Material	56	—	—	0	0	—	—	0	0
Health & Medical	47	—	—	0	0	—	—	0	0
Safety & Security	46	—	—	0	0	—	—	0	0
Transportation	131	—	—	2	0	—	—	1.5	0
Total	**755**	**—**	**—**	**4**	**1**	**—**	**—**	**0.5**	**0.1**

Critical facilities and community lifelines that are exposed to the landslide, debris flow and mass movement hazards are likely to experience functional downtime following these events, which could increase the net impact of these events.

12.6.3. Estimates of Loss

Although landslides can cause significant damage to State assets, there are no standard generic formulas for estimating associated losses. Instead, loss estimates were developed representing 10 percent, 30 percent, and 50 percent of the replacement cost value of all State-owned facilities exposed to landslide hazards (see Table 12-6).

Table 12-6. Loss Potential of State-Owned Assets for Landslide

Type of Facility	Total Replacement Cost Value (contents only)	Estimated Loss Potential Based on % Damage		
		10% Damage	30% Damage	50% Damage
Facilities Housing Vulnerable Populations				
Correctional Facility	$0	$0	$0	$0
Development Center	$0	$0	$0	$0
Hospital	$66,960	$6.696	$20,088	$33,480
Migrant Center	$0	$0	$0	$0
Special School	$0	$0	$0	$0
All Other Facilities	**$5,026,342,542**	**$502,634,254**	**$1,507,902,763**	**$2,513,171,271**
Total	**$5,026,409,502**	**$502,634,261**	**$1,507,922,851**	**$2,513,204,751**

Note: Quantities are based on a partial evaluation of landslide hazards in the State and therefore represent minimum values

This allows the State to select a range of potential economic impacts based on an estimate of the percentage of damage to these assets. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure.

12.6.4. Buildable Land

Of 11.7 million acres of land available for development statewide, 254,039 acres (2.2 percent) are located in a landslide zone (this quantity is based on a partial evaluation of landslide hazards in the State and therefore represents a minimum value). Appendix G provides a detailed assessment of exposed buildable lands by county.

12.6.5. Equity Priority Communities

The risk analysis for landslide found that 2.7 percent of people living in landslide zones live in equity priority communities (16,892 people). This quantity is based on partial evaluation of landslide hazards in the State and therefore represents a minimum value. Additionally, landslide hazards can affect lifelines and transportation networks, further impacting equity priority communities. A breakdown of exposed equity priority communities by county is included in Appendix I.

12.6.6. NRI Scores

According to the NRI, all of the State's counties have landslide risk, rated from relatively low to very high. Table 12-7 shows scores for the six counties with the highest rating. See Section 4.1.3 for a description of the components of the NRI.

Table 12-7. NRI Scoring of Counties for Landslide

County	Expected Annual Loss	Social Vulnerability Rating	Community Resilience Rating	Community Risk Factor	Risk Value	Score
Nevada	$732,244	Relatively Low	Relatively High	0.98	$812,736	98.55
Tuolumne	$634,232	Relatively Moderate	Relatively Moderate	1.16	$787,739	98.43
Marin	$770,102	Relatively Low	Very High	1.02	$736,098	98.33
Kern	$608,770	Very High	Very Low	1.41	$711, 545	98.23
San Bernardino	$509, 034	Very High	Relatively Moderate	1.34	$620,827	97.88
Sonoma	$502,986	Relatively Moderate	Relatively High	1.14	$535,891	97.53

12.7. MITIGATING THE HAZARD

12.7.1. Opportunities for Mitigating the Hazard

Exposure to landslide hazards can be reduced by effective land use planning and hillside development practice. Enhanced understanding of the risk through studies and plans that include risk assessment also creates the opportunities to identify mitigation actions. Like slope steepness and material strength, potential for water-saturated hillsides or earthquake shaking is a design parameter that should be considered when preparing a building site.

Reducing landslide hazard is accomplished by either reducing gravity forces acting on a slope by grading to decrease steepness or increasing slope resistance and restraint by using structural systems and effective dewatering and drainage. If either approach is not economically viable for a particular project, avoiding the hazard by relocating the project to a safer site is the alternative.

Landslides that affect existing structures can often be stabilized using engineering resistance and retention systems and effective dewatering that strengthen the slope and hold the rock and/or soil mass in place (Cal OES 2018).

Table 12-8 provides a range of potential alternatives for mitigating the landslide hazard (see Section 1.2.3 for a description of the different types of alternatives).

Additionally, the State has many current landslide hazard mitigation efforts, some of which are explained further in Appendix T.

12.7.2. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address the landslide hazard:

- Action 2023-011: Pre-Wildfire Geologic Hazard Mitigation Planning & Post-Wildfire Hazard Identification Program: Build capacity by increasing current staffing and resources to fully implement each task of the Program.
- Action 2018-008: Develop a database containing a description of the specific natural hazard event for which each project was designed to mitigate.
- Action 2018-037: Landslide Inventory Maps: Continue to map earthquake induced landslides through the Seismic Hazards Mapping Program.
- Action 2018-038: Post-Fire Runoff & Debris Flows: Develop regional modeling to assess potential effects of post-fire runoff. Develop an early warning system for post-fire flash floods and debris flows.

Table 12-8. Potential Opportunities to Mitigate the Landslide/Mass Movement Hazard

Community-Scale	Organizational 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 ▪ Apply engineering solutions that minimize/eliminate the hazard **Reduce exposure and vulnerability:** ▪ Locate structures outside of hazard area (off unstable land and away from slide-run out area) ▪ Retrofit home **Build local capacity:** ▪ Institute warning system, and develop evacuation plan ▪ Keep cash reserves for reconstruction	**Manipulate the hazard:** ▪ Stabilize slope (dewater, armor toe) ▪ Reduce weight on top of slope ▪ Apply engineering solutions that minimize/eliminate the hazard **Reduce exposure and vulnerability:** ▪ Locate structures outside of hazard area (off unstable land and away from slide-run out area) ▪ Retrofit at-risk facilities **Build local capacity:** ▪ 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 ▪ Apply engineering solutions that minimize/eliminate the hazard **Reduce exposure and vulnerability:** ▪ Acquire properties in high-risk landslide areas ▪ Adopt land use policies that prohibit the placement of habitable structures in high-risk landslide areas ▪ Adopt higher regulatory standards for new development within unstable slope areas ▪ Armor/retrofit critical infrastructure against the impact of landslides **Build local capacity:** ▪ Produce better hazard maps Implement WERT-recommended mitigation measures. ▪ 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. ▪ Consider the probable impacts of climate change on the risk associated with the landslide hazard ▪ Create risk communication products

<table>
<tr><th>Community-Scale</th><th>Organizational Scale</th><th>Government-Scale</th></tr>
<tr><td>Become educated on risk reduction techniques for landslide hazards</td><td></td><td></td></tr>
<tr><td colspan="3">Nature-based opportunities:
Replace or restore native vegetation known to stabilize steep slope areas.
Soil bioengineering can be used to mitigate risk in larger areas that have a potential for shallow, slow-moving landslides or areas abandoned after past landslides that show signs of reactivation and have a high landslide hazard potential.
Hybrid solutions refer to conventional engineering solutions that are combined with nature-based solutions using appropriate vegetation.</td></tr>
</table>

DROUGHT

Climate Impacts:
Hazard expected to increase in frequency, duration, and intensity
Equity Impacts:
The entire population of the State is considered to be exposed; 30.4% of exposed population has been identified as living in equity priority communities
State Facilities Exposed:
All facilities exposed, but no impacts
Community Lifelines Exposed:
All lifelines exposed

Impact Rating: Medium (27)

13. DROUGHT

Drought has been identified as a medium-impact natural hazard of interest based on the hazard impact rating protocol applied for this SHMP. Droughts happen frequently but have little to no potential impact on State-owned or -leased facilities and community lifelines. The entire population of the State is exposed to this hazard, and greater than 30 percent of that population has been identified as living in equity priority communities. The greatest impacts from drought tend to be on the economy, the environment, public health, and safety. Economic impacts could be increased by future development with increasing demand for water supply. The frequency and severity of droughts is anticipated to increase over the next 30 years due to impacts from climate change.

13.1. HAZARD OVERVIEW

Drought is defined as a deficiency in precipitation over an extended period, resulting in a water shortage (National Integrated Drought Information System 2022b). Normally, one dry year does not constitute a drought in California. The State's extensive system of water supply infrastructure (reservoirs, groundwater basins, and interregional conveyance facilities) generally mitigates the effects of short-term dry periods for most water users (DWR n.d.-a), yet there are water shortage emergencies caused by drought. Drought is a gradual phenomenon, occurring slowly over a period of time.

13.1.1. The Impacts of Drought

Drought results in a decline of stream flows, lake levels, and reservoir levels and a decrease in water depth in wells (USGS n.d.-e). It can lead to serious problems, including crop losses, fish and wildlife losses, subsidence, saltwater intrusion, reduced water quality, and water supply shortages. As a drought continues, its impacts increase (DWR 2022k).

Drought Types

There are five ways drought is commonly defined:

- Meteorological drought is said to occur when rainfall has been deficient for an extended period.
- Hydrological drought is said to occur when rainfall deficits impact the water supply available from streams, reservoirs, lakes, and groundwater.
- Agricultural drought is said to occur when factors such as rainfall deficits, soil water deficits, reduced groundwater, or low reservoir levels for irrigation result in impacts on agriculture.
- Socioeconomic drought is said to occur when diminished water supply reduces the supply of economic goods such as fruits, vegetables, grains, or meat.
- Ecological drought is said to occur when a prolonged and widespread deficit in naturally available water supplies—including changes in natural and managed hydrology—creates multiple stresses across ecosystems.

Sources: (National Drought Mitigation Center 2022); (NWS 2022c)

Drought increases wildfire risk, and wildfires in turn increase demand for water. Prolonged periods of drought can result in detrimental changes in the vegetative structure and health of forests, making them more vulnerable not only to pest outbreaks but also to fire (EPA 2011). The loss of forests due to distressed health, pests, or fire can produce increased risk of other hazards due to reduced ability to retain runoff during heavy rainfall events (Hoegh-Guldberg 2018).

During droughts, groundwater use intensifies, stressing groundwater-dependent ecosystems and potentially resulting in increased overdraft, subsidence, and saltwater intrusion (in some areas), which can result in permanent loss of storage and damage to overlying infrastructure. Groundwater is the only source of water for much of California's most productive farmland, and agricultural water needs are likely to be heightened during prolonged hot and dry periods. Groundwater is also often the only source of water for small, rural water systems and households (CNRA 2018). Additionally, droughts exasperate headwater streams' ability to naturally recharge groundwater.

The impacts of drought can lead to harmful health impacts on California residents (NWS 2022f). Drought can have financial, physical, and emotional impacts on farmers and farm workers and others in Tribal Nation, rural, and farming communities (Walters 2021). In 2021, water allocations and deliveries to farms were significantly reduced across the State. Total surface water deliveries for Central Valley and North Coast farms dropped 41 percent below the 2002-2016 average (Escriva-Bou, et al. 2022). Impacts include hardships for farmers, farm workers, packers, and shippers of agricultural products. In some cases, drought can cause significant increases in food prices to the consumer due to agriculture production shortages and can result in lack of water and feed for grazing livestock, potentially leading to risk of livestock death (L. Anderson 2022).

Drought is harmful to water quality and public health. Reduced stream and river flows can increase the concentration of pollutants and bacteria in water, making contamination or water-related illness more likely (CDC 2020). Other infectious disease threats arise when drought leads to the contamination of surface waters and other types of water that are used for recreational purposes (CDC 2020). When temperatures rise and rainfall declines, algal blooms can grow and release dangerous toxins. At the same time, people are more likely to participate in water-related recreation, and those exposed to contaminated recreational waters are more likely to become infected with pathogens (CDC 2020). Drought and its consequences can also lead to increased mental health impacts, including acute or post-traumatic stress, substance abuse, domestic violence, and suicide (National Integrated Drought Information System 2022).

Droughts can exasperate conditions in the Sacramento San Joaquin Delta and other water sources where harmful algal blooms can develop. A lack of water flow and volume conflate with warmer temperatures, which allow conditions for out-of-control production of harmful algal blooms. These can be toxic or harmful and affect people, fish, shellfish, marine mammals, and birds.

During California droughts, impacts have been felt first by those most dependent on or affected by annual rainfall and snowpack. These include but are not limited to agencies fighting forest fires, ranchers engaged in dryland grazing, farmers growing crops in arid zones, rural residents relying on wells in low-yield rock formations, or small water systems lacking a reliable water source.

13.1.2. Declaring a Drought

California has not established an official definition of when a drought begins or ends or process for defining or declaring drought. A proclamation of emergency conditions pursuant to the California Emergency Services Act may be used to respond to drought impacts, but such a proclamation is not a drought definition (DWR 2021a).

Hydrologic conditions causing impacts for water users in one location may not represent drought for water users in a different part of California, or for users with a different water supply. Individual water agencies may use criteria such as rainfall/runoff, amount of water in storage, or expected supply from a water wholesaler to define their water supply conditions (DWR 2022e).

13.2. HAZARD LOCATION

The entire State of California is vulnerable to drought, although the conditions of drought are not experienced uniformly across the State (California Water Watch 2022). The effects of drought depend on the climate zone, the type of water supply available, and water users' ability to manage drought impacts (California Water Watch 2022).

Droughts are dynamic, and locations of the State susceptible to drought can change monthly. The U.S. Drought Monitor is a map that is updated weekly to show the location and intensity of drought across the country. The drought monitor uses the five-category system shown in Table 13-1.

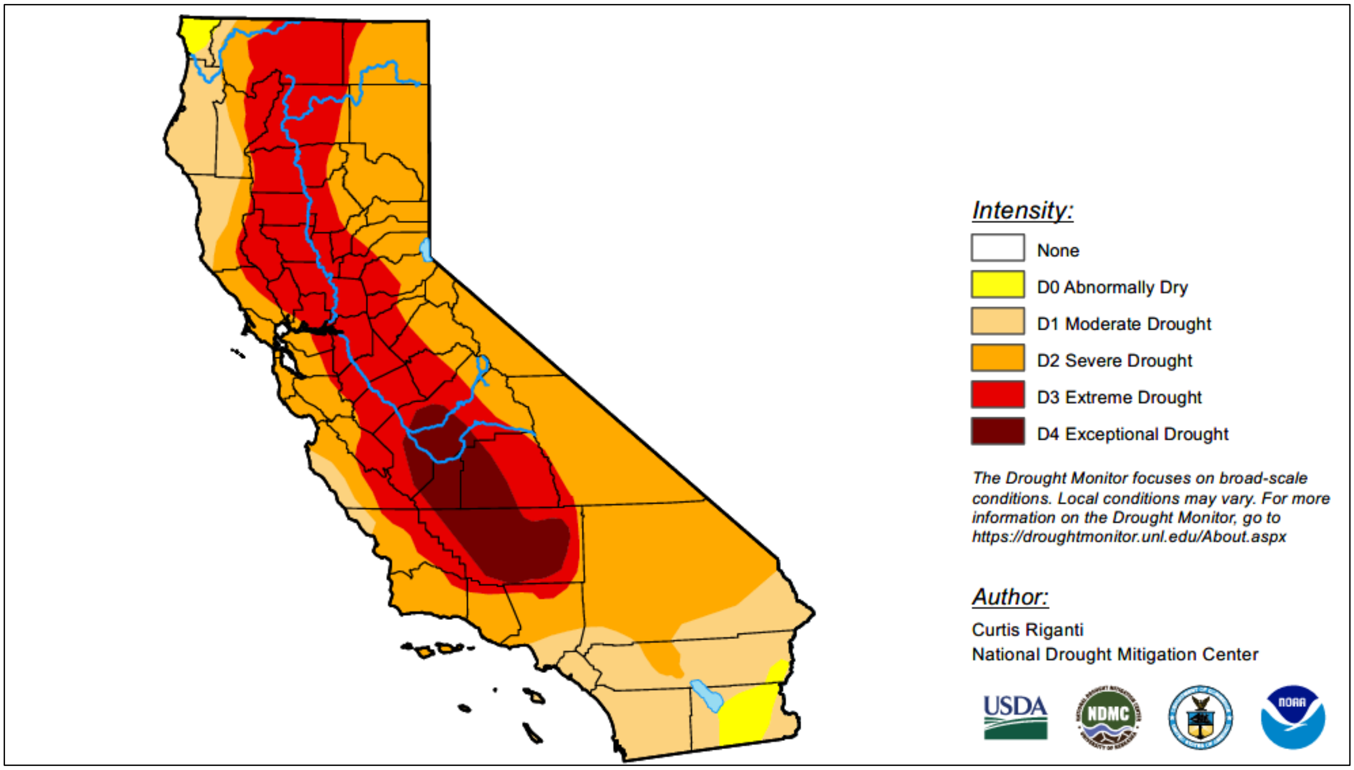
Table 13-1. U.S. Drought Monitor Categories

Category	Description	Possible Impacts
D0	Abnormally Dry	▪ Short-term dryness slowing planting, growth of crops ▪ Some lingering water deficits ▪ Pastures or crops not fully recovered
D1	Moderate Drought	▪ Some damage to crops, pastures ▪ Some water shortages developing ▪ Voluntary water-use restrictions requested
D2	Severe Drought	▪ Crop or pasture loss likely ▪ Water shortages common ▪ Water restrictions imposed
D3	Extreme Drought	▪ Major crop/pasture losses ▪ Widespread water shortages or restrictions
D4	Exceptional Drought	▪ Exceptional and widespread crop/pasture losses ▪ Shortages of water creating water emergencies

Source: (U.S. Drought Monitor 2023)

Figure 13-1 shows an example drought monitor map, for December 13, 2022, giving an example of the level of detail for this type of mapping. These maps can be accessed at: [California | U.S. Drought Monitor (unl.edu).](https://droughtmonitor.unl.edu)

Figure 13-1. U.S. Drought Monitor Map of California, December 13, 2022



Source: (U.S. Drought Monitor 2022)

13.3. PREVIOUS HAZARD OCCURRENCES

13.3.1. Disaster and Emergency Declarations

The following disaster declarations or emergency proclamations related to drought have been issued for California (see Appendix F for details):

- Federal DR or EM declaration, 1953 – 2022: one event, classified as drought
- California Emergency Proclamations, 1950 – 2022: 11 events, classified as drought
- USDA agricultural disaster declarations, 2012 – 2022: 112 events

13.3.2. Event History

Drought played a role in shaping California's early history. The so-called Great Drought in 1863–1864 contributed to the demise of the cattle rancho system, especially in Southern California. A period of extended dry conditions was experienced during most of the 1920s and well into the 1930s, which was when the Dustbowl drought gripped much of the United States. Three 20th-century droughts were of particular importance from a water supply standpoint:

- The 1929–1934 drought was notable for its duration and for its occurrence within a longer period of very dry hydrology. This drought's hydrology was subsequently widely used in evaluating and designing storage capacity and yield of large Northern California reservoirs.
- The 1976–1977 drought served as a wake-up call for California water agencies that were unprepared for major cutbacks in their supplies. Forty-seven of the State's 58 counties declared local drought-related emergencies at that time.
- The 1987–1992 drought stands out because of its six-year duration. Twenty-three counties declared local drought emergencies. Santa Barbara experienced the greatest water supply reductions among the larger urban areas.

Twenty-first century statewide droughts include the three-year 2007–2009 event and the five-year 2012–2016 event. These events were the first statewide emergency proclamations used to respond to drought impacts. They illustrated the effect of a warming climate on drought impacts (DWR 2021a). The experiences of California during recent years have motivated actions to examine more closely the State's water storage, distribution, management, conservation, and use policies.

Drought has affected virtually every county in California at one time or another, causing billions of dollars in damage. Droughts exceeding three years are relatively rare in Northern California, which is the regional source of much of the State's water supply. The 2018 SHMP discussed drought events that occurred in the State from 1972 through February 2017. Drought events in the State since then are listed in Table 13-2. There has never been a FEMA-designated disaster declaration for drought in California.

Table 13-2. Drought Events in the State of California (2017 to 2022)

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties/Areas Impacted
January 2017	Drought	N/A	S4144, S4151, S4157, S4158	Alameda, Alpine, Amador, Calaveras, Contra Costa, Fresno, Imperial, Inyo, Kern, Kings, Los Angeles, Madera, Mariposa, Merced, Mono, Monterey, Orange, Riverside, Sacramento, San Benito, San Bernardino, San Diego, San Joaquin, San Luis Obispo, San Diego, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Stanislaus, Tulare, Tuolumne, Ventura
Impacts from the 2016 drought continued through January 2017 in many counties.				
January – August 2018	Drought	N/A	S4279, S4298, S4303, S4332, S4359, S4390, S4399, S4427, S4460, S4477, S4467	Del Norte, Humboldt, Imperial, Inyo, Kern, Kings, Lassen, Los Angeles, Mendocino, Modoc, Monterey, Nevada, Orange, Placer, Riverside, San Bernardino, San Diego, San Luis Obispo, Santa Barbara, Shasta, Sierra, Siskiyou, Tehama, Trinity, Tulare, Ventura
July was the warmest month in the history of the State. A 120 °F temperature was recorded at the Chino Airport in San Bernardino County on July 6, 2018. Record-breaking temperatures across the State amplified already dangerous fire conditions where vegetation fuels were exceptionally dry and prone to ignition.				
September – November 2019	Drought	N/A	S4647, S4575, S4593	Imperial, Inyo, Kern, Los Angeles, Orange, Riverside, San Bernardino
October started dry, tying for the 10th driest October statewide, with records dating back to 1895. The dryness continued into November.				

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties/Areas Impacted
April – September 2020	Drought	N/A	S4675, S4676, S4691, S4697, S4717, S4715, S4741, S4758, S4765, S4769, S4780, S4797, S4819, S4824, S4859	Alameda, Amador, Butte, Calaveras, Colusa, Contra Costa, Del Norte, El Dorado, Glenn, Humboldt, Imperial, Inyo, Kern, Lake, Lassen, Los Angeles, Marin, Mendocino, Merced, Modoc, Mono, Napa, Nevada, Orange, Placer, Plumas, Riverside, Sacramento, San Benito, San Bernardino, San Francisco, San Joaquin, San Mateo, Santa Clara, Santa Cruz, Shasta, Sierra, Siskiyou, Solano, Sonoma, Stanislaus, Sutter, Tehama, Trinity, Yolo, Yuba
Precipitation was below average, and temperatures were above average. For maximum temperature, August 2020 came in second to 1967. For September, the maximum temperature ranked sixth warmest. On August 16, Death Valley recorded a temperature of 130 °F. Five of the State's largest six fires in history were ignited in August and September.				
October 2020 – May 2021	Drought	N/A	S4915, S4916, S4921, S4923, S4927, S4936, S4941, S4945, S4958, S4963, S4969, S4979, S4995, S5131	Alameda, Alpine, Alpine, Amador, Butte, Calaveras, Colusa, Contra Costa, Del Norte, Del Norte, El Dorado, Fresno, Glenn, Humboldt, Imperial, Inyo, Kern, Kern, Kings, Lake, Lassen, Los Angeles, Madera, Marin, Mariposa, Mendocino, Merced, Modoc, Mono, Monterey, Napa, Nevada, Orange, Pauma and Yuima, Placer, Plumas, Riverside, Sacramento, San Benito, San Bernardino, San Diego, San Francisco, San Joaquin, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Shasta, Sierra, Siskiyou, Solano, Sonoma, Stanislaus, Sutter, Tehama, Trinity, Tulare, Tuolumne, Ventura, Yolo, Yuba

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties/Areas Impacted
October 2021 – April 2022	Drought	N/A	S5145, S5146, S5155, S5157, S5165, S5169, S5208	Alameda, Alpine, Alpine, Amador, Butte, Calaveras, Colusa, Contra Costa, Del Norte, El Dorado, Fresno, Glenn, Humboldt, Imperial, Inyo, Kern, Kings, Lake, Lassen, Los Angeles, Madera, Marin, Mariposa, Mendocino, Merced, Modoc, Mono, Monterey, Napa, Nevada, Orange, Placer, Plumas, Riverside, Sacramento, San Benito, San Bernardino, San Diego, San Francisco, San Joaquin, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Shasta, Sierra, Siskiyou, Solano, Sonoma, Stanislaus, Sutter, Tehama, Trinity, Tulare, Tuolumne, Ventura, Yolo, Yuba
The 2021 water year was the second driest on record, with extreme heat and lack of precipitation. By the end of 2021, all 58 counties in California were placed under a drought emergency proclamation (State of California 2022d). The drought has continued through 2022; as of April 2022, the snowpack of the Sierra Nevada was at 38% of its statewide average (Becker 2022). The State experienced $1.2 billion in crop damage as a result of this drought period.				

13.4. PROBABILITY OF FUTURE HAZARD EVENTS

13.4.1. Overall Probability

The cyclical occurrence of drought and documentation of past and current losses point to the strong probability that California will continue to be vulnerable to short- and longer-term drought impacts. Based on the historical and more recent drought events in California, the State has a high probability of future drought events. According to FEMA, USDA, and NOAA, California experienced 117 drought events between 1950 and 2022. California can anticipate at least one period of drought somewhere in the State every year.

13.4.2. Climate Change Impacts

Climate change is expected to affect California's water supply conditions over the long term, with a significant impact being reduction in mountain snowpack. Climate change models show pronounced impacts—such as loss of half or more of the Sierra Nevada snowpack—by the end of the century, with noticeable impacts occurring by mid-century. Even though some climate models predict that Northern California may be slightly wetter by century's end, the loss of winter storage capacity in mountain snowpack and warmer temperatures will exacerbate drought conditions.

The record warm temperatures California experienced in the winters of Water Years 2014 and 2015 illustrate how future droughts may unfold, with greatly reduced spring runoff into major reservoirs and water temperatures too warm to support anadromous fish populations in many areas. Climate change is intensifying drought impacts, as observed in the 2012-16 drought and in the 2020-2022 drought years. Figure 13-2 illustrates the projected climate shift, showing a warmer average temperature.

Rising temperatures also will affect snowpack. By the end of the 21st century, California's Sierra Nevada snowpack is projected to experience a 48 to 65 percent loss from the historical April 1 average. California's snowpack has historically been an integral part of California's water supply systems (Water Education Foundation 2014).

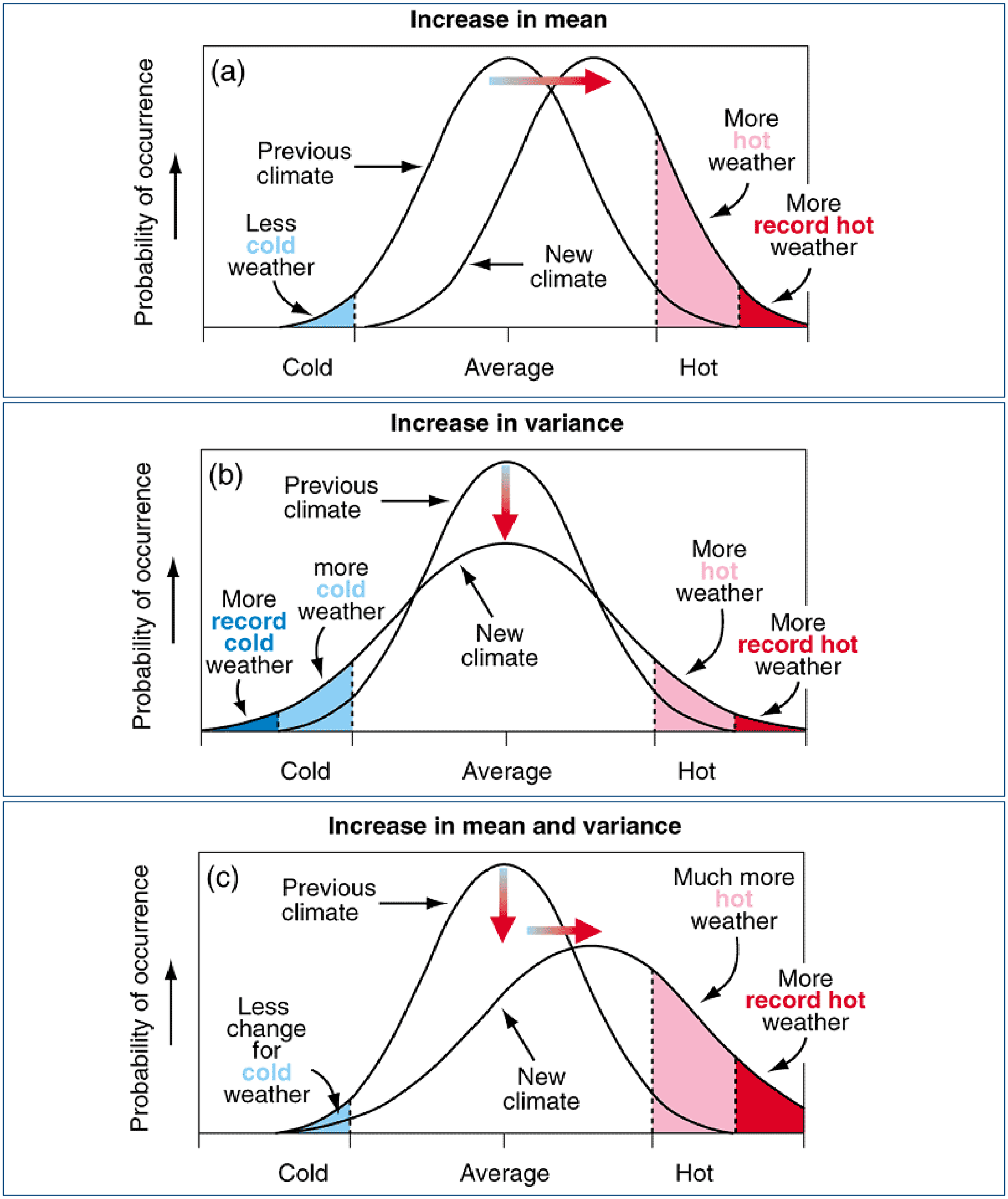
13.5. IMPACT ANALYSIS

13.5.1. Severity

The State of California uses three indicators to define the severity of a drought: weather, runoff, and water supply. Figure 13-3 shows recent (2009 through 2021) drought severity in the State based on indicators commonly used to evaluate water conditions in California.

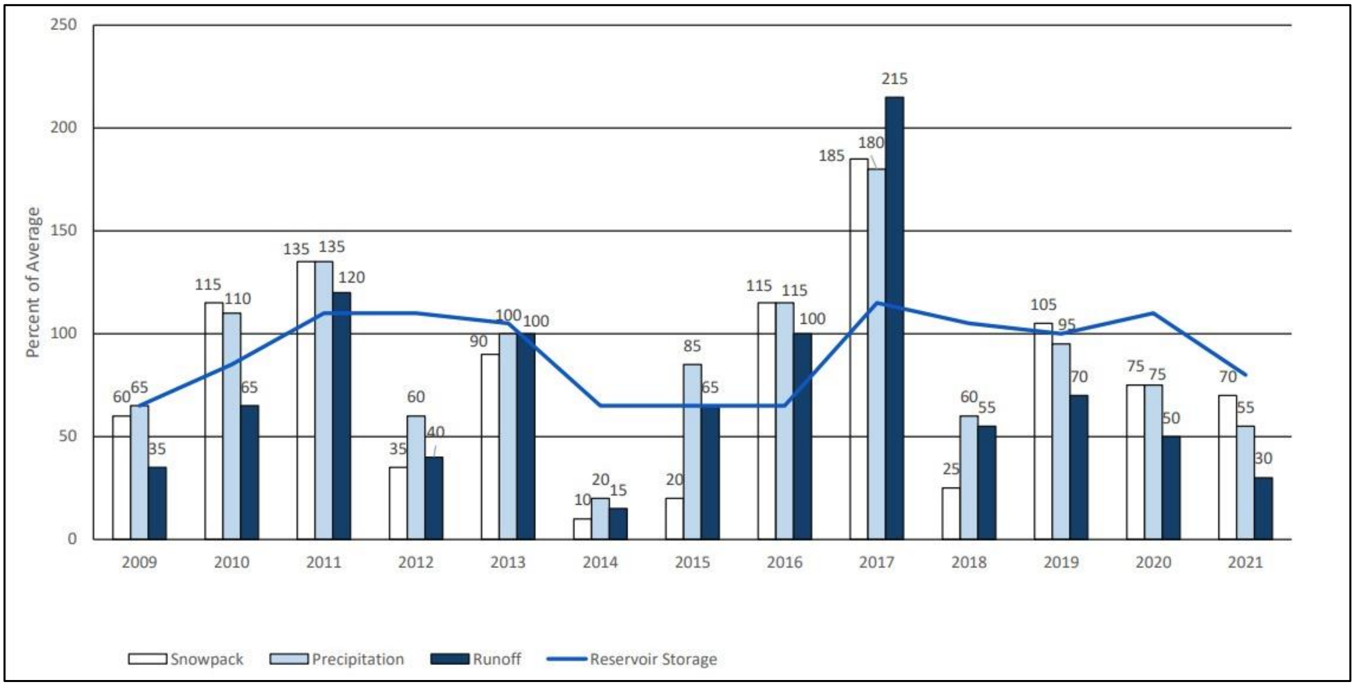
The percentage of average values in the figure is determined by measurements made in each of the State's 10 major hydrological regions. The chart illustrates the cyclical nature of weather patterns in California.

Figure 13-2. Future Climate Shift



Source: (IPCC 2001)

Figure 13-3. Water Supply Conditions, 2009 to 2021



Source: (DWR 2021)

Snowpack and precipitation increased from 2009 to 2011, decreased sharply in 2012, recovered somewhat in 2013, and again dramatically declined in 2014. Snowpack levels in 2015 remained low before reaching average levels again in 2016 (DWR 2021). In 2017, precipitation, snowpack, and runoff were significantly above average (resulting in other hazard events such as flooding), but 2018 followed with rainfall and snowpack well below average. Rainfall and snowpack returned to about average levels in 2019, before falling again in 2020 and 2021 (DWR 2021).

13.5.2. Warning Time

Most of California's moisture originates from the Pacific Ocean. During the wet season, the atmospheric high-pressure belt that sits off western North America shifts southward, allowing Pacific storms to bring moisture to California. On average, 75 percent of the State's average annual precipitation occurs between November and March, with half of it occurring between December and February. A persistent high-pressure zone over California during the peak winter water production months predisposes the water year to be dry.

The ability to reliably predict precipitation conditions at seasonal or annual timescales is very limited. The El Niño-Southern Oscillation—a periodic shifting of ocean-atmosphere conditions in the tropical Pacific that ranges from El Niño (warm phase) to neutral to La Niña (cold phase)—offers only limited predictive capability for precipitation in California. La Niña conditions tend to favor a drier outlook for Southern California, but do not typically show significant correlation with water year type for Northern and Central California. Seasonal precipitation forecasting is an important drought response tool and a research area requiring focused investment to develop the predictive ability needed to support water management. Dry conditions become a drought when the impacts of prolonged dry conditions create problems.

13.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following sections describe notable cascading impacts associated with drought:

Public Health

Drought can lead to various physical and mental health impacts: diminished water quality, groundwater contamination, reduced air quality from arid lands and dust, and increased stagnant water creating breeding grounds for disease-carrying pests, such as mosquitoes. These impacts, in turn, increase the risk of water-borne or food-borne diseases, worsen chronic respiratory conditions or risk of acute respiratory illness, and increase risk of Valley fever as well as vector-borne diseases. Drought and its consequences can also lead to increased mental health impacts, including acute or post-traumatic stress, substance abuse, domestic violence, and suicide.

A 2015 assessment of the potential vulnerability of populations exposed to drought conditions in Tulare and Mariposa counties evaluated household water access, acute stressors, exacerbations of chronic diseases, behavioral health issues, and financial impacts (Barreau, et al. 2017).

The household impact ranged from 3 to 12 percent of households reporting not having running water, 25 to 39 percent reporting impacts on finances, 39 to 54 percent reporting impacts on property, 10 to 20 percent reporting impacts on health, and 33 to 61 percent reporting impacts on peace of mind. Additionally, 16 to 46 percent of households reported worsening conditions for chronic disease, 8 to 26 percent reported worsening conditions for acute stress, and 14 to 34 percent considered moving. Impacts on finances and property were associated with impacts on health, peace of mind, and acute stress levels. Issues related to personal hygiene that could lead to personal health issues included a decrease in frequency or duration of handwashing, which ranged from 58 to 68 percent (CDPH, MCHD 2016); (CDPH, TCHHSA 2016).

Wildfire

Drought can create hazardous conditions in forests and other vegetation-covered spaces, providing fuel for wildfires (LAO 2022). Droughts can also create more prolonged fires fueled by excessively dry vegetation, along with reduced water supply for firefighting (NIDIS n.d.). Bouts of severe drought, heat, and low humidity are becoming more extreme as the climate warms. As climate change makes hot and dry conditions more common and severe, vegetation dries out and landscapes become more flammable, pushing up the odds of dangerous wildfires.

Tree Mortality

Droughts put stress on trees and make them more susceptible to pest infestations. This, in turn, can lead to more diseased, dying, and dead trees, (LAO 2022). Increased tree mortality has resulted in millions of dead trees around the State, causing hazards to people, property, and infrastructure and creating a greater risk of wildfires (Borunda 2020). An estimated 170 million trees in forest lands died between 2010 and 2021. Extreme drought puts additional pressure on already stressed trees, leading to new and expanding mortality. According to the Fourth National Climate Assessment Report, the combination of worsening droughts and expanding bark beetle populations due to warming winters killed 7 percent of the western U.S. Forest area over the past four decades (NCA 2018).

Subsidence

Drought can contribute to land subsidence caused by groundwater pumping from wells. Land subsidence is the phenomenon in which the earth’s surface gradually settles or sinks due to sub-surface activities, primarily groundwater pumping, which compacts aquifer systems (Water Science School 2018). Pumping of groundwater is greatly increased during dry years. Land subsidence due to groundwater pumping can permanently damage or collapse underground aquifers, increase flood risk in low-lying areas, and pose hazards to buildings, infrastructure, and water storage facilities (Water Science School 2018). Long-term subsidence can alter water system flow patterns and exacerbate water managers’ capabilities to move and distribute water supplies to and within subsided affected areas.

Water Quality

Over-pumping of groundwater can diminish the water quality of groundwater supplies through contamination from agricultural runoff or infiltration of saltwater in coastal basins. This can cause water to become unsafe to drink and require costly treatment to remove contaminants. This can be an insurmountable challenge for rural residents who rely on private wells for drinking water, as well as small, rural water systems that are dependent on local basins or aquifers (Hanak, Chappelle and Harter 2017). These impacts can lead to localized conflicts, anxiety, and stress, as well as increased risk of infectious diseases, such as water- or food-borne diseases (CDC 2020). Over-pumping of groundwater can diminish the water quality of groundwater supplies through contamination from agricultural runoff, movement of nearby contaminated aquifers into non-contaminated aquifers, or infiltration of saltwater in coastal basins.

Energy

All sources of energy require water in their production processes, and energy is required to extract, convey, and deliver water. Because energy and water are so interdependent, the availability and predictability of water resources can directly affect energy systems.

Dust Storms

Reduced moisture in air and soil and longer periods between precipitation periods can result in increased coating of dust and other contaminants, mainly impacting electrical transmission lines.

13.5.4. Environmental Impacts

Drought affects animal and plant species. A 2016 CDFW report on wildlife affected by the 2012-2016 drought indicated that amphibian, reptile, bird, and mammal populations that depend on freshwater marsh, streamside habitat, and wet meadows struggled the most to endure the drought. Tribal Nations from Owens Valley in the Eastern Sierra region saw near loss of an entire habitat that holds cultural significance, as drought accompanied by over-pumping groundwater and exporting water from Owens Valley to Los Angeles resulted in loss of alkali meadows (State of California 2018). The lack of surface water affects migratory birds and alters their patterns, which in turn can impact agriculture that relies on migratory bird habitat within the ecosystem.

The lack of surface water also threatens salmon and other fish species in California rivers. And it forces farmers to pump more water from groundwater aquifers, which leads to land subsidence that also stresses infrastructure.

13.5.5. Local Hazard Impacts

LHMP Rankings

Of the 58 counties in California, 54 assessed drought as a hazard of concern in their hazard mitigation plans. Of these, 30 ranked drought as high risk, 17 ranked it as medium risk, and seven ranked it as low risk. The following counties listed drought as a high-risk hazard:

- Alameda
- Alpine
- Butte
- Calaveras
- Colusa
- El Dorado
- Glenn
- Inyo
- Kern
- Kings
- Lake
- Lassen
- Los Angeles
- Madera
- Mendocino
- Merced
- Modoc
- Monterey
- Napa
- Nevada
- Placer
- San Diego
- San Luis Obispo
- Santa Barbara
- Santa Cruz
- Solano
- Stanislaus
- Trinity
- Yolo
- Yuba

LHMP Estimates of Potential Loss

A review of the LHMPs in the counties (as called for in FEMA's Standard State Mitigation Planning Requirement S6.b) found no quantitative risk analysis that identifies population or structures exposed to this hazard. This can be attributed to the lack of extent and location hazard mapping to use for such an analysis. Therefore, no summary of risk for local plan reviews is provided for this hazard.

13.6. VULNERABILITY ANALYSIS

13.6.1. Exposure of State-Owned or -Leased Facilities, Critical Facilities, and Community Lifelines

For drought, the entire State of California is exposed and vulnerable. Drought events generally do not impact buildings. No structures are anticipated to be directly affected by a drought, and all are expected to be operational during a drought event. However, facilities that provide potable water may be affected by short supplies of water.

13.6.2. Estimates of Loss

Drought can impact the economy, including loss of business function and damage and loss of inventory. Economic impacts may include the following:

- Losses from crop, livestock, timber, and aquaculture production and associated businesses
- Losses from recreation providers and associated businesses
- Increased costs resulting from increased energy demand and from shortages caused by reduced hydroelectric generation capacity
- Revenue losses for federal, State, and local governments from a reduced tax base and for financial institutions from defaults and postponed payments
- Long-term loss of economic growth and development

Even though the majority of businesses will still be operational, they may be impacted aesthetically. These aesthetic impacts are most significant to the recreation and tourism industry which is an important part of the State's economy. In 2021, the tourism industry brought in over $100 billion, contributing to $9.8 billion in State and local tax revenue and supported 927,100 jobs (CalChamber 2022).

Industries that rely on water for business may be impacted the hardest (e.g., agriculture/aquaculture). A prolonged drought event could have significant impacts in counties that have large amounts of agricultural lands. According to the current Census of Agriculture 2017 State Profile, there are 70,521 farms across California covering more than 24 million acres. The market value of products sold is estimated at $45.1 billion (USDA 2017).

13.6.3. Buildable Lands

An estimated 11.7 million acres of land is available for development in California. Because the entire State is vulnerable to drought, any type of development of any of this land will be susceptible to damage and impacts from this hazard. With ongoing development, the demand for water will increase, exacerbating drought instances. As water is drawn down from increased rates of use, drought can occur more readily than from lack of precipitation alone.

13.6.4. Equity Priority Communities

The 2012-2017 drought adversely affected at least one public water system in 39 of the State's 58 counties, and the most impacts were seen in the San Joaquin Valley, North Coast, and Central Coast regions. A study of that drought found that, among 92 drought-affected water systems, two-thirds served a disadvantaged community (characterized by a medium household income less than 80 percent of the State median) and almost one-third served a cumulatively burdened community (a community that ranks in the top quarter of census tracts in the State for environmental burdens and socioeconomic vulnerability) (Feinstein, et al. 2017). These communities include rural communities, and those with high rates of low-income households, as well as federally and non-federally recognized Tribal Nations. The lack of available water during a drought impacts culturally significant habitat and species. Tribal Nations usually do not have recourse to provide additional water supplies to protect such culturally significant habitat and species.

Overall, the entire population of the State of California is exposed and vulnerable to drought. Therefore, the exposed population to drought in equity priority communities is equal to the statewide percentage: 30.4 percent of the total population (12 million people). The sections below describe potential drought impacts on specific equity priority communities.

Tribal Nations

The State's history has left many Tribal Nations with limited or no access to their traditional or culturally significant water sources, (Secaira 2021); (State of California 2018). Furthermore, Tribal Nations that do have autonomous water systems do not have the funding to properly maintain this infrastructure, due to their low population size and resources. This places Tribal Nation residents at greater risk of exposure to contaminated water or loss of water as a result of drought (National Integrated Drought Information System 2022a).

Farmworkers

When surface water runs dry in a drought, farms become increasingly reliant on groundwater. Not all farms have access to sufficient groundwater, and some owners opt to leave their farmland uncultivated during a prolonged drought. During the height of the drought in 2015, California experienced a 45 percent increase in idle land area and lost over 10,000 seasonal farming jobs (Mahadevan 2021).

Low-Income Communities of Color

Low-income communities of color in California, especially in the Central Valley, are highly vulnerable to drought (Mahadevan 2021). Hispanic/Latina/e/o residents make up about 40 percent of the population in the Central Valley. About 25 percent of households in the region experience poverty. These residents were highly vulnerable during the 2012-2017 drought as they were both a majority of rural farmworkers vulnerable to job losses and disproportionately living in areas that lost access to safe drinking water (Mahadevan 2021).

During the 2012-2017 drought, 50 percent of State emergency food assistance was distributed to Tulare County residents (Feinstein, et al. 2017). Reduced food production as a result of drought can cause food prices to increase, and those who experience food insecurity or are low-income may be further burdened with limited access to affordable, healthy food (EPA 2022a).

Households Using Wells for Water Supply

Dry household wells are a major problem for vulnerable communities. In Tulare County during the 2012-2017 drought, for example, two-thirds of 1,600 reported dry wells were in a disadvantaged community, and nearly 90 percent were in a cumulatively burdened community.

13.6.5. NRI Scores

According to the NRI, 55 of the State’s counties have drought risk, rated from very low to very high. Table 13-3 shows scores for the six counties with the highest rating. See Section 4.1.3 for a description of the components of the NRI.

Table 13-3. NRI Scoring of Counties for Drought

County	Expected Annual Loss	Social Vulnerability Rating	Community Resilience Rating	Community Risk Factor	Risk Value	Score
Santa Barbara	$214,679,980	Very High	Relatively Moderate	1.21	$255,580,287	100
Yolo	$101,615,001	Relatively High	Relatively High	1.26	$127,479,110	99.97
Sutter	$72,530,063	Relatively High	Relatively Moderate	1.36	$96,884,296	99.94
Napa	$85,116,691	Relatively High	Relatively High	1.17	$96,048,060	99.90
Colusa	$61,575,357	Relatively High	Relatively Low	1.48	$90,715,786	99.87
Butte	$57,215,924	Very High	Relatively High	1.25	$67,313,611	99.81

13.7. MITIGATING THE HAZARD

13.7.1. Existing Measures for Mitigating the Hazard

Hazard mitigation planning can help the State reduce the impact of droughts in California and plan for future events. Since 2016, California has made key improvements to its drought response:

- Requiring local agencies to bring over-drafted groundwater basins into sustainable conditions by 2042 (under the Sustainable Groundwater Management Act)
- Establishing new standards for indoor, outdoor, and industrial use of water
- Funding solutions for disadvantaged communities lacking access to safe drinking water
- Increasing the frequency of water use reporting
- Ordering failing public water systems to consolidate with better-run systems
- Tightening landscape efficiency standards for new developments
- Analyzing the drought risk of thousands of water suppliers
- Gathering stakeholder recommendations on drought contingency plans
- Assessing failing or at-risk water systems across the State and compiling the first-ever comprehensive needs assessment

- 2018 legislation required larger urban water suppliers to plan for 5 years of drought, up from 3 years, in the water shortage contingency plan element of their Urban Watershed Master Plans
- SB 552 for the first time required drought planning for smaller suppliers and by counties on behalf of the smallest suppliers and self-supplied residential properties

13.7.2. Opportunities for Mitigating the Hazard

A range of potential opportunities for mitigating the hazard is provided in Table 13-4. See Section 1.2.3 for a description of the different types of alternatives.

13.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address the drought hazard:

- Action 2023-005: Coordinate planning efforts for aquifer storage and recharge actions within areas of known liquefaction risk so that the liquefaction risk is not increased by the storage basin mitigation action.
- Action 2018-048: California Water Plans: Ensure reliable water supplies and foundational actions for sustainable water use in California.
- Action 2018-075: State Water Efficiency and Enhancement Program: Reduce agricultural water usage through installation of more efficient irrigation practices.
- Action 2018-079: California Drought Contingency Plan: Minimize drought impacts by improving agency coordination and enhancing monitoring and early warning capabilities.

Table 13-4. Potential Opportunities to Mitigate the Drought Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ Recycle gray water **Reduce exposure and vulnerability:** ▪ Drought-resistant landscapes ▪ Reduce water system losses ▪ Modify plumbing systems through water saving kits ▪ For homes with on-site water systems, increase storage, utilize rainwater catchment ▪ Increased access to water testing **Build local capacity:**	**Manipulate the hazard:** ▪ Recycle gray water **Reduce exposure and vulnerability:** ▪ Drought-resistant landscapes ▪ Reduce water system losses ▪ Support alternative irrigation techniques to reduce water use and use climate-sensitive water supplies ▪ For businesses with on-site water systems, increase storage, utilize rainwater catchment ▪ For corporate-owned farms, reduce over-pumping/over-reliance on groundwater and identify methods to reduce overall water use **Build local capacity:**	**Manipulate the hazard:** ▪ Groundwater recharge through stormwater management ▪ Develop a water recycling program ▪ Increase "above-the-dam" regional natural water storage systems ▪ Maintain and improve Delta levees **Reduce exposure and vulnerability:** ▪ Identify and create groundwater backup sources ▪ Water use conflict regulations ▪ Reduce water system losses ▪ Distribute water saving kits ▪ Increase conventional storage that is filled during high-flow periods ▪ Create water storage space to capitalize on big storms when they occur and store water for dry periods ▪ Capture stormwater and desalinate ocean water and salty water in groundwater basins ▪ Expand average annual groundwater recharge ▪ Rehabilitate dams to regain storage capacity ▪ Mutual aid/financial support for farmworkers or disadvantaged-population-owned farms that must fallow their land ▪ Regularly maintain and improve Delta levees **Build local capacity:** ▪ Public education and intentional community engagement on drought mitigation plans ▪ Identify alternative water supplies for times of drought, mutual aid agreements with alternative suppliers ▪ Work with Tribal Nations to regain water access/rights and increase water sources managed by Tribal Nations (to redress historical and

Community-Scale	Organizational Scale	Government-Scale
▪ Practice active water conservation	▪ Practice active water conservation ▪ Participate in the Integrated Regional Water Management program	current harms, and reduce over-pumping and syphoning/channeling of water) ▪ Develop drought contingency plans ▪ Develop criteria triggers for drought-related actions ▪ Improve accuracy of water supply forecasts ▪ Modify rate structure to influence active water conservation techniques ▪ Consider the probable impacts of climate change on the risk associated with the drought hazard ▪ Support, participate in and advocate for funding for the Integrated Regional Water Management program ▪ Support, encourage, and implement multi-benefit nature-based recharge projects such as off-channel wetlands that provide habitat and groundwater filtration and infiltration ▪ Improve data collection and modernize forecasts for a changed climate ▪ Continue to support the Delta Levees Program to mitigate impacts on water supply ▪ Improve sub-seasonal to seasonal precipitation forecasting to support actions such as Forecast-Informed Reservoir Operations and Flood-MAR
Nature-based opportunities ▪ Promote and use reclaimed water supplies ▪ Increase capacity for stored surface water to create habitats and ecosystems for aquatic species ▪ Promote and use active groundwater recharge		

TSUNAMI AND SEICHE

Climate Impacts:
Tsunamis are geologically driven events and are therefore not likely to be directly impacted by climate change; increases in severe storm events may result in an increased probability of seiches

Equity Impacts:
10.2% of exposed population (those living in mapped tsunami inundation areas) identified as living in equity priority communities

State Facilities Exposed:
994 facilities in the mapped tsunami inundation area

Community Lifelines Exposed:
43 lifelines in the mapped tsunami inundation area

Impact Rating: Medium (24)

14. Tsunami and Seiche

The tsunami and seiche hazard have been identified as a medium-impact natural hazard of interest based on the hazard impact rating protocol applied for this SHMP. These events happen frequently and impact only the coastal exposures of the State. Less than 5 percent of State-owned or -leased facilities and community lifelines are exposed to this hazard. Less than 1 percent of the population resides in tsunami inundation area; over 10 percent of that population has been identified as living in equity priority communities. Less than 1 percent of buildable land in the State intersects mapped tsunami inundation areas. While the frequency of tsunamis is not anticipated to significantly increase over the next 100 years due to impacts from climate change, there could be an associated increase in severity in these events when they do occur due to the impacts from sea-level rise.

14.1. HAZARD OVERVIEW

14.1.1. Tsunami

A tsunami is a wave triggered by any form of land displacement along the edge or bottom of an ocean or lake. Submarine landslides or submarine seismic events can move the overlying water at the surface and cause a tsunami (W. F. Chen and C. Scawthorn 2003). The size of the tsunami is proportional to the mass of material that moved to generate it. A tsunami also can be generated from air pressure disturbances associated with fast-moving weather systems, but these events are often minor and are uncommon on the West Coast.

Tsunamis travel radially outward from the area of initiation. They can travel at speeds of over 600 miles per hour in the open ocean and can grow to over 50 feet in height when they approach a shallow shoreline.

Tsunamis can originate near the affected shoreline (local source tsunamis) or far from it (distant source tsunamis). Local tsunamis present higher risk because they leave exposed populations only a few minutes to find safety. As a tsunami approaches the shore and the water depth decreases, the energy in the wave pushes the wave crest above the water surface resulting in a larger wave height. Wave run-up is the elevation above mean sea level on dry land that a tsunami reaches. Run-up inundates coastal areas that are below the run-up height (W. F. Chen and C. Scawthorn 2003).

At some locations, the advancing turbulent wave front is the most destructive part of a tsunami. In other situations, the greatest damage is caused by the outflow of water back to the sea between crests, sweeping away items on the surface and undermining roads, buildings, bulkheads, and other structures. This outflow action can carry enormous amounts of highly damaging debris, resulting in further destruction. Ships and boats, unless moved away from shore, may be forced against breakwaters, wharves, and other craft, or be washed ashore and left grounded after the seawater withdraws.

Tsunami hazards include coastal flooding, strong damaging currents, extreme water-level fluctuations, eddies, erosion, and sedimentation. Once coastal areas become flooded, any subsequent, tsunami-induced hazards can include free-floating debris and environmental contamination from spills (W. F. Chen and C. Scawthorn 2003).

14.1.2. Seiche

A seiche is a large wave in a body of water that has been disturbed by wind, atmospheric pressure variations, or seismic activity. The wave travels the length of the water basin and reflects off the other end or sides. These reflected waves can then interfere with each other and create amplified standing waves. Seiches can occur in large bays or lakes as well as large, odd-shaped harbors.

14.2. HAZARD LOCATION

The Cascadia Subduction Zone is the most significant local tsunami source for the California coast north of Cape Mendocino. This subduction zone stretches from the coast of British Columbia to offshore of California north of Cape Mendocino. It could generate large tsunami surges onshore within minutes after an earthquake. The most significant tsunami source region for the entire State from a distant-source event is the subduction zone off the coast of the eastern Aleutian Islands.

In addition, local tsunamis can be caused by offshore faults or coastal and submarine landslides and have the potential to cause locally greater wave heights that pose a threat to the State. The largest historical local-source tsunami on the west coast was caused by the 1927 Point Arguello, California, earthquake that produced waves of about 7 feet in the nearby coastal area.

CGS and Cal OES have prepared California tsunami hazard area maps and data to assist cities and counties in identifying the tsunami hazard for their tsunami response planning. These maps and data are compiled with the best currently available scientific information and represent areas that could be exposed to tsunami hazards during a tsunami event. They are based on the State of California 2009 Tsunami Inundation Maps for Emergency Planning (recently updated in 2021-2022) and enhanced high-resolution, 975-year return period probabilistic tsunami inundation model results.

The boundaries of tsunami hazard areas are defined by CGS. These limits have been extended to reflect potential local tsunami sources not considered in probabilistic analysis and are modified to reflect the practical need to define limits that coincide with geographic features or city streets. Local stakeholders, including emergency managers, first responders, and subject matter experts, are consulted on the placement of the final hazard area in places that would help the public and government safely evacuate during a tsunami event. Figure 14-1 shows the approximate extent of the maps for the entire State. These maps can be viewed in higher detail and resolution at: https://www.conservation.ca.gov/cgs/tsunami/maps.

Seiches can occur in natural basins such as Lake Tahoe or human-made basins such as the Ports of Los Angeles and Long Beach.

Figure 14-1. Tsunami Hazard Areas

14.3. PREVIOUS HAZARD OCCURRENCES

14.3.1. Disaster and Emergency Declarations

The following disaster declarations or emergency proclamations related to tsunami or seiche have been issued for California (see Appendix F for details):

- Federal DR or EM declaration, 1953 – 2022: Two events, classified as "tsunami waves" and "seismic sea waves"
- California Emergency Proclamations, 1950 – 2022: Two events, classified as tsunami
- USDA agricultural disaster declarations, 2012 – 2022: None

14.3.2. Event History

Geological evidence indicates that large Cascadia earthquakes and associated tsunamis have occurred at least 19 times over the past 10,000 years. Event recurrence varies from 200 years to more than a thousand years over that 10,000-year period. A 2005 report by SSC indicates that over 80 tsunamis have been observed or recorded along the coast of California in the past 150 years (SSC 2005).

NOAA's Global Historical Tsunami Database identifies 831 wave runup events impacting the California coastline since 1806 (NCEI 2023).

The following sections describe the most recent event to affect California and the largest known event.

Most Recent Tsunami Affecting California

An underwater volcano erupted near the island of Tonga on January 15, 2022, generating a tsunami. Strong currents, rising tides, tsunami waves, and minor damage were reported in four California coastal counties (NOAA 2023a); (FEMA 2022u); (USDA 2022):

- In Santa Cruz County, wave energy caused $6.5 million in damage to Santa Cruz Harbor. Damage was inflicted on utility infrastructure, pilings, and bathroom facilities, as more than 3 feet of water poured in. Waves knocked out power around the harbor docks, where many people live on their boats.

- In Monterey County, the tsunami caused at least $3 million in damage to the Moss Landing Harbor District. There was also potential damage to the shoreline and a possible need for dredging.
- In Orange County, damage was reported across the coast, including a buoy reported to be broken off from Huntington Bay.
- In San Diego County, water rise of 0.6 feet was reported at La Jolla and 1.7 feet at San Diego Bay. Strong currents were observed at San Diego Bay. Minor damage was reported across the coast, including damaged ballast pipes and damage to floating docks. The county issued wireless emergency alerts through the morning.
- In Ventura County, damage occurred in Ventura Harbor. A 100-foot section of a dock was broken off with a 75-foot yacht attached. A Harbor Patrol boat capsized. This event occurred about seven years after the last event recorded in California, which was the September 2015 event triggered by an 8.3 magnitude earthquake that struck off the coast of Chile.

Largest Known Tsunami Affecting California

In 1700, an earthquake estimated at magnitude 9.0 ruptured along the Cascadia Subduction Zone. Scientists originally recognized the event from geological evidence and oral histories from the Native American people in the area as no local, written accounts of the event exist. This information was eventually cross-referenced with Japanese documents that described an “orphan” tsunami that was not accompanied by a large earthquake in Japan. The exact date and time of this earthquake are known because of a combination of tsunami deposit evidence, carbon-14 and tree-ring dating, tsunami modeling, and historical Japanese records (The Seattle Times 2021).

14.4. PROBABILITY OF FUTURE HAZARD EVENTS

14.4.1. Overall Probability

Based on the previous tsunami and seiche events, California can expect a tsunami event about every five years.

14.4.2. Climate Change Impacts

The earthquakes and landslides that create tsunamis could be impacted by climate change. Some scientists say that melting glaciers could induce tectonic activity. Heavy rainfall could cause soil instability that may increase the likelihood of landslides into water bodies, which can generate tsunamis. Increases in severe storms may result in an increased probability of seiches. Rising seas could result in an increase in wave runup when tsunamis occur. Even modest rises in sea level will dramatically increase the frequency and intensity of flooding when a tsunami occurs, as the tsunami can travel further inland. Future smaller tsunamis could have the same impact as larger tsunamis today. A warming climate can increase the risk of underwater and above ground landslides, thereby increasing the risk of local tsunamis.

14.5. IMPACT ANALYSIS

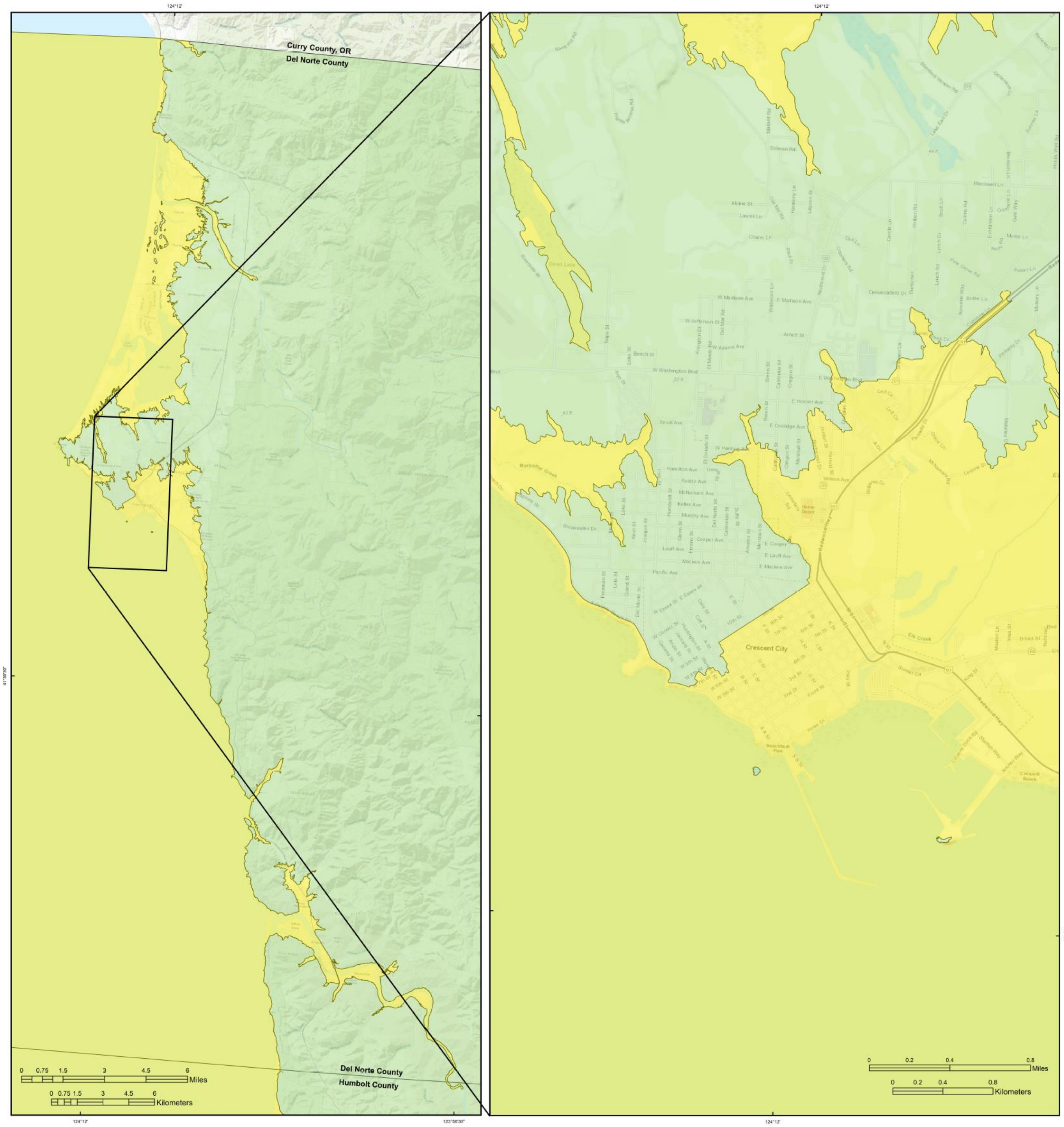
14.5.1. Severity

In tsunami-inundation mapping developed by the California Tsunami Program and the University of Southern California Tsunami Research Center, projected maximum tsunami flood elevations varied from 25 to 50 feet along the coast north of Cape Mendocino, from 15 to 30 feet along the coast from Cape Mendocino to Point Conception, from 3 to 12 feet within the San Francisco Bay, and from 5 to 15 feet south of Point Conception. Figure 14-2 shows an example local area tsunami inundation map for Crescent City prepared by CGS.

14.5.2. Warning Time

The cause of a tsunami (earthquake, landslide, etc.) and its distance from the coast determine the warning time. Warning times can range from a little less than a day for an event triggered in the South Pacific Ocean to no warning at all for events triggered locally (NCEI n.d.). NOAA developed Deep-Ocean Assessment and Reporting of Tsunami (DART) systems to detect, measure, and report tsunamis in the open ocean in real-time. The NWS National Data Buoy Center operates and maintains the U.S. network of DART systems, which is part of a larger international network. The Tsunami Warning Center, a branch of the National Weather Service, releases tsunamis warnings. The National Tsunami Warning Center in Palmer, Alaska, serves the continental United States, Alaska, and Canada. (NWS n.d.-b).

Figure 14-2. Tsunami Inundation Map—Crescent City



Source: (CGS 2022)

The Tsunami Warning Center depends on an observation system that includes seismic and water-level networks from around the world to help determine when and where to issue tsunami messages. These networks are critical to the warning centers' ability to provide timely and accurate messages (NWS n.d.-b):

- Seismic Networks—When an earthquake occurs, seismic networks provide information about the location, depth, magnitude, and other characteristics. The warning centers analyze this information to determine if the earthquake could have generated a tsunami and if a tsunami message is necessary.
- Water-Level Networks—If an earthquake meets certain criteria, the warning centers turn to water-level information, looking for changes in water-level height that could indicate the existence and size of a tsunami. The primary sources of information about water-level change are a network of DART systems and an extensive array of coastal water-level stations. Tsunami warnings are typically issued following coastal earthquakes of magnitude 6.5 or greater for U.S. and Canadian Atlantic and Gulf coasts, and magnitude 7.1 or greater for all coasts along the Pacific Ocean and Caribbean Sea.

In most cases, the first sign of a potential tsunami is an earthquake. Seismic waves travel about 100 times faster than tsunamis, so information about an earthquake is available before information about any tsunami it may have generated. The Tsunami Warning Center uses preliminary seismic information on an earthquake's location, depth, and magnitude to decide if it should issue a tsunami message and at what alert level. The warning center then conducts additional seismic analysis and runs tsunami forecast models using information from the seismic and water-level networks as it becomes available. The resulting forecasts, combined with historical tsunami information and additional seismic analysis, help the warning center decide if it should issue an updated or cancellation message (NWS n.d.-b).

It is more difficult to forecast non-seismic tsunamis (caused by landslide, volcanic activity, or atmospheric factors), which can arrive with little to no warning. Even if a DART system or coastal water-level station detects a non-seismic tsunami, there may not be time to develop a detailed forecast (NWS n.d.-b).

For local tsunami sources, where there are only minutes before a tsunami can arrive after an earthquake, people must rely on the "natural" warnings of a tsunami. These natural warning signs include feeling strong shaking from the earthquake, observing the water receding away from the beach, and hearing a loud rumbling wave coming toward the shore. The only way to prepare the public is to educate them about tsunamis and the natural warning signs. The California Tsunami Program and local emergency managers hold workshops and meetings to continuously educate the public about tsunamis, so they know what to do and where to evacuate.

14.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with tsunami or seiche:

- Tsunami inundation can result in flooding, erosion and scouring, debris movement and impact, water contamination, and spread of disease due to standing water.
- Loss of wetlands from erosion and wetland migration due to tsunami inundation can reduce the natural filtration provided by wetland plants, increasing the likelihood of water quality issues.
- Healthy coastal ecosystems support fisheries, tourism, human health, and public safety. Many of these ecosystems are being transformed, degraded, or lost due in part to climate change, particularly sea-level rise and higher numbers of extreme weather events.
- Indirect economic costs (such as lost business) and adverse socio-psychological impacts have the potential to negatively affect people and their communities.
- Individuals exposed to weather- or climate-related disasters have been shown to experience negative mental health impacts. Among those most likely to suffer these impacts are some of society's most priority populations.
- Fires can be fueled by spreading water-borne liquid fuels released from petrochemical facilities damaged by the tsunami. These are referred to as "tsunamigenic fires."

14.5.4. Environmental Impacts

Ecosystems within the inundation areas for tsunamis and seiches that can withstand periodic inundation, such as wetlands, may be relatively unharmed by minor events. However, severe events that result in larger inundation areas may result in negative environmental impacts due to sediment, erosion, debris, saltwater and pollutant contamination of soil and water bodies, and other impacts (Geoffrey S. Plumlee 2013).

14.5.5. Local Hazard Impacts

LHMP Rankings

Of the 58 counties in California, 15 assessed tsunami or seiche as a hazard of concern in their hazard mitigation plans. Of these, two ranked this hazard as high risk (Del Norte and Santa Cruz), five ranked it as medium risk, and eight ranked it as low risk.

LHMP Estimates of Potential Loss

Table 14-1 summarizes potential losses to vulnerable structures based on estimates from the local risk assessments (as called for in FEMA's Standard State Mitigation Planning Requirement S6.b). Due to variances in approaches to assessing risk at the local level as well as the hazards assessed and the age of each assessment reviewed, this data is considered approximate.

Table 14-1. Tsunami Risk Exposure Analysis for LHMP Reviews

Estimated Total Population Exposed	262,461
Estimated Number of Structures at Risk	54,607
Estimated Value of Structures at Risk	$13.67 billion

14.6. VULNERABILITY ANALYSIS

To assess the vulnerability of State assets to the tsunami hazard, GIS software was used to overlay State assets with mapped tsunami inundation areas (see Figure 14-1).

14.6.1. Exposure of State-Owned or -Leased Facilities

Table 14-2 and Table 14-3 summarize the numbers and replacement cost value of State-owned or -leased assets within the mapped tsunami inundation areas. Figure 14-3 summarizes the exposed assets as a percentage of total assets statewide. Appendix I provides detailed results by county.

Table 14-2. State-Owned or -Leased Facilities Exposed to the Tsunami Hazard

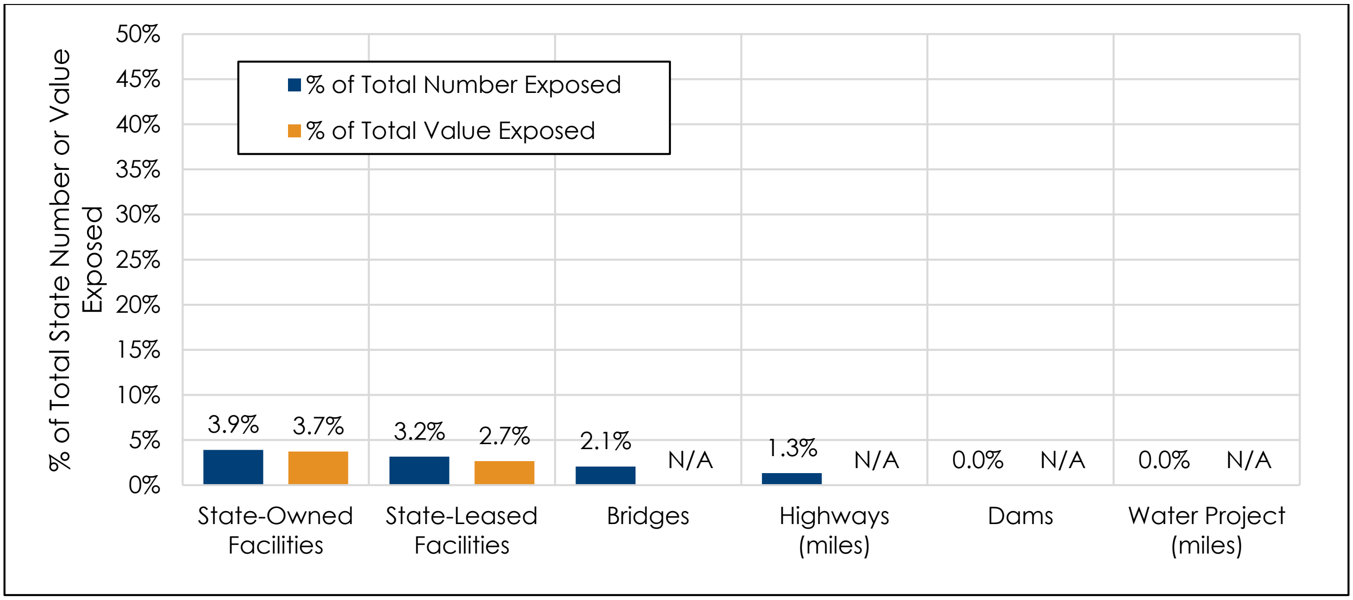
Type of Facility	Number of Structures	Total Area (sq. ft.)	Replacement Cost Value		
			Structure	Content	Total
State-Leased Facilities	60	—	$251,248,391	$244,989,719	$496,238,110
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	3	174,077	$6,184,245	$3,160,553	$9,344,798
Development Center	0	0	$0	$0	0
Hospital	0	0	$0	$0	0
Migrant Center	0	0	$0	$0	0
Special School	0	0	$0	$0	0
All Other Facilities	931	2,275,168	$691,272,289	$671,568,162	$1,362,840,452
Total State-Owned	***934***	***2,449,245***	***$697,456,535***	***$674,728,715***	***$1,372,185,250***
Total Facilities	**994**	**N/A***	**$948,704,926**	**$919,718,434**	**$1,868,423,359**

* The inventory of State assets does not include building area for State-leased facilities, so no total area for all State facilities is provided; the building area of vulnerable assets is shown for State-owned facilities only.

Table 14-3. State-Owned or -Leased Infrastructure Exposed to the Tsunami Hazard

Type of Facility	State-Owned Infrastructure in the Mapped Hazard Area
Bridges	273
Highway (miles)	401.3
Dams	0
Water Project (miles)	0

Figure 14-3. State Assets Exposed to Tsunami Inundation as % of Statewide Total



The following are significant results of the analysis of State-owned assets in mapped tsunami inundation areas:

- For facilities that the State owns within the tsunami inundation area, the average building area is 2,622 square feet, with an average replacement cost value of $1.5 million.
- The average replacement cost value for State-leased facilities within the tsunami inundation area is $496 million.
- The five State agencies with the most State-owned or -leased facilities within the tsunami inundation area are State Parks (690), District Agriculture Associates (166), CDFW (75), CSU (14) and Caltrans (12).

- The State agency with the highest total replacement cost for State-owned or -leased facilities within the tsunami inundation area is the District Agriculture Associations at $857 million.

14.6.2. Exposure of Critical Facilities and Community Lifelines

Table 14-4 summarizes the total number of critical facilities, by community lifeline, located in the tsunami inundation areas statewide. The County with the largest percentage of exposed community lifelines is Alameda (23.2 percent) followed by Los Angeles (18.6 percent) and San Francisco (14 percent). Appendix I provides detailed results by county.

Table 14-4. Critical Facilities and Community Lifelines Exposure to Tsunami

Lifeline Category	Total Number of Facilities	Number of Facilities in Hazard Area	% of Total Facilities
Communications	42	1	2.4%
Energy	176	5	2.8%
Food, Water, Shelter	257	5	1.9%
Hazardous Material	56	0	0.0%
Health & Medical	47	1	2.1%
Safety & Security	46	0	0.0%
Transportation	131	31	23.7%
Total	**755**	**43**	**5.7%**

Critical facilities and community lifelines that are exposed to the tsunami and seiche hazard are likely to experience functional downtime following these events, which could increase the net impact of the event. Hazus estimates damage and functional downtime for tsunami scenarios. Local governments are encouraged to use tools such as Hazus when creating or updating their LHMPs.

14.6.3. Estimates of Loss

While models exist that can estimate damages for tsunami events, it was not feasible to model the 994 facilities identified as exposed to the tsunami hazard. To estimate losses to these exposed facilities, this Plan applies the methodologies that FEMA's Hazus risk assessment platform uses for tsunami hazards. The Hazus methodology applies loss ratios of 15, 50, and 85 percent that consider factors associated with building strength. Each of the three loss ratios considers two lateral strength conditions:

- Building strength corresponding to modern construction in a high seismic region (high-code)
- Building strength corresponding to older construction (pre-code)

Table 14-5 shows the loss estimations applying this methodology.

Table 14-5. Tsunami Loss Estimation Summary

State Asset	15% Loss Ratio	50% Loss Ratio	85% Loss Ratio
State-Owned	$205,827,787	$686,092,625	$1,166,357,462
State-Leased	$74,435,716	$248,119,055	$421,802,393
Total	**$280,263,503**	**$934,211,680**	**$1,588,159,855**

14.6.4. Buildable Lands

The State has over 11.7 million acres of land available for development and 0.35 percent (40,808 acres) is within the tsunami inundation area. Any type of development in these exposed areas will be susceptible to damage associated with a tsunami event.

With its growth management policies and active participation in the NFIP, the State is well equipped with regulatory oversight of new development that may occur within these buildable lands. State regulations have provisions that significantly overlap the inundation areas and the mapped floodplain. The State will need to continually improve its understanding of tsunami risk within these buildable land areas so that its regulatory capacity can be effective.

14.6.5. Equity Priority Communities

The cost of interventions to protect properties from tsunami and seiche risk may financially stress lower- or middle-income residents. Relocating may be difficult because of the expenses and the availability of accessible housing or the time needed to make housing accessible.

The population over the age of 65 is also more vulnerable and, physically, may have more difficulty evacuating during tsunami and seiche events. They may require extra time or outside assistance during evacuations and are more likely to seek or need medical attention, which may not be available due to isolation during a tsunami or seiche event.

The risk analysis for tsunami found that 10.2 percent of people living in the mapped tsunami inundation area live in equity priority communities (35,891people). A breakdown of by county is included in Appendix I.

14.6.6. NRI Scores

According to the NRI, 19 of the State's counties have tsunami risk, rated from very low to relatively high. Table 14-6 shows scores for the six counties with the highest rating. See Section 4.1.3 for a description of the components of the NRI.

Table 14-6. NRI Scoring of Counties for Tsunami

County	Expected Annual Loss	Social Vulnerability Rating	Community Resilience Rating	Community Risk Factor	Risk Value	Score
Del Norte	$172,758	Very High	Relatively Low	1.42	$298,500	94.59
Humboldt	$114,717	Very High	Relatively Moderate	1.36	$144,615	89.19
Santa Cruz	$114,064	Relatively High	Relatively High	1.18	$143,153	87.84
Monterey	$59,112	Very High	Relatively Low	1.37	$67,482	75.68
Alameda	$46,364	Relatively Moderate	Very High	1.13	$56,120	71.62
San Mateo	$44,573	Relatively Low	Relatively High	1.05	$42,986	68.92

14.7. MITIGATING THE HAZARD

Tsunamis and seiches are rare, but they can quickly put the lives of millions in jeopardy. The impacts on people and property in the wake of the 2004 Indian Ocean tsunami (230,000 fatalities in 14 countries) and 2011 Japan tsunami (18,000 fatalities in Japan alone; costliest modern natural disaster at $235 billion) emphasize the need to improve tsunami and seiche preparedness, mitigation, and recovery planning efforts wherever these hazards present themselves.

(DOF 2017)

14.7.1. Existing Measures to Mitigate the Hazard

A recent study indicated that a large tsunami event originating from the Aleutian Islands could cause coastal flooding that would result in extensive damage and lead to years of recovery, costing the State billions of dollars. However, this study also found that 80 to 90 percent of the damage could be prevented with detailed response, mitigation, land use, and recovery planning. The California Tsunami Program, led by Cal OES and CGS, is coordinating among all levels of government to engage in this type of hazard mitigation and planning work.

Harbor Studies

Cal OES, CGS, and the University of Southern California have prepared 33 Maritime Tsunami Response Playbooks covering over 70 ports, harbors, and marinas to provide harbor officials with information about where damage could occur during a distant-source tsunami. Figure 14-4 shows an example for the Port of Long Beach.

Tsunami Inundation Mapping

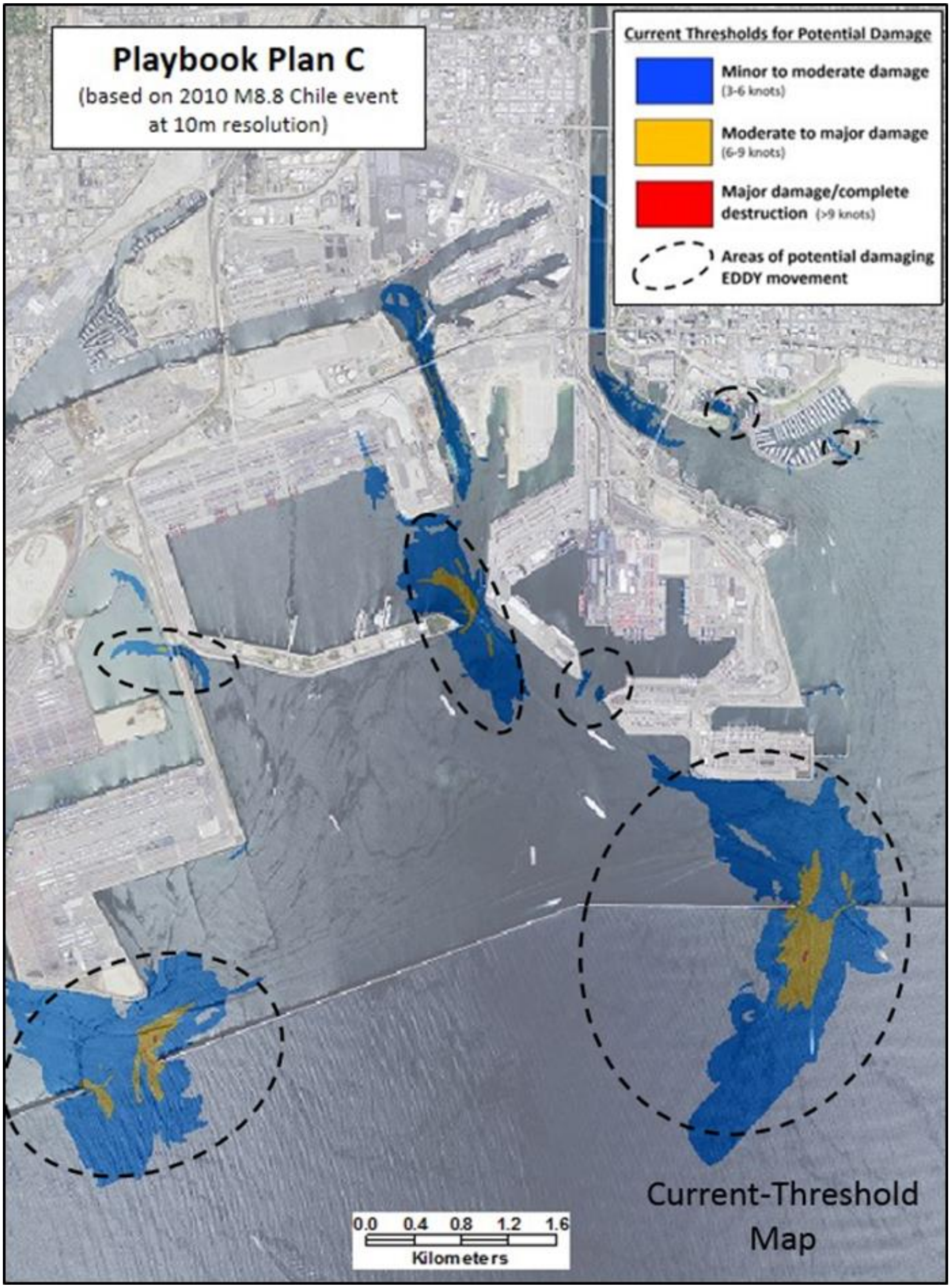
In 2009, the California Tsunami Program and the University of Southern California Tsunami Research Center completed statewide tsunami inundation maps appropriate for evacuation planning. These maps, most recently updated in 2021 and 2022, are a composite of numerical tsunami inundation model runs from a suite of large, realistic tsunami sources both local and distant. They are developed for all populated areas at risk from tsunamis in California and represent a combination of the maximum considered tsunamis for each area. The most recently updated maps identify areas of expected flooding for various average return periods: 100-, 200-, 475-, 975-, 2,475-, and 3,000-year.

Investigations of Previous Events

A statewide assessment for geological evidence of tsunamis included a reconnaissance of 20 coastal marshlands through site visits and coring of shallow surface sediments to look for evidence for past tsunamis existed. Geologic evidence consistent with tsunami inundation was found at two locations: three marshes in the Crescent City area for the 1700 and 1964 tsunamis, and Pillar Point Marsh near Half Moon Bay from the 1946 Aleutian Islands event. Potential tsunami deposits were also evaluated at the Carpinteria Salt Marsh Reserve in Santa Barbara County. The absence of tsunami evidence does not necessarily imply that no large tsunamis have occurred. This most likely means that the geologic conditions were not suitable for capturing these past events at most locations.

The State also worked with Cal Poly Humboldt State University to complete a tsunami deposit database cataloging data from the statewide study and other studies, especially past studies which have found tsunami deposits in Northern California from pre-historic Cascadia events.

Figure 14-4. Example Maritime Tsunami Playbook Current-Threshold Map for the Port of Long Beach



Source: (CGS 2016)

14.7.2. Opportunities for Mitigating the Hazard

A range of potential opportunities for mitigating the tsunami and seiche hazards is provided in Table 14-7 (see Section 1.2.3 for a description of the different types of alternatives).

14.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address the tsunami and seiche hazard:

- Action 2018-054: Reducing Tsunami Hazards and Risks—Support and provide matching funds for development of improved technologies and methodologies to assess, mitigate, and recover from the tsunami risk.
- Action 2018-055: Understanding and Utilizing Tsunami Probability—Improve the understanding of tsunami hazards in California through coordinated research and apply these products to land-use and construction mitigation practices.
- Action 2018-056: Tsunami Mitigation and Preparedness Planning—Continue tsunami preparedness activities and develop loss estimation models to compute potential impacts from tsunamis.

Table 14-7. Potential Opportunities to Mitigate the Tsunami and Seiche Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ Implement tsunami construction measures at a project level, including elevated living spaces and debris deflection structures **Reduce exposure and vulnerability:** ▪ Locate outside of hazard area ▪ Apply personal property mitigation techniques to your home such as anchoring your foundation and foundation openings to allow flow though **Build local capacity:** ▪ Develop and practice a household evacuation plan	**Manipulate the hazard:** ▪ Implement tsunami construction measures at a project level, including elevated living spaces and debris deflection structures **Reduce exposure and vulnerability:** ▪ Locate structure or mission critical functions outside of hazard area whenever possible ▪ Mitigate property for the impacts of tsunami ▪ Construct vertical evacuation shelters **Build local capacity:** ▪ Develop and practice a corporate response and evacuation plan	**Manipulate the hazard:** ▪ Build wave abatement structures (e.g., sea walls and the "jacks- looking structures designed by the Japanese) **Reduce exposure and vulnerability:** ▪ 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 ▪ Adopt higher regulatory standards that will provide higher levels of protection to structures built in a tsunami inundation area ▪ Use tsunami mapping and land use planning to guide development away from high-risk areas ▪ Construct vertical evacuation shelters **Build local capacity:** ▪ Use probabilistic tsunami mapping and land use guidance from the State ▪ Provide incentives to guide development away from hazard areas ▪ Improve the tsunami warning and response system ▪ Provide residents with updated tsunami hazard and inundation maps for the coast and vulnerable in-land lakes ▪ Join NOAA's Tsunami Ready program ▪ Develop and communicate evacuation time products and routes ▪ Enhance the public information program to include risk reduction options for the tsunami hazard ▪ Develop products useful for tsunami mitigation and recovery

Community-Scale	Organizational Scale	Government-Scale
▪ Become educated about the risk exposure from the tsunami hazard and ways to minimize that risk ▪ Understand tsunami warning signs and signals	▪ Educate employees on the risk exposure from the tsunami hazard and ways to minimize that risk	▪ Utilize multi-hazard mitigation strategies that address tsunami hazards and sea-level rise from global climate change ▪ Provide tsunami products useful for the maritime industry
Nature-based opportunities ▪ Restore wetlands, mangroves, marshes, and oyster reefs, and install living shorelines to help reduce wave impacts ▪ Preserve/restore tidal marshes ▪ Establish living shorelines (plants and natural elements designed to stabilize and protect coastlines) to prevent erosion ▪ Incentivize voluntary retreat from coastal hazard areas		

Dam Failure

Climate Impacts:

Increase in severe weather events will increase dam failure potential

Equity Impacts:

34.9% of exposed population (those living in mapped dam failure inundation areas) identified as living in equity priority communities

State Facilities Exposed:

2,308 facilities in dam failure inundation areas

Community Lifelines Exposed:

300 lifelines in dam failure inundation areas

Impact Rating: Medium (24)

15. DAM FAILURE

Dam failure has been identified as a medium-impact natural hazard of interest based on the hazard impact rating protocol applied for this SHMP. These events do not happen frequently and impact only areas downstream of dams. Less than 10 percent of State-owned or -leased facilities and community lifelines are exposed to this hazard. Less than 13 percent of the population resides in dam failure inundation area; over 34 percent of that population has been identified as living in equity priority communities. Less than 4 percent of the buildable land in the State intersects mapped dam failure inundation areas. The frequency and severity of dam failure events is anticipated to increase over the next 50 years due to impacts from climate change.

The DWR Division of Safety of Dams (DSOD) was a major contributor to this chapter, providing Section 15.2.1 (Dam Locations), Figure 15-1 (Dam Inundations), content up to page 15-5, and final review and approval of the entire chapter.

HHPD2. Did Element S6 (risk assessment) address all dam risk for high hazard potential dams in the risk assessment?
Chapter 15 include a comprehensive assessment of State-owned and -regulated dams within California, and a limited assessment of federal dams. The federal dam assessment was limited due to the accessibility of data on federal dams.

15.1. HAZARD OVERVIEW

A dam is an artificial barrier that can store water, wastewater, or any liquid-borne material for reasons including flood control, water supply, irrigation, livestock water supply, energy generation, recreation, and pollution control (ASDSO 2022).

Dam failure is the structural collapse of a dam, resulting in release of the water or other liquid stored behind it (Monterey County Office of Emergency Services 2022a). Dam failures usually occur when spillway capacity is inadequate and excess flow overtops the dam, or when internal erosion through the dam or its foundation occurs. Complete failure is the complete structural breach of the dam, releasing a high-velocity wall of debris-filled water that rushes downstream damaging anything in its path.

Hundreds of dam failures in the United States have caused property and environmental damage, injuries, and fatalities. The Association of State Dam Safety Officials identifies the most likely causes of dam failures as follows (ASDSO 2021a):

- Overtopping caused by water spilling over the top of a dam
- Foundation defects, including settlement and slope instability
- Cracking caused by movement
- Inadequate maintenance and upkeep
- Seepage through a dam that is not properly filtered, so that soil particles form sinkholes in the dam

Common Types of Dams

Dams can be classified according to their construction, slope, purpose, or method of resisting water pressure or controlling seepage. The following are common dam types:

- **Embankment Dams** are the most common type of dam used today. Natural soil, rock, or waste materials are used to construct these dams. An embankment dam is an earth fill or rockfill dam, depending on whether it is made of compacted earth or mostly compacted or dumped rock. The ability of an embankment dam to resist the reservoir water pressure is primarily a result of the mass weight, type, and strength of the materials from which the dam is made.
- **Concrete Dams** are categorized according to the designs used to resist the stress of reservoir water pressure:
  - **Gravity Dams** are the most common type of concrete dams. The weight of concrete and friction resist the reservoir water pressure.
  - **Buttress Dam** is a specific type of gravity dam where a large mass of concrete is reduced, and the forces are diverted to the dam foundation through vertical or sloping buttresses.
  - **Arch Dams** are thin in cross section and where the reservoir water forces acting on the dam are carried laterally into the abutments. These dams are made of thin, vertical blocks keyed together.

Source: (ASDSO 2021)

15.2. HAZARD LOCATION

15.2.1. Jurisdictional Dams

The California Water Code defines a "jurisdictional" dam (one that falls under the jurisdiction of State dam regulations) as a dam with a height greater than 6 feet that impounds 50 acre-feet or more, or a height greater than 25 feet with storage capacity of 15 acre-feet or more (DWR 2022c). About 1,250 jurisdictional-sized dams are under the jurisdiction of the DSOD, which is part of DWR (DWR 2018). Of these jurisdictional dams, 265 have been identified as "extremely high" hazard and 461 have been identified as "high" hazard, based on possible downstream impacts to life and property (see Table 15-1). The number of dams that fall into the categories shown in the table changes annually; these numbers are a representation of these statistics as of this SHMP update.

Table 15-1. Downstream Hazard Potential Classifications

Downstream Hazard Potential Classifications	Potential Downstream Impacts to Life and Safety	Number of Dams in California
Low	No probable loss of human life and low economic and environmental losses. Losses are expected to be principally limited to the owner's property.	370
Significant	No probable loss of human life but can cause economic loss, environmental damage, impacts to critical facilities, or other significant impacts.	141
High	Expected to cause loss of at least one human life.	461
Extremely High	Expected to cause considerable loss of human life or would result in an inundation area with a population of 1,000 or more.	265

Source: (DSOD 2022a)

Due to the number of such dams in California, information specific to each dam is not provided in this SHMP. The information can be accessed on the DSOD website (https://fmds.water.ca.gov/maps/damim/). This website is maintained regularly and reflects the most updated information each time it is accessed. Appendix S provides a list of high hazard dams that have been rated as being in unsatisfactory, poor, or fair condition. These are potential targets for funding under the High Hazard Potential Dam (HHPD) grant program. This list of dams can change annually.

Dam Locations

Los Angeles County leads the State with 90 jurisdictional dams, followed by Sonoma County with 64 dams. Del Norte County is the only county in the State that has no dams of jurisdictional size (DSOD 2021).

Dam Failure Inundation Mapping

Inundation maps show where flooding is expected in the event of a dam failure at a specific dam. The California Legislature passed a law in 2017 (California Water Code section 6161) requiring all State jurisdictional dams—except low hazard dams—to develop inundation maps and emergency action plans (EAPs). The maps must be submitted for approval to the DSOD, and the plans must be submitted for approval to Cal OES.

Inundation maps for extremely high, high, and significant hazard dams and their critical appurtenant structures are prepared by licensed engineers and submitted by dam owners for DSOD review and approval. The maps are based on a hypothetical failure of a dam or critical appurtenant structure and the information depicted on the maps is approximate. Areas to be evacuated in the event of an actual failure of a dam or critical appurtenant structure are determined by local emergency managers.

DSOD has made inundation mapping available online for extremely high, high, and significant hazard dams in the State (https://fmds.water.ca.gov/maps/damim/) (DWR 2022h). These maps are the basis for this impact analysis. A statewide overview of the mapped inundation areas for high hazard dams and extremely high hazard dams is provided in Figure 15-1. For access to information on all State jurisdictional dams regulated by DSOD, visit: https://gis.water.ca.gov/app/boundaries/

The National Inventory of Dams
The National Inventory of Dams documents all known dams in the U.S. and its territories that meet certain criteria. It provides users the ability to search for specific data about dams in the U.S. and serves as a resource to support awareness of dams and actions to prepare for a dam-related emergency. The National Inventory of Dams can be accessed at: https://nid.usace.army.mil/#/.

Figure 15-1. Inundation Boundaries for Extremely-High-Hazard or High-Hazard Jurisdictional Dams

15.2.2. Federal Dams

Dams and reservoirs owned by the federal government are not subject to State jurisdiction except as otherwise provided by federal law. According to USACE, there are 220 dams in California owned by federal government agencies, such as the National Park Service, U.S. Forest Service, U.S. Bureau of Reclamation, and USACE (USACE 2021).

In California, Whittier Narrows Dam is the only dam owned by the federal government with a mapped inundation area that was made available to support this SHMP update (see Figure 15-2). Whittier Narrows Dam is a 56-foot-tall earthen dam built, owned, and operated by the USACE Los Angeles District. Table 15-2 presents the National Inventory of Dams information for the Whittier Narrows Dam. The dam is within the City of Pico Rivera.

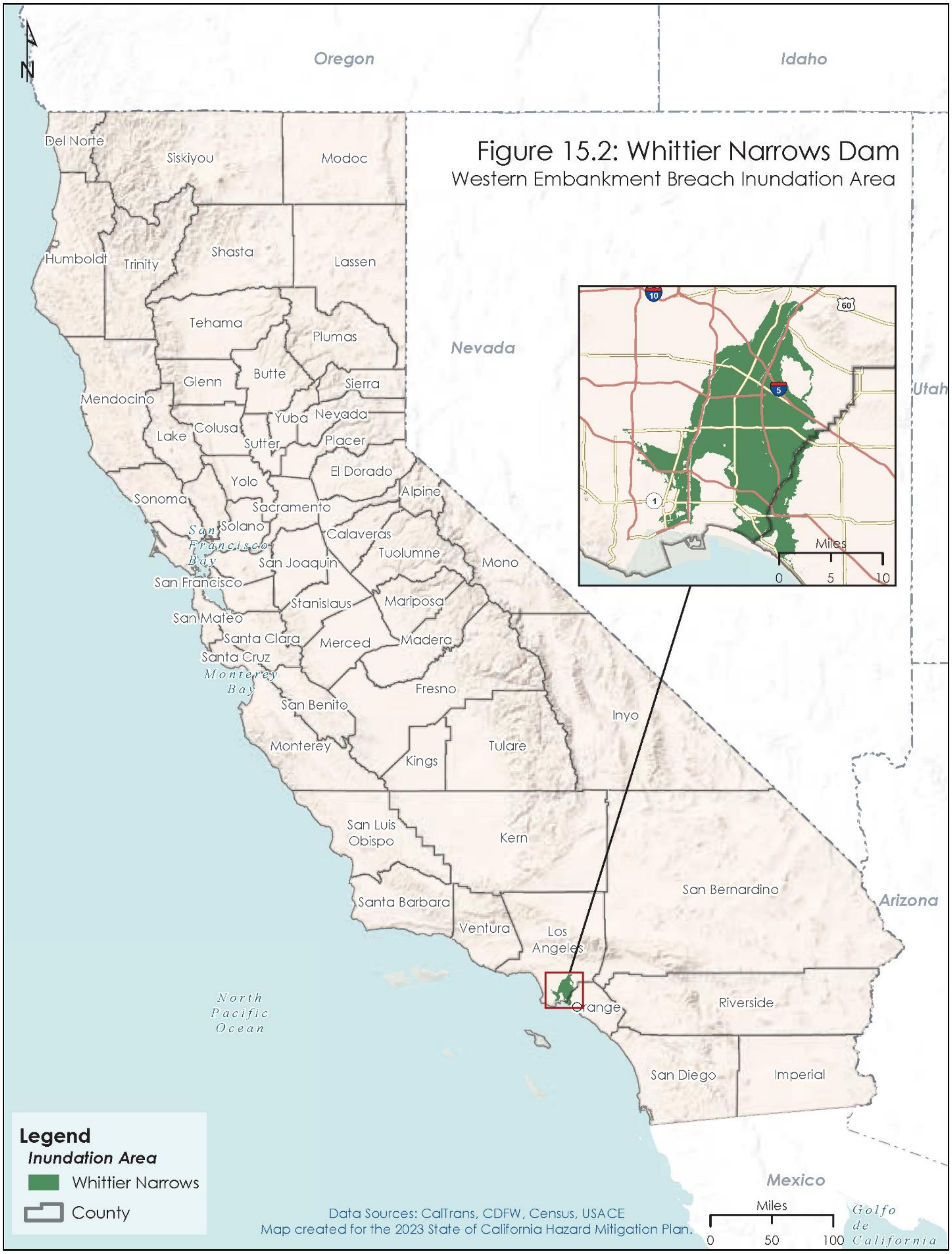
Table 15-2. National Inventory of Dams Detail Report on Whittier Narrows Dam

Dam Name	Whittier Narrows Dam	**River**	San Gabriel River
Other Name	Whittier Narrows Reservoir	**City**	Pico Rivera
ID	CA10027	**County**	Los Angeles
Owner Type	Federal	**Inspection Date**	June 6, 2017
Owner Name	Corps of Engineers Los Angeles District	**State Permitting Authority?**	No
Height	56 feet	**State Inspection Authority?**	No
Storage	66,702 acre-feet	**State Enforcement Authority?**	No
Primary Purpose	Flood Control	**EAP Last Date**	August 1, 2014
Dam Type	Earth	**Data Current as of**	September 30, 2018

Source: (USACE 2021)

Inundation mapping is not required by law for federally owned dams. To address this data deficiency, a mitigation action has been added to this SHMP to map inundation areas of all federal high-hazard dams in the State.

Figure 15-2. Whittier Narrows Dam Western Embankment Breach Inundation Area



15.2.3. Obstacles and Challenges

Since the development and implementation of the 2018 SHMP, California has made great strides in addressing challenges identified for overall State dam safety. Driven by SB 92 (2017), DSOD has made inundation mapping available on jurisdictional dams in the State and has made that information publicly accessible through an interactive website. The availability and accessibility of this type of information has had a significant impact on increasing the understanding of dam failure risk in California.

However, some challenges identified in the 2018 SHMP remain. Some dam owners lack resources to respond to new State requirements. The financial burden on dam owners to produce inundation maps is significant. Inundation maps are required to be produced by a qualified, licensed engineer for the dams and any critical appurtenant structures. With a limited pool of qualified engineers, there may not be enough resources to produce the maps, and the expense to dam owners may be increased if they need to contract out for mapping services. As of this SHMP update, all of the extremely-high-hazard dams and several of the high-hazard dams have presented updated EAPs to meet the requirements of SB 92. DSOD is committed to providing the necessary technical assistance to dam owners with outstanding EAPs to close this gap.

15.3. PREVIOUS HAZARD OCCURRENCES

15.3.1. Disaster and Emergency Declarations

The following disaster declarations or emergency proclamations related to dam failure have been issued for California (see Appendix F for details):

- Federal DR or EM declaration, 1953 – 2022: three events, classified as dam failure
- California Emergency Proclamations, 1950 – 2022: nine events, classified as flood/dam/levee failure
- USDA agricultural disaster declarations, 2012 – 2022: None

15.3.2. Event History

In the past 50 years, there have been few dam failures in California. The 2018 SHMP update discussed dam failure events that occurred from 1928 through 2017. Dam failure events that have impacted the State between 2018 and 2022 are identified in Table 15-3. Refer to Appendix K for the complete history of past events.

Table 15-3. Dam Safety Incidents in the State of California (2018 to 2022)

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties/Areas Impacted
February 2017	Gated Spillway Failure—Oroville Dam	N/A	N/A	Butte, Yuba, Sutter
The gated spillway at Oroville Dam, the tallest dam in the United States, suffered a failure within its concrete chute. A 60-foot-deep hole developed in the lower third of the chute as a result of normal spillway operations undertaken to lower the reservoir in advance of a moderately large storm. The subsequent occurrence of the storm in the days after the initial incident and the inability to fully use the primary spillway led to the filling of the reservoir and the use of its unlined emergency spillway for the first time ever. After two days of usage and erosion of the unlined hillside and head cutting, concerns regarding the stability of the emergency spillway weir developed, and nearly 200,000 people downstream were evacuated.				
March 22, 2018	Insufficient Spillway Capacity—Moccasin Lower	N/A	N/A	Tuolumne
Blockage of Moccasin Creek Bypass Tunnel caused sudden rise of the reservoir above core wall to nearly the dam crest because of insufficient spillway capacity. Twenty people had to be evacuated from their homes as a result of this event. One property was flooded, and water and sewer lines were impacted. This event caused approximately $25 million to $50 million in damages.				
April 2, 2018	Insufficient Spillway Capacity—Auberry Lumber Mill	N/A	N/A	Fresno
The dam overtopped due to spillway pipes being clogged with overgrown vegetation. Overtopping eroded the downstream slope, which could have potentially led to failure. No evacuations or damages reported for this event.				
June 26, 2018	Seepage/Internal Erosion—Lower Blue Lake	N/A	N/A	Alpine
Damp spots on the downstream face along the length of the left embankment, localized small active seep from damp area, and seepage boil located approximately 10 feet downstream of the toe on left side of the dam. No evacuations or damages reported for this event.				
April 30, 2019	Deterioration Or Poor Condition—Lake Van Norden	N/A	N/A	Nevada and Placer
Large hole at the downstream right end of the spillway invert during high spring spill flows. No evacuations or damages reported for this event.				

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties/Areas Impacted
June 3, 2019	Sediment Build-up – Misselbeck	N/A	N/A	Shasta
Sediment build-up in the reservoir has likely caused the entrance of the outlet works to become plugged. A combined release of approximately 1 cubic foot per second from both pipes while all four valves were fully open was observed during inspections. No evacuations or damages reported for this event.				

Source: (ASDSO 2020)

15.4. PROBABILITY OF FUTURE HAZARD EVENTS

15.4.1. Overall Probability

Dam failure events are infrequent and usually coincide with events that cause them, such as earthquakes, landslides, excessive rain, and snowmelt. The three federal disaster declarations for dam failure-related events between 1953 and 2022 represent an average of one event about every 23 years. Dam safety incidents, which are less severe than actual dam failures, occurred multiple times per year in 2018 and 2019.

15.4.2. Climate Change Impacts

Modeling described in California's Fourth Climate Change Assessment projects less frequent but more extreme daily precipitation. Year-to-year precipitation will become more volatile, and the number of dry years will increase by mid-century. As the climate continues to warm, atmospheric rivers will carry more moisture, and extreme precipitation may increase. Climate model projections show a tendency for the northern part of the State to become wetter, and the very southern portion of California, extending and intensifying in Mexico, to become drier (CNRA; CEC; OPR 2022). Several Fourth Assessment technical reports (State of California 2018) provide improved projections and analysis of precipitation impacts to facilitate adaptive decision-making for water management. Strategically employing precipitation and runoff forecasts has some potential to improve the operation of reservoirs, flood control, infiltration strategies, and hydropower.

Climate change played a significant role in one recent example of dam failure in California. Severe weather events caused by climate change were a causal factor in the potential overflow of the spillway at Oroville Dam in 2017. More specifically, an atmospheric river moved into Northern California from the Pacific, causing additional snow to fall on what was already an unusually large snowpack, and then causing warmer precipitation to fall upon the expanded snowpack a few days later, melting much of the snow and causing a greater—and more difficult to accommodate—inflow of water into Oroville Dam's reservoir (Michalis, et al. 2022). Some experts see the Oroville Dam episode as a demonstration of how severe weather events brought on by climate change, combined with the aging and degrading condition of dam infrastructure, could result in more dam failure incidents (Mount, Swain and Ullrich 2019).

15.5. IMPACT ANALYSIS

15.5.1. Severity

DSOD assigns hazard ratings to large dams in the State based on a classification system developed by FEMA (FEMA 2013). FEMA categorizes the downstream hazard potential into three categories in increasing severity: Low, Significant, and High. DSOD adds a fourth category of "Extremely High" (DSOD 2021a). The definitions of the hazard categories and the numbers of California jurisdictional dams assigned to each category are shown in Table 15-1.

15.5.2. Warning Time

Warning time for dam failure depends on the cause of the failure, and the size and location of the dam. In the event of a structural failure due to earthquake, there may be no warning time. In events of extreme precipitation or massive snowmelt, the weather can be predicted, and evacuations can be planned with sufficient time. When dam operators need to release water to relieve pressure from a dam, with potential for flooding downstream, advance warning can be provided (Monterey County Office of Emergency Services 2022).

A dam's structural type affects the warning time of how quickly a failure occurs. A dam failure can sometimes occur within hours of the first signs of breaching. Other failures and breaches can take much longer—from days to weeks—as a result of debris jams, the accumulation of melting snow, buildup of water pressure on a dam with deficiencies after days of heavy rain, etc. (FEMA 2013); (FEMA 2016).

15.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The notable cascading impacts associated with dam failure are flooding, landslides, bank erosion, and destruction of habitat. Dam failure can be a cascading impact itself; hazards that can lead to a dam failure include earthquakes, landslides, and floods. Other notable cascading impacts from dam failures include:

- Potential to impact multiple downstream jurisdictions
- Loss of power associated with facilities that provide hydropower
- Loss of water supply
- Damage to agricultural lands
- Impacts on multiple jurisdictions

15.5.4. Environmental Impacts

Dam failures can cause downstream flooding and can transport large volumes of sediment and debris. Other examples of environmental impacts include pollution from septic system failures, pollution of potable water supplies, changes in configurations of streams, loss of wildlife habitats, and degradation of wetlands (FEMA 2012).

15.5.5. Local Hazard Impacts

LHMP Rankings

Of the 58 counties in California, 54 assessed dam failure as a hazard of concern in their hazard mitigation plans. Of these, 28 ranked dam failure as high risk, 17 ranked it as medium risk, and nine ranked it as low risk. The following counties listed dam failure as a high-risk hazard:

- Alameda
- Amador
- Butte
- Colusa
- El Dorado
- Fresno
- Imperial
- Kings
- Los Angeles
- Madera
- Marin
- Mendocino
- Merced
- Modoc
- Nevada
- Orange
- Placer
- Plumas
- Sacramento
- San Diego
- San Joaquin
- San Luis Obispo
- Stanislaus
- Sutter
- Trinity
- Ventura
- Yolo
- Yuba

LHMP Estimates of Potential Loss

Table 15-4 summarizes potential losses to vulnerable structures based on estimates from the local risk assessments (as called for in FEMA's Standard State Mitigation Planning Requirement S6.b). These losses also represent the potential multi-jurisdictional impacts from dam failures (as called for in FEMA's HHPD requirement HHPD2-b). Due to variances in approaches to assessing risk at the local level as well as the hazards assessed and the age of each assessment reviewed, this data is considered approximate. Not all LHMPs have assessed dam failure risk, even though there may be high hazard potential dams within a defined planning area.

Table 15-4. Dam Failure Risk Exposure Analysis for LHMP Reviews

Estimated Total Population Exposed	5,027,019
Estimated Number of Structures at Risk	1,237,432
Estimated Value of Structures at Risk	$56.6 billion

15.6. VULNERABILITY ANALYSIS

To assess the vulnerability of State assets to the dam failure hazard, GIS software was used to overlay dam failure inundation areas with State assets. The analysis included State dams that are rated as extremely high or high hazard. A separate analysis was conducted with the available mapping of the federal Whittier Narrows Dam.

15.6.1. Exposure of State-Owned or -Leased Facilities

Table 15-5 and Table 15-6 summarize the number and replacement cost value of State assets located in the State jurisdiction dam failure inundation areas for high-hazard or extremely-high-hazard dams and those in the federally owned Whittier Narrows Dam failure inundation area.

Figure 15-3 summarizes the exposed assets from State jurisdiction dams as a percentage of total assets statewide. Figure 15-4 summarizes the exposed assets from the Whittier Narrows Dam as a percentage of total assets statewide. Appendix I provides detailed results by county.

Table 15-5. State-Owned or -Leased Facilities Exposed to the Dam Failure Hazard

Type of Facility	Number of Structures	Total Area (sq. ft.)	Replacement Cost Value		
			Structure	Content	Total
State Facilities in the Extremely-High-Hazard or High-Hazard Dam Inundation Area					
State-Leased Facilities	275	—	$1,075,039,281	$1,083,589,590	$2,158,628,872
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	188	2,103,228	$79,249,251	$72,977,386	$152,226,636
Development Center	0	0	$0	$0	$0
Hospital	0	0	$0	$0	$0
Migrant Center	6	426,750	$51,675,434	$32,181,714	$83,857,148
Special School	64	510,744	$10,729,356	$9,928,709	$20,658,065
All Other Facilities	1,775	16,259,876	$1,711,584,724	$1,670,821,422	$3,382,406,146
Total State-Owned	***2,033***	***19,300,598***	***$1,853,238,764***	***$1,785,909,230***	***$3,639,147,994***
Total Facilities	**2,308**	**N/A***	**$2,928,278,046**	**$2,869,498,820**	**$5,797,776,866**
State Facilities in the Whittier Narrows Dam Western Embankment Breach Inundation Area					
State-Leased Facilities	31	—	$183,499,555	$186,215,032	$369,714,587
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	26	166,767	$3,664,024	$3,141,158	$6,805,182
Development Center	0	0	$0	$0	$0
Hospital	0	0	$0	$0	$0
Migrant Center	0	0	$0	$0	$0
Special School	0	0	$0	$0	$0
All Other Facilities	124	3,398,562	$74,669,522	$64,013,981	$138,683,503
Total State-Owned	***150***	***3,565,329***	***$78,333,546***	***$67,155,139***	***$145,488,685***
Total Facilities	***181***	**N/A***	***$258,169,077***	***$250,229,013***	***$508,398,090***

* The inventory of State assets does not include building area for State-leased facilities, so no total area for all State facilities is provided; the building area of vulnerable assets is shown for State-owned facilities only.

Table 15-6. State-Owned or -Leased Infrastructure Exposed to the Dam Failure Hazard

Type of Facility	State-Owned Infrastructure in the Mapped Hazard Area	
	Extremely-High-Hazard or High-Hazard Dam Inundation Area	Whittier Narrows Dam Western Embankment Breach Inundation Area
Bridges	3,180	185
Highway (miles)	4,810.7	93.8
Dams	18*	0
Water Project (miles)	46.8	0

* This number includes dams that are within dam inundation areas. Some of these dams would not be at risk if they have capacity to pass on the flow from a failed dam upstream.

Figure 15-3. State Assets Exposed to Jurisdictional Dam Failure as % of Statewide Total

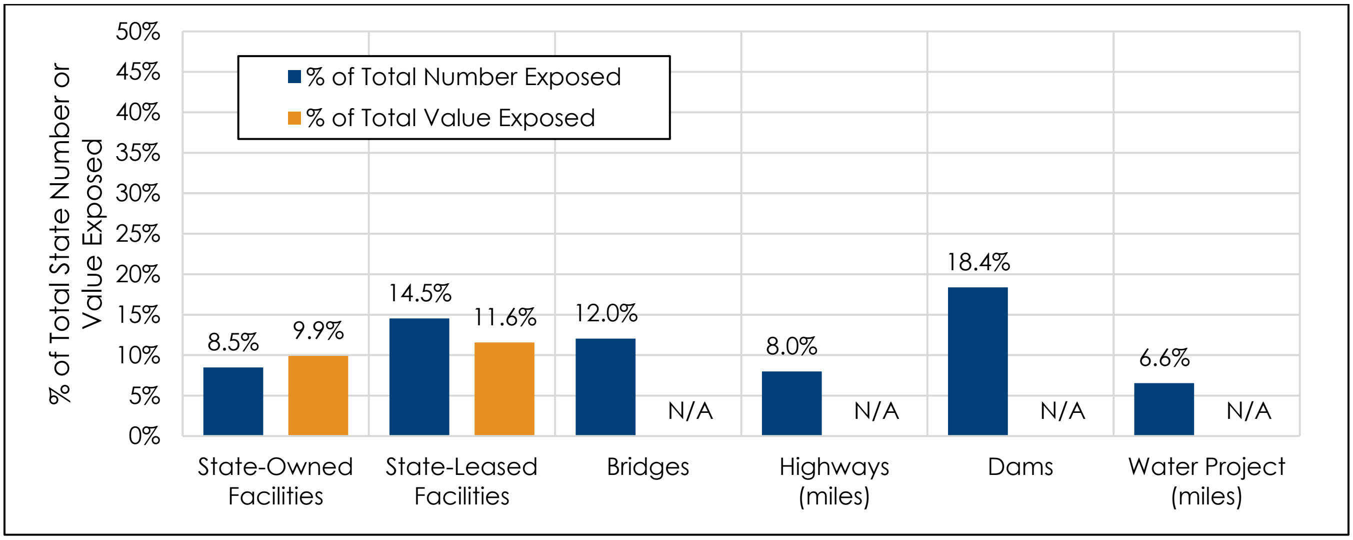
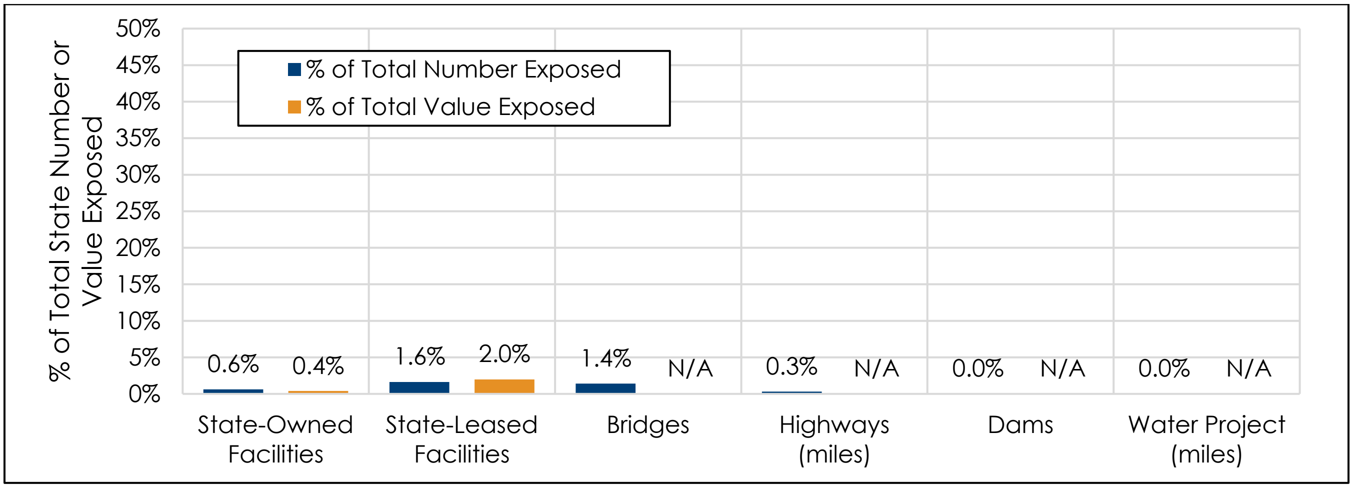


Figure 15-4. State Assets Exposed to Whittier Narrows Dam Inundation Area as % of Statewide Total



The following are noteworthy statistics on State-owned or -leased facilities in the dam failure Inundation areas:

- For facilities that the State owns in the dam failure inundation area, the average building area is 9,494 square feet, and the average replacement cost value is $17.9 million (structure and contents).
- The average replacement cost value for State-leased facilities in the dam failure inundation area is $ 7.8 million (Structure and Contents).
- The five State agencies with the most State-owned or -leased facilities in the dam failure inundation area are State Parks (422), Caltrans (396), District Agricultural Associations (318), CDFW (295) and CSU (237).
- The State agency with the highest total replacement cost for State-owned or -leased facilities in the dam failure inundation area is CSU at $1.0 billion.

15.6.2. Exposure of Critical Facilities and Community Lifelines

Transportation routes, including bridges and highways, are vulnerable to dam inundation and have the potential to be wiped out, creating isolation and supply chain issues. Those that are most vulnerable are those that are already in poor condition and would not be able to withstand a large water surge. The State's utility infrastructure is also vulnerable; interruption of services may impact priority populations as well as facilities that need to be in operation during a disaster.

Table 15-7 summarizes the total number of critical facilities, by community lifeline, located in the dam failure inundation areas statewide. Appendix I provides detailed results by county.

Table 15-7. Critical Facilities and Community Lifelines Exposure to Dam Failure Inundation Areas

Lifeline Category	Total Number of Facilities	Number of Facilities in Hazard Area	% of Total Facilities
Communications	42	12	28.6%
Energy	176	37	21.0%
Food, Water, Shelter	257	135	52.5%
Hazardous Material	56	16	28.6%
Health & Medical	47	11	23.4%
Safety & Security	46	9	19.6%
Transportation	131	80	61.1%
Total	**755**	**300**	**39.7%**

Functional downtime is the most significant dam failure impact on critical facilities and community lifelines. The severity of this impact is based on the amount of time it takes to restore damaged facilities to an operational status. Hazus estimates damage and functional downtime for dam failure scenarios. Local governments are encouraged to use Hazus or similar tools when developing LHMPs.

15.6.3. Estimates of Loss

Loss estimations for hazard events that cause flooding typically use an approach that correlates damage to the depth of flood water impacting a structure and the time of inundation. USACE has established depth/damage correlations based on analysis of the impacts historical flood events have had on the built environment. The assessment of potential loss associated with dam failure for this SHMP used the USACE depth-damage curve for facilities with "average government function" (see Figure 15-5).

Table 15-8 shows the resulting estimates of potential damage to State-owned or -leased facilities in the dam failure inundation zone per foot of flood depth, up to the flood depth that would trigger substantial damage (50 percent of replacement cost value).

Figure 15-5. Depth/Damage Curve for "Average Government Function" Occupancy

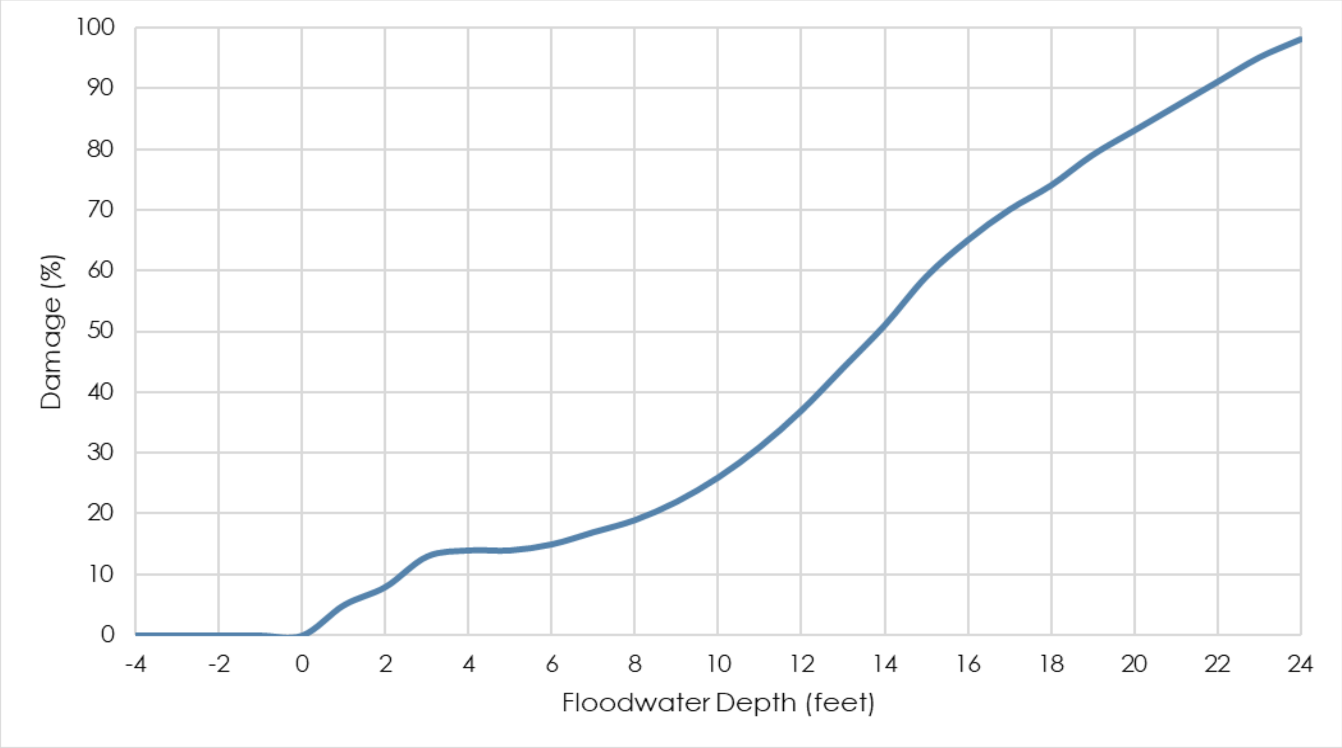


Table 15-8. Estimates of Flood Loss for Facilities in the Dam Failure Inundation Zone

Flood Depth (feet)	Estimates of Flood Loss*		
	State-Owned	State-Leased	Total
1	$92,661,938	$53,751,964	$146,413,902
2	$148,259,101	$86,003,143	$234,262,244
3	$240,921,039	$139,755,107	$380,676,146
4	$259,453,427	$150,505,499	$409,958,926
5	$259,453,427	$150,505,499	$409,958,926
6	$277,985,815	$161,255,892	$439,241,707
7	$296,518,202	$172,006,285	$468,524,487
8	$352,115,365	$204,257,463	$556,372,829
9	$407,712,528	$236,508,642	$644,221,170
10	$481,842,079	$279,510,213	$761,352,292
11	$574,504,017	$333,262,177	$907,766,194
12	$685,698,343	$397,764,534	$1,083,462,877
13	$815,425,056	$473,017,284	$1,288,442,340
14	$945,151,770	$548,270,033	$1,493,421,803

* Structure losses only. Does not include contents losses.

15.6.4. Buildable Land

Of the 11.7 million acres of land available for development in California, 3.2 percent (375,861 acres) is within dam failure inundation areas. This does not include all dam failure risk in the State because only a subset of dam inundation areas was analyzed. There are likely other dams whose failures would impact buildable land areas as well.

Any development in these areas will be susceptible to damage associated with a dam failure. While existing floodplain development regulations at the county level may offer some protection for new development in these areas, such protections would likely not be sufficient for a catastrophic dam failure. Such a failure could have an inundation area much larger than the regulated floodplain and greater water depths and higher flow velocities than the 1% annual chance flood event.

15.6.5. Equity Priority Communities

The risk analysis for dam failure found that 34.9 percent of people exposed to the dam failure hazard live in equity priority communities (1,756,718 people). A breakdown of exposed equity priority communities by county is included in Appendix I.

15.6.6. NRI Scores

The National Risk Index does not provide rankings for the dam failure hazard.

15.7. MITIGATING THE HAZARD

15.7.1. Opportunities for Mitigating the Hazard

A range of potential opportunities for mitigating the dam failure hazard is provided in Table 15-9. See Section 1.2.3 for a description of the different types of alternatives.

Table 15-9. Potential Opportunities to Mitigate the Dam Failure Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ None **Reduce exposure and vulnerability:** ▪ Relocate out of dam failure inundation areas ▪ Elevate home to appropriate levels **Build local capacity:** ▪ Learn about risk reduction for the dam failure hazard ▪ Learn the evacuation routes for a dam failure event ▪ Become educated about early warning systems and the dissemination of warnings	**Manipulate the hazard:** ▪ Remove dams ▪ Harden dams **Reduce exposure and vulnerability:** ▪ Replace or rehabilitate dams with deficiencies ▪ Flood-proof facilities within dam failure inundation areas **Build local capacity:** ▪ Educate employees on the probable impacts of a dam failure ▪ Develop a continuity of operations plan	**Manipulate the hazard:** ▪ Remove dams ▪ Harden dams **Reduce exposure and vulnerability:** ▪ 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 ▪ Adopt higher floodplain standards in mapped dam failure inundation areas ▪ Retrofit critical facilities within dam failure inundation areas **Build local capacity:** ▪ 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 change 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
Nature-based opportunities ▪ Restore and reconnect floodplains that intersect dam failure inundation areas that have been degraded by development and structural flood control		

Community-Scale	Organizational Scale	Government-Scale
▪ Use soft approaches for stream bank restoration and hardening. Soft approaches can include but are not limited to the introduction of large woody debris into a system ▪ Set back levees on systems that rely on levee protection to allow the river channel to meander, which reduces erosion and scour potential ▪ Acquire property within dam failure inundation areas, remove or relocate structures, and preserve these areas as open space in perpetuity ▪ Preserve floodplain storage capacity by limiting or prohibiting the use of fill within the floodplain		

15.7.2. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address the dam failure hazard:

- Action 2023-013: Federal HHPD Inundation Mapping: Develop inundation models for federal high hazard potential damsin the State.
- Action 2018-008: Develop a database containing a description of the specific natural hazard event for which each project was designed to mitigate.
- Action 2018-062: Ensure dam safety.
- Action 2018-063: Review and approve EAPs for State jurisdictional dams with a hazard classification from DSOD of significant, high, or extremely high.

LEVEE FAILURE

Climate Impacts:
As sea levels rise, flood stages in the Sacramento-San Joaquin Delta may also rise, increasing pressure on Delta levees

Equity Impacts:
34.0% of exposed population (those living in the levee flood protection zone) identified as living in equity priority communities

State Facilities Exposed:
577 facilities in levee flood protection zone; $4.2 billion total replacement cost values for facilities in levee flood protection zone

Community Lifelines Exposed:
16 lifelines in levee flood protection zone

Impact Rating: Medium (21)

16. LEVEE FAILURE

Levee failure has been identified as a medium-impact natural hazard of interest based on the hazard impact rating protocol applied for this SHMP. These events happen frequently and impact only areas protected by levee systems. Less than 3 percent of State-owned or -leased facilities and community lifelines are exposed to this hazard. Less than 1 percent of the population resides in levee failure inundation area; over 34 percent of that population has been identified as living in equity priority communities. Less than 1 percent of buildable land in the State intersects mapped levee failure inundation areas. The frequency and severity of levee failure events is anticipated to increase over the next 50 years due to impacts from climate change.

16.1. HAZARD OVERVIEW

A levee is a physical barrier constructed to protect areas from floodwaters. A levee breach occurs when part of a levee gives way, creating an opening through which floodwaters may pass. A breach can occur gradually or suddenly. The most dangerous breaches happen quickly during periods of high water. A catastrophic and sudden failure under extreme flood events has the potential to result in loss of life and destruction of property (National Geographic 2022a).

16.1.1. History of Levees in California

Soils in California's Central Valley and on islands in the Sacramento-San Joaquin Delta place these regions among the most agriculturally productive regions in the world, providing a significant economic benefit for California. The soil is rich for growing crops as a result of river-deposited silts or river-nourished backwater peats in these locations.

During the 1850s, hydraulic mining in the mountains at the headwaters of the rivers that feed the Delta flushed huge amounts of sediment downstream, raising riverbeds and causing increased flooding. To prevent buildup of this sediment and to protect or reclaim floodplain for agricultural purposes in the Central Valley and Delta, construction began on new or enlarged levees. In many cases, soil was scraped from adjacent land or dredged from adjacent channels and placed onto existing natural levees. However, the soils that make this region ideal for agriculture generally make poor foundation material for levees.

After several devastating floods, USACE started modifying and constructing levees as early as the early 1900s using soils from adjacent rivers and channels. Levees were also constructed by others in the early 1900s in areas subject to coastal influences, such as in San Francisco and San Pablo Bays.

Until about the 1940s to 1950s, most levees were not engineered to appropriate standards and frequently failed. The levees have been augmented since their early construction to produce the current system, but many remain as they were first built or have deteriorated. Some of the areas protected by the Central Valley levees have evolved from their original agricultural uses to urban development. The levees protecting urban areas today have mostly been investigated and improved to meet current levee design standards developed by USACE and supported by FEMA.

What Causes a Levee to Fail

Earthen levees can be damaged in several ways:

- 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 can create holes that enable water to pass through a levee.
- 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 also can cause levees to slide or slump, which also can lead to failure.

Any of these situations can lead to a zone of weakness that causes a levee breach.

Source: (ASCE 2010)

16.1.2. Increasing Risk and Consequences

Low-Elevation Land Adjacent to Levees

Levees typically remove valuable floodplain storage and block the ability of a river channel to move water. With reclaimed floodplains not being replenished with new sediment and the drying out of some of the boggy areas, the land protected by the levees began to drop in elevation via subsidence and wind erosion of topsoil.

The Bay Area has numerous substandard levees protecting both low-lying and below-sea-level urban areas and infrastructure, including the Oakland International Airport. With potential sea-level rise due to climate change exacerbating the situation, land behind the levees will continue to drop. As can be seen in Figure 16-1, vast areas in the Delta are already below sea level.

Risks to Water Systems

Water systems face risks from potential Delta levee failures. The Bay-Delta is a complex system where three rivers bring in fresh water and tidal fluctuations cycle in saltwater or brackish water. Water projects carry fresh water to millions of citizens in Central and Southern California. Approximately 60 percent of the water supply of the San Francisco Bay Area is extracted from or passes through the Delta.

Levee Designs Insufficient for Large Storm Events

Many of the levees in California are intended to protect against a storm that as a 1 percent chance of occurring in any year. Some areas have an even lower level of protection. For perspective, the levee system protecting the city of New Orleans was intended to protect against a storm that has a 0.4 percent chance of occurring in any year but failed in 2005 due to Hurricane Katrina.

16.2. HAZARD LOCATION

California's levees protect farmland, ranchland, rural residential areas, urban residential areas, and infrastructure such as roads, highways, and waterways or canals. According to the USACE National Levee Database, there are 1,756 levee systems in California, comprising 5,403 miles of levee (USACE n.d.). The average age of these levees is 59 years. Figure 16-2 shows the statewide levee system relative to mapped 1% annual chance flood zones. Based on the levee locations, mapping was developed to show regions of the State that are protected by levees, as shown in Figure 16-3.

Figure 16-1. Delta Elevation Relative to Mean Sea Level

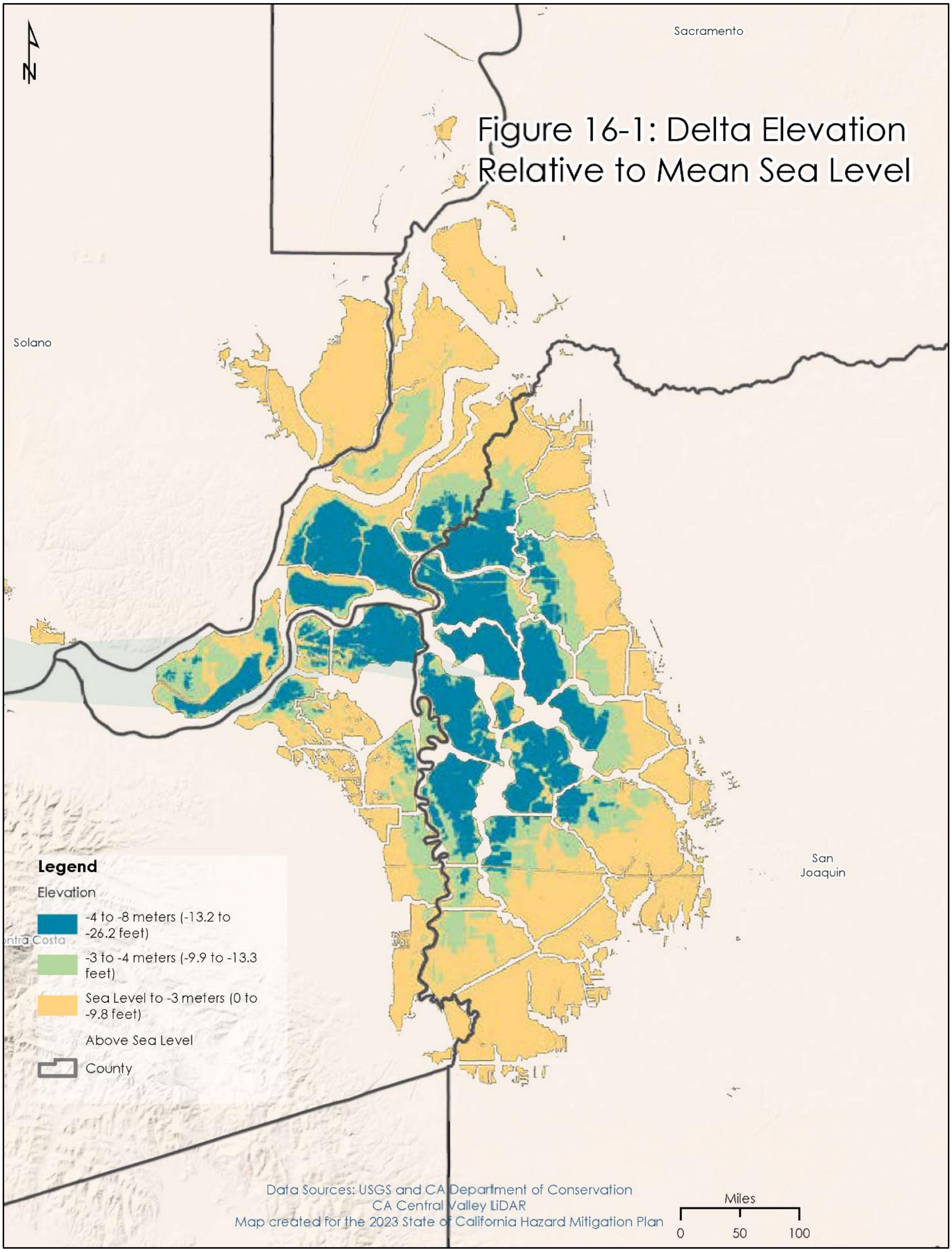


Figure 16-2. California Levee System with 1% Annual Chance Flood Zones

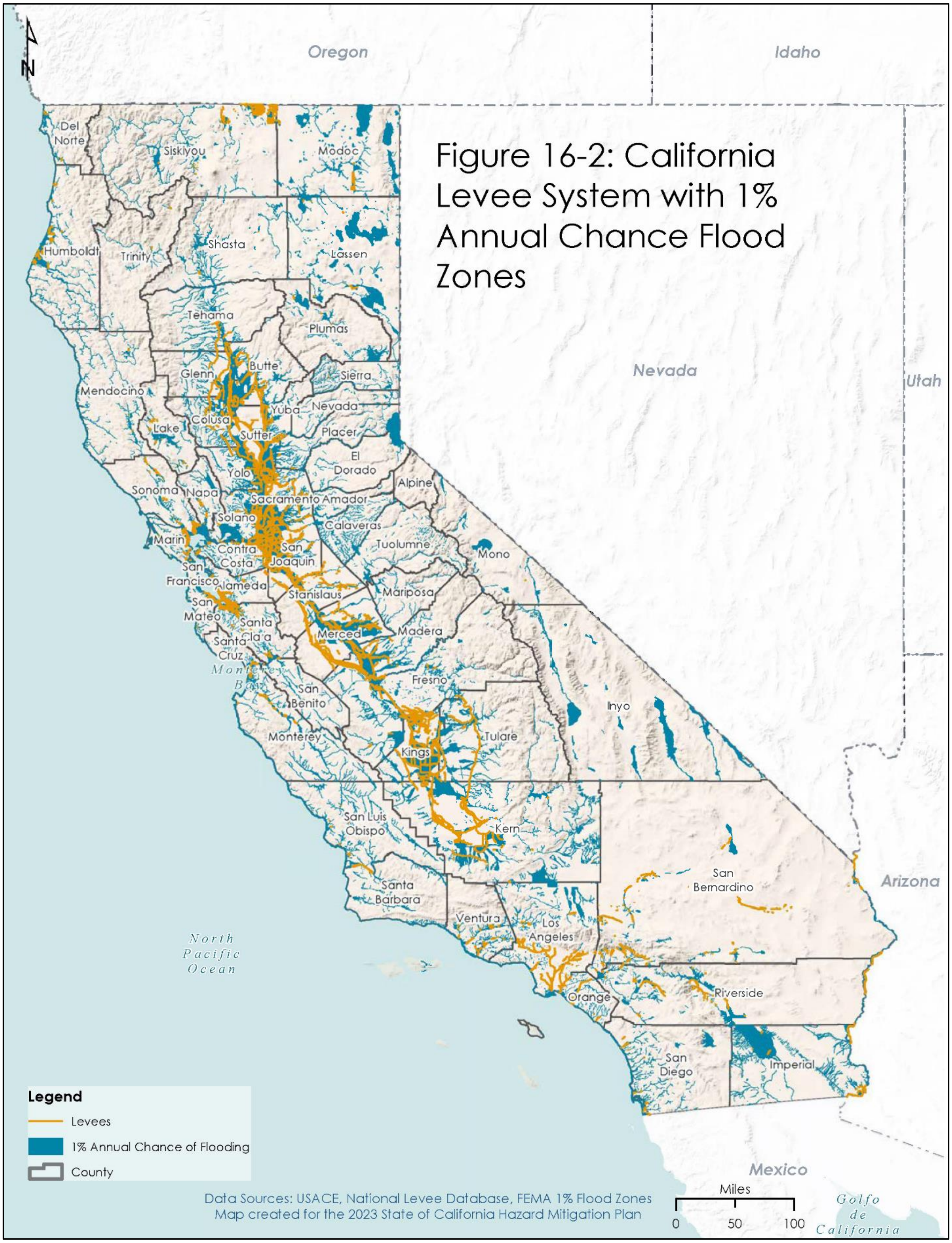
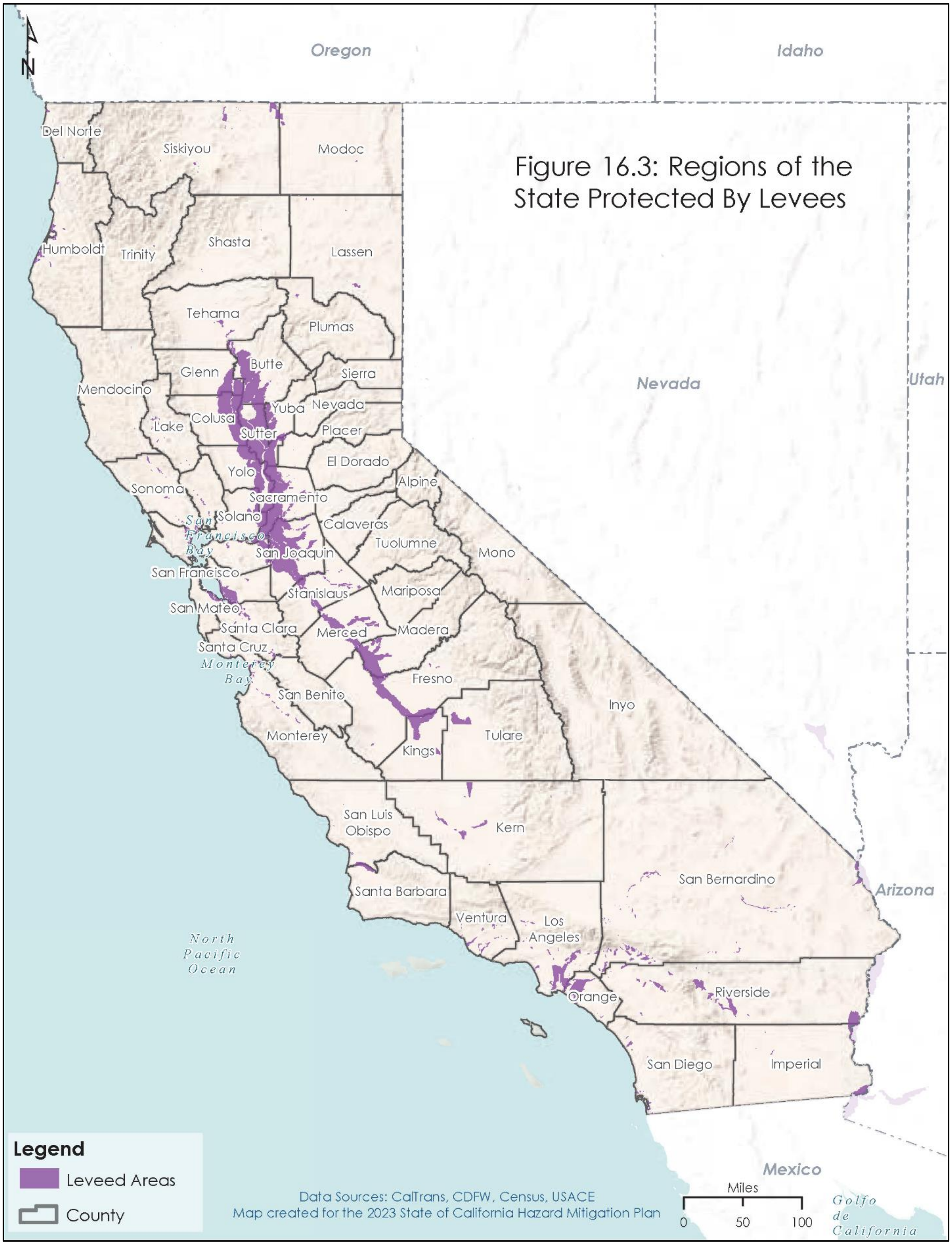


Figure 16-3. Regions of the State Protected by Levees



In 2007, the California legislature designated USACE Project levees in most of the Sacramento-San Joaquin Valley under the State Plan of Flood Control (SPFC) to be assessed every five years as part of the CVFPP. The costs of these assessments and resulting improvements are so high that the legislature limited this legal requirement to areas for which courts have held the State financially responsible. The Previous Occurrences and Vulnerability Assessment reflect this legislatively and judicially imposed limitation.

The Risk Assessment for State-owned or -leased facilities used levee flood protection zone (LFPZ) mapping prepared for the Central Valley by DWR. The LFPZ maps were developed by DWR as required by Water Code Section 9130 to increase awareness of flood risks associated with State and federal levees. DWR prepared LFPZ maps by estimating the maximum area that could be flooded if a levee under federal or State regulation were to fail while conveying flows at the maximum reasonable capacity. Lands in the LFPZ may be subject to flooding due to other factors, but the mapping indicates only inundation attributable to levee breach.

Figure 16-4 shows the LFPZ mapping used for this SHMP. The LFPZ is only available for the Central Valley of California and represents the best available uniform data set to assess the risk from this hazard to State-owned or -leased facilities and community lifelines. This is not a complete data set for all levees in the State, so the Risk Assessment is not representative of the total risk from this hazard. The Risk Assessment is inclusive of the best available data and science for this hazard of concern at the time of this SHMP update.

16.3. PREVIOUS HAZARD OCCURRENCES

Table 16-1 lists significant levee failures in the Bay-Delta from 1900 to the present. This list documents the spatial and temporal variability of levee failure but does not attribute the failures to a particular loading function or failure mechanism.

Figure 16-4. California Central Valley Levee Flood Protection Zones

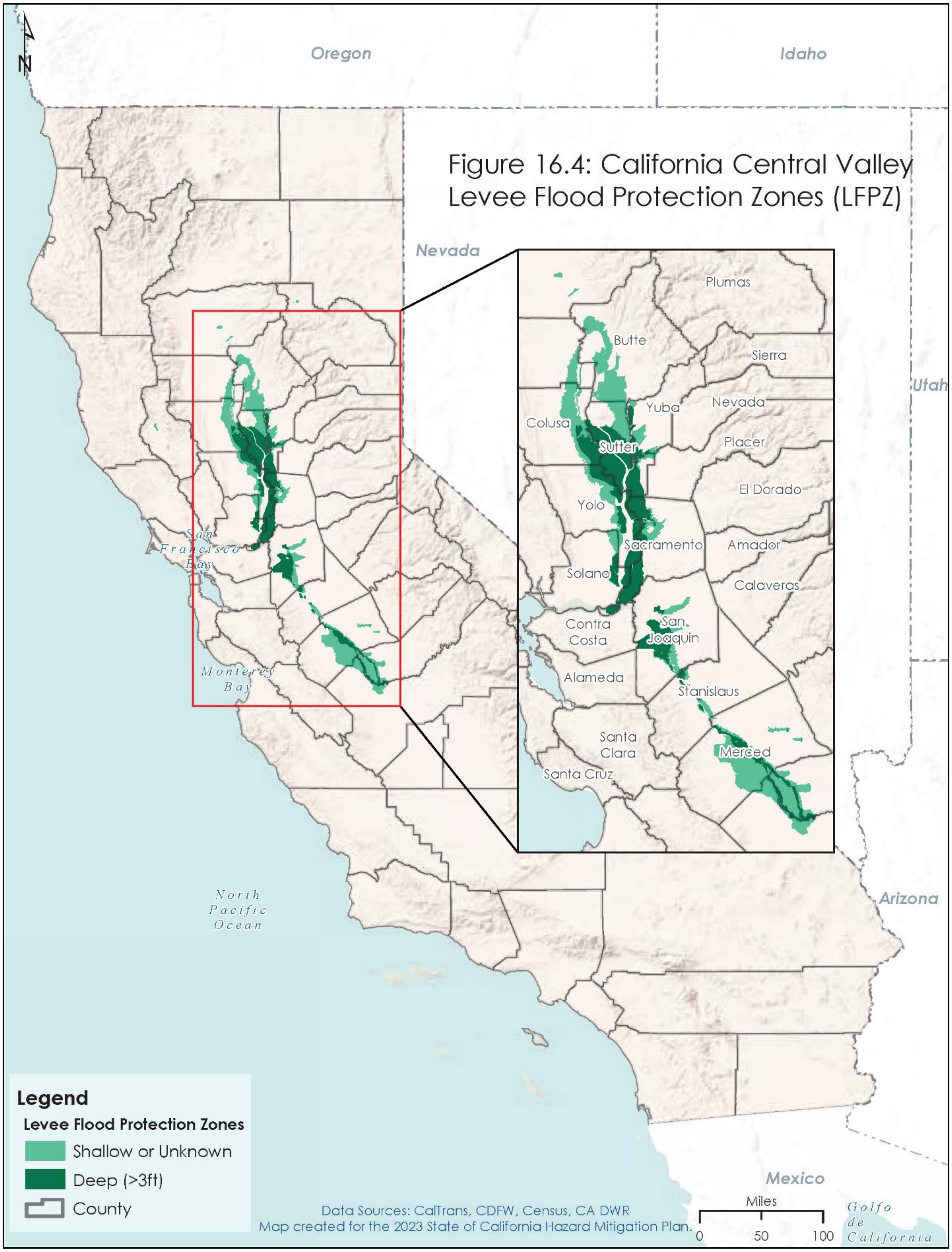


Table 16-1. San Francisco Bay-San Joaquin-Sacramento Delta Levee Failures, 1900-2022

Delta Island Tract	Total Acres Flooded	Year Flooded
Andrus Island	7,200	1902, 1907, 1909, 1972
Bacon Island	5,546	1938
Bethel Island	3,400	1907, 1908, 1909, 1911, 1971, 1981, 1983
Big Break	2,200	1927
Bishop Tract	2,100	1904
Bouldin Tract	5,600	1904, 1907, 1908, 1972
Brack Tract	2,500	1904
Bradford Island	2,000	1950, 1983
Brannan Island	7,500	1902, 1904, 1909, 1972
Byron Tract	6,100	1907
Canal Ranch Tract	500	1958, 1986
Clifton Court Tract	3,100	1901, 1907
Coney Island	900	1907
Dead Horse Island	200	1950, 1955, 1958, 1980, 1986, 1997
Donlon Island	3,000	1937
Edgerly Island	150	1983
Empire Tract	3,500	1950, 1955
Fabian Tract	6,200	1901, 1906
Fay Island	100	1983
Franks Tract	3,300	1907, 1936, 1938
Glanville Tract	--	1986, 1997
Grand Island	--	1955
Grizzly Island	8,000	1983
Holland Tract	4,100	1980
Ida Island	100	1950, 1955
Jersey Island	3,400	1900, 1904, 1907, 1909, 1981, 1983
Little Franks Tract	350	1981, 1982, 1983
Little Mandeville Island	22	1980
Lower Jones Tract	5,700	1907, 1980
Lower Roberts Island	10,300	1906
Lower Sherman Island	3,200	1907, 1925
Mandeville Island	5,000	1938
McCormack Williamson Tract	1,500	1938, 1950, 1955, 1958, 1986, 1997, 2017
McDonald Island	5,800	1982
Medford Island	1,100	1936, 1983
Middle Roberts Island	500	1938
Mildred Island	900	1965, 1969, 1983
New Hope Tract	2,000	1900, 1904, 1907, 1928, 1950, 1986

Delta Island Tract	Total Acres Flooded	Year Flooded
Palm Tract	2,300	1907
Pescadero	3,000	1938, 1950
Prospect Island	1,100	1980, 1981, 1982, 1983, 1986
Quimby Island	700	1936, 1938, 1950, 1955, 1986
RD 1007	3,000	1925
RD 17	4,500	1901, 1911, 1950
Rhode Island	100	1938
Ryer Island	11,600	1904, 1907
Sargent Barnhart Tract	1,100	1904, 1907
Sherman Island	10,000	1904, 1906, 1909, 1937, 1969
Shima	2,394	1983
Shin Kee Tract	700	1938, 1958, 1965, 1986
Staten Island	8,700	1904, 1907
Stewart Tract	3,900	1938, 1950, 1997
Terminous Tract	5,000	1907, 1958
Twitchell Island	3,400	1906, 1907, 1909
Tyler Island	8,700	1904, 1907, 1986
Union Island	2,400	1906
Upper Jones Tract	5,700	1906, 1980, 2004
Upper Roberts Island	500	1938
Van Sickle	--	1983, 2017
Venice Island	3,000	1904, 1906, 1907, 1909, 1932, 1938, 1950, 1982
Victoria Island	7,000	1901, 1907
Webb Tract	5,200	1950, 1980

Source: (Cal OES 2018a)

16.4. PROBABILITY OF FUTURE HAZARD EVENTS

16.4.1. Overall Probability

Complete levee failures are infrequent and typically coincide with the events that cause them, such as heavy rainfall, storm surge, or earthquakes. Over the past 120 years, 124 levee failure events have occurred in California, which equates to an annual recurrence interval. As levees continue to age, the State will continue to see annual recurrence of levee failure events.

16.4.2. Climate Change Impacts

Increased flood frequency and magnitude are predicted consequences of climate change, which in turn will increase the probability of levee failures. The following climate-related changes are expected to result in flooding increases:

- As annual temperatures increase, more of the precipitation that would have fallen into the Sierra Nevada Mountain range as snow may fall instead as rain, increasing winter flows in rivers downstream into the Delta system.
- As the sea levels rise, flood stages in the Sacramento-San Joaquin Delta may also rise, putting increasing pressure on Delta levees. Water levels upstream in the Sacramento and San Joaquin Rivers will also increase, putting pressure on levees there. Extreme high-water levels in the Bay and Delta will increase markedly if the sea level rises above its historical rate. During storm events, these extremes are likely to lead to more severe damage from waves and floods.

16.5. IMPACT ANALYSIS

16.5.1. Severity

Levees provide strong flood protection, but they are not infallible. Levees are designed to protect against a specific flood level and could be overtopped during severe weather events. Levees reduce but do not eliminate the risk to people and structures behind them. A levee system failure or overtopping can create severe flooding and high-water velocities. Proper operation and maintenance are necessary to reduce the probability of failure.

Overtopping is common during high water events in winter, and levee failures during large floods generally do not pose an immediate threat to water supplies outside the Delta.

16.5.2. Warning Time

Warning time depends on the cause of the failure:

- If heavy rains are impacting a levee system, communities in the immediate danger zone can be evacuated before a failure occurs.

- If a 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. A levee breach caused by structural failure can occur with little to no warning.
- A structural failure during a period of low inflow, such as summer, can draw ocean salinity into the Delta. The saline water could cause a multi-year disruption to statewide water use. Large-scale disruptions could cost hundreds of billions of dollars annually.

16.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others.

The following are notable cascading impacts associated with levee failure:

- Levee failure can cause bank erosion, which can have effects worse than those of flooding itself. On the upper courses of rivers where there are steep gradients, floodwaters pass quickly and scour the banks, edging properties closer to the water way or causing them to fall in.
- Flooding associated with levee failure can lead to landslides if high flows over-saturate soils on steep slopes, causing them to fail. Hazardous materials spills can occur if waters that overtop levees rupture storage tanks and cause them to spill into streams, rivers, or drainage sewers.
- Critical infrastructure failures such as loss of power, potable and wastewater treatment, and road and bridge failure can be caused by levee failure events, depending on the magnitude of the resulting flood.

16.5.4. Environmental Impacts

Wildlife and fish can be impacted if flood waters from a levee failure destroy or fundamentally alter plant communities and thus reduce habitat. Floodwaters can also erode riverbanks and convey sediment to locations where it can clog riverbeds and streams, smother aquatic organisms, and destroy habitats. Erosion and sedimentation have a more negative impact on ecosystems that are already degraded. Receding flood waters can leave behind stagnant pools that provide breeding grounds for mosquitoes, which can transmit diseases.

16.5.5. Local Hazard Impacts

LHMP Rankings

According to the USACE National Levee Database, Alpine, Amador, Calaveras, El Dorado, Inyo, and Tuolumne Counties do not have any State or federally regulated levees. Of the remaining 52 counties in California, 23 assessed levee failure as a hazard of concern in their hazard mitigation plans. Of these, 11 ranked levee failure as high risk, nine ranked it as medium risk, and three ranked it as low risk. The following counties listed levee failure as a high-risk hazard:

- Butte
- Calusa
- Fresno
- Glenn
- Lassen
- Merced
- Orange
- Sacramento
- San Joaquin
- Sutter
- Yolo

LHMP Estimates of Potential Loss

A review of the LHMPs in the counties (as called for in FEMA's Standard State Mitigation Planning Requirement S6.b) found no quantitative risk analysis that identifies population or structures exposed to this hazard. This can be attributed to the lack of extent and location hazard mapping to use for such an analysis. Therefore, no summary of risk for local plan reviews is provided for this hazard.

16.6. VULNERABILITY ANALYSIS

16.6.1. Exposure of State-Owned or -Leased Facilities

Table 16-2 and Table 16-3 summarize the number and replacement cost value of State assets located in the LFPZ. Figure 16-5 summarizes the exposed assets as a percentage of total assets statewide. Appendix I provides detailed results by county.

Table 16-2. State-Owned or -Leased Facilities Exposed to Levee Flood Protection Zones

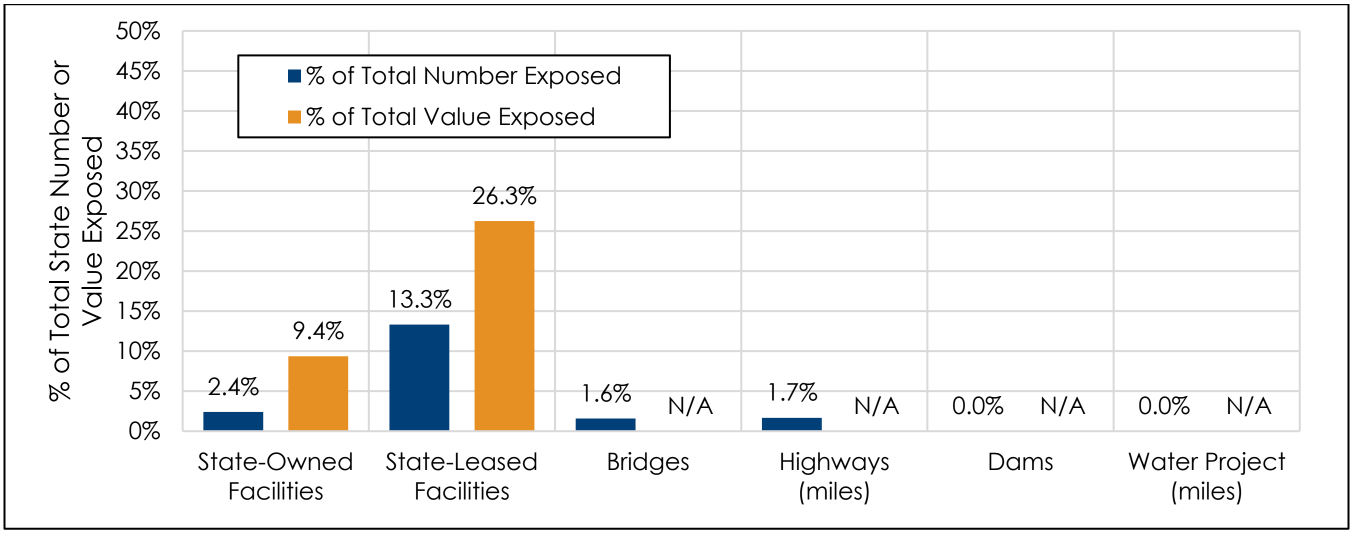
Type of Facility	Number of Structures	Total Area (sq. ft.)	Replacement Cost Value		
			Structure	Content	Total
State-Leased Facilities	252	—	$2,404,840,757	$2,492,284,065	$4,897,124,822
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	82	884,450	$47,371,469	$47,371,469	$94,742,939
Development Center	0	0	$0	$0	$0
Hospital	0	0	$0	$0	$0
Migrant Center	1	81,500	$8,146,732	$4,544,727	$12,691,459
Special School	0	0	$0	$0	$0
All Other Facilities	242	13,771,328	$1,652,186,723	$1,681,578,914	$3,333,765,637
Total State-Owned	***325***	***14,737,278***	***$1,707,704,925***	***$1,733,495,110***	***$3,441,200,035***
Total Facilities	**577**	**N/A***	**$4,112,545,682**	**$4,225,779,175**	**$8,338,324,857**

* The inventory of State assets does not include building area for State-leased facilities, so no total area for all State facilities is provided; the building area of vulnerable assets is shown for State-owned facilities only.

Table 16-3. State-Owned or -Leased Infrastructure Exposed to Levee Flood Protection Zones

Type of Facility	State-Owned Infrastructure in the Mapped Hazard Area
Bridges	210
Highway (miles)	498.7
Dams	0
Water Project (miles)	0

Figure 16-5. State Assets Exposed to Levee Failure as % of Statewide Total



The following are key findings of the levee failure Risk Assessment for State-owned or -leased assets:

- The average building area of State-owned or -leased facilities in the LFPZ is 43,345 square feet, and the average replacement cost value is $10.6 million.
- The average replacement cost value for State-owned or -leased facilities in the LFPZ is $19.4 million.
- The following are the five State agencies with the most State-owned or -leased facilities in the LFPZ:
  - DGS (126)
  - CDCR (85)
  - California Exposition and State Fair (47)
  - Caltrans (40)
  - CDFW (35)

- The State agency with the highest total replacement cost value for State-owned or -leased facilities in the LFPZ is DGS, at $2.2 billion.

16.6.2. Exposure of Critical Facilities and Community Lifelines

The analysis identified 16 facilities and community lifelines in the LFPZ for which it is critical for the State to maintain continuity of operations during and after hazard events. Of those, 25 percent are in the "hazardous material" lifeline category and another 25 percent are in the "transportation" lifeline category. The County with the largest percentage of these facilities is Sacramento (37.5 percent) followed by San Joaquin (31.3 percent) and Ventura (12.5 percent). For a detailed breakdown of facility counts by county, see Appendix I.

Critical facilities and community lifelines exposed to the levee failure hazard are likely to experience functional downtime following failure events, which could increase the net impact in the affected area. Hazus estimates damage and functional downtime for flood-related events such as levee failures. Local governments are encouraged to use tools such as Hazus when creating or updating their LHMPs.

16.6.3. Estimates of Loss

Loss estimations for hazard events that cause flooding typically use an approach that correlates damage to the depth of flood water impacting a structure and the time of inundation. USACE has established depth/damage correlations based on analysis of the impacts historical flood events have had on the built environment. The assessment of potential loss associated with levee failure for this SHMP used the USACE depth-damage curve for facilities with "average government function" (see Figure 16-6).

Table 16-4 shows the resulting estimates of potential damage to State-owned or -leased facilities in the LFPZ per foot of flood depth, up to the flood depth that would trigger substantial damage (50 percent of replacement cost value).

Figure 16-6. Depth/Damage Curve for "Average Government Function" Occupancy

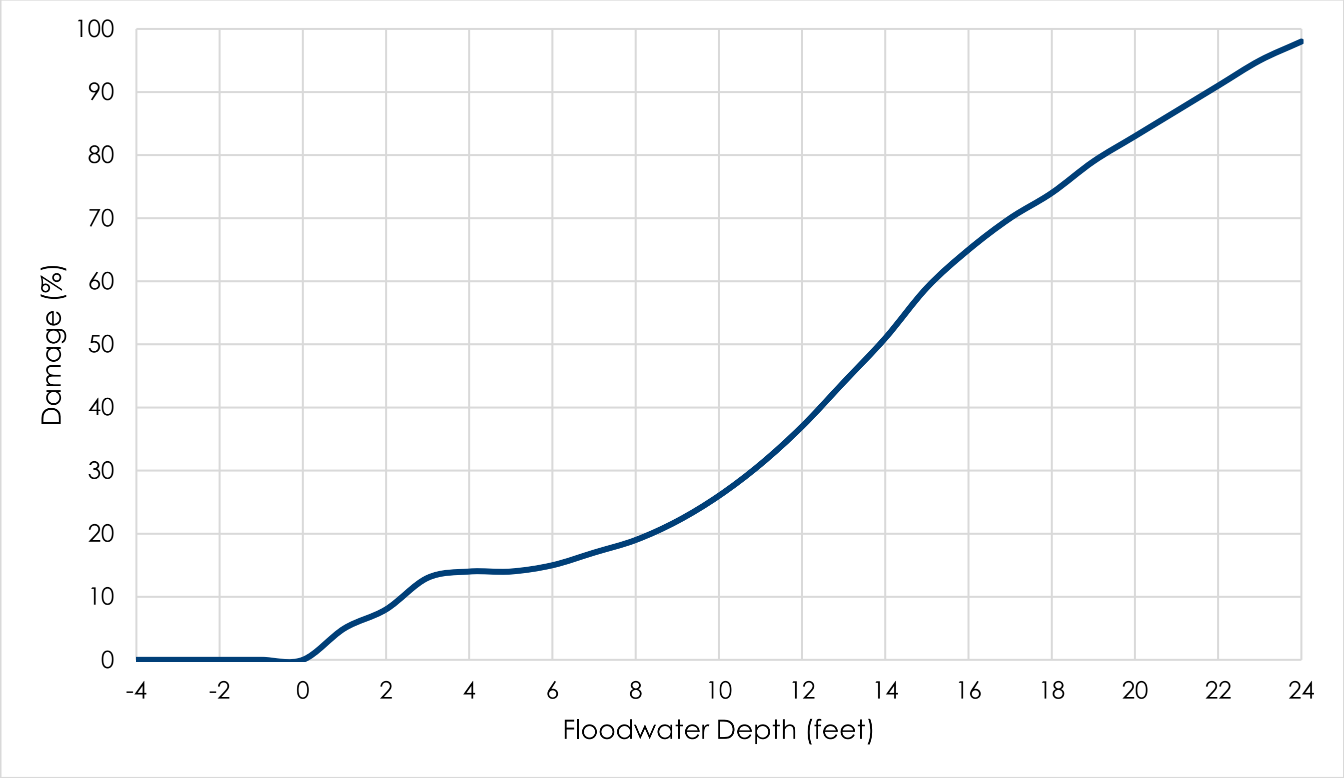


Table 16-4. Estimates of Flood Loss for Facilities in the LFPZ

Flood Depth (feet)	Estimates of Flood Loss*		
	State-Owned	State-Leased	Total
1	$172,060,002	$244,856,241	$416,916,243
2	$275,296,003	$391,769,986	$667,065,989
3	$447,356,005	$636,626,227	$1,083,982,231
4	$481,768,005	$685,597,475	$1,167,365,480
5	$481,768,005	$685,597,475	$1,167,365,480
6	$516,180,005	$734,568,723	$1,250,748,729
7	$585,004,006	$832,511,220	$1,417,515,226
8	$653,828,007	$930,453,716	$1,584,281,723
9	$757,064,008	$1,077,367,461	$1,834,431,469
10	$894,712,009	$1,273,252,454	$2,167,964,463
11	$1,066,772,011	$1,518,108,695	$2,584,880,706
12	$1,273,244,013	$1,811,936,184	$3,085,180,197
13	$1,514,128,016	$2,154,734,922	$3,668,862,937
14	$1,755,012,018	$2,497,533,659	$4,252,545,677

* Structure losses only. Does not include contents losses.

16.6.4. Buildable Land

Of 11.7 million acres of land available for development statewide, 55,363 acres (0.5 percent) are located in the LFPZ. Appendix G provides a detailed assessment of exposed buildable lands by county.

16.6.5. Equity Priority Communities

The risk analysis for levee failure found that 34.0 percent of people exposed to the levee failure hazard live in equity priority communities (186,000 people). A breakdown of exposed equity priority communities by county is included in Appendix I.

16.6.6. NRI Scores

The National Risk Index does not provide rankings for the levee failure hazard.

16.7. MITIGATING THE HAZARD

16.7.1. Opportunities for Mitigating the Hazard

A range of potential opportunities for mitigating the levee failure hazard is provided in Table 16-5. See Section 1.2.3 for a description of the different types of alternatives.

16.7.2. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address the levee failure hazard:

- Action 2023-009: Implement the 2022 CVFPP.
- Action 2018-006: Enhance Collaboration on the Development and Sharing of Data Systems and GIS Modeling.
- Action 2018-008: Develop a database containing a description of the specific natural hazard event for which each project was designed to mitigate.
- Action 2018-059: Delta Levees Program: Provide funding to local agencies in the Sacramento- San Joaquin for levee maintenance and improvement and for habitat mitigation and enhancement.

Table 16-5. Potential Opportunities to Mitigate the Levee Failure Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ None **Reduce exposure and vulnerability:** ▪ Relocate out of levee failure inundation areas ▪ Elevate home to appropriate levels ▪ Have designated shelters or temporary or permanent housing locations for displaced persons **Build local capacity:** ▪ Learn about risk reduction for the levee failure hazard ▪ Learn the evacuation routes for a levee failure event ▪ Become educated about early warning systems and the dissemination of warnings	**Manipulate the hazard:** ▪ Remove levees ▪ Harden levees ▪ Set back levees **Reduce exposure and vulnerability:** ▪ Replace earthen levees with hardened structures such as floodwalls ▪ Floodproof facilities in levee failure inundation areas **Build local capacity:** ▪ Educate employees on the probable impacts of a levee failure ▪ Develop a continuity of operations plan	**Manipulate the hazard:** ▪ Remove levees ▪ Harden levees ▪ Set back levees **Reduce exposure and vulnerability:** ▪ Replace earthen levees with hardened structures such as floodwalls ▪ Relocate critical facilities out of levee failure inundation areas ▪ Consider open space land use in designated levee failure inundation areas ▪ Adopt higher floodplain standards in mapped levee failure inundation areas ▪ Retrofit critical facilities in levee failure inundation areas **Build local capacity:** ▪ Map levee failure inundation areas ▪ Enhance emergency operations plans to include a levee failure component ▪ Inform the public on risk reduction techniques ▪ Adopt real-estate disclosure requirements for the re-sale of property located within levee failure inundation areas ▪ Consider the probable impacts of climate change in assessing the risk associated with the levee failure hazard ▪ Establish early warning capability for those protected by levees ▪ Consider the residual risk associated with protection provided by levees in future land use decisions ▪ Increase ability to respond quickly to events
Nature-based opportunities ▪ Restore and reconnect floodplains that have been degraded by development and structural flood control		

Community-Scale	Organizational Scale	Government-Scale
▪ Use soft approaches for stream bank restoration and hardening. Soft approaches can include but are not limited to the introduction of large woody debris into a system ▪ Set back levees on systems that rely on levee protection to allow the river channel to meander, which reduces erosion and scour potential ▪ Acquire property within the floodplain, remove or relocate structures, and preserve these areas as open space in perpetuity ▪ Preserve floodplain storage capacity by limiting or prohibiting the use of fill within the floodplain ▪ Incorporate green infrastructure into stormwater management facilities ▪ Protect and/or restore riparian buffers		

SNOW AVALANCHE

Climate Impacts:
Greater variability in weather patterns driven by climate change will cause layers of rain to fall after light layers of snow, and these forms of precipitation can destabilize snowpack and increase the frequency, and severity, of avalanches

Equity Impacts:
Approximately 20% of the exposed population is identified as living in equity priority communities; however, those living in counties susceptible to avalanches are at greater risk

State Facilities Exposed:
All facilities in counties identified with avalanche susceptibility are exposed; however, those located in areas prone to avalanches are more at risk

Community Lifelines Exposed:
All lifelines in counties identified with avalanche susceptibility are exposed; however, those located in areas prone to avalanches are more at risk

Impact Rating: Medium (21)

17. Snow Avalanche

Snow avalanche has been identified as a medium-impact natural hazard of interest based on the hazard impact rating protocol applied for this SHMP. These events happen frequently in areas susceptible to accumulated snowfall. Less than 14 percent of State-owned or -leased facilities and community lifelines are exposed to this hazard. Less than 14 percent of the State population resides in counties with snow avalanche susceptibility; about 20 percent of that population has been identified as living in equity priority communities. The chance of the risk of this hazard increasing due to new development is low, since the majority of areas that are susceptible are State or national forests or are currently zoned for recreational use. The frequency and severity of snow avalanche is anticipated to increase over the next 30 years due to impacts from climate change.

17.1. HAZARD OVERVIEW

An avalanche is a mass of snow, ice, soil, or rocks that fall down a mountainside. Avalanches of rock and soil are landslides, as assessed in Chapter 12. This chapter assesses avalanches of snow (National Geographic n.d.). Snow avalanches occur in the steep mountainous areas of California that receive significant amounts of snow. They are weather-related threats to communities, residents, and visitors in the high mountain areas of the State.

17.2. HAZARD LOCATION

Avalanches tend to occur in three distinct areas in California: the Eastern Sierras, the Central Sierra Nevada, and the southern part of the Cascade Range near Mount Shasta (Avalanche.org 2022).

17.3. PREVIOUS HAZARD OCCURRENCES

Avalanches are a yearly occurrence in California. The main source of documentation for avalanches in the United States is NOAA's National Center for Environmental Information, which provides details on avalanches in California.

17.3.1. Disaster and Emergency Declarations

No FEMA, USDA, or State disaster declarations or proclamations related to snow avalanche have been issued relevant to California or any of its counties.

17.3.2. Event History

Avalanches have caused property damage and loss of life in California. The 2018 SHMP discussed avalanches that occurred in the State from 1996 to 2016. Table 17-1 lists avalanches that occurred in the State since January 2018. Refer to Appendix K for the history of avalanches since 1996.

Table 17-1. Avalanche Events in the State of California (2018 to 2022)

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties/Areas Impacted
January 27, 2018	Avalanche	N/A	N/A	Greater Lake Tahoe Area
A dry slab avalanche was triggered by a snowboarder on North Castle Peak. No injuries or deaths reported.				
March 2, 2018	Avalanche	N/A	N/A	Greater Lake Tahoe Area
Avalanche occurred at Squaw Valley Ski Resort. The avalanche caught five people, all of whom survived.				
March 3, 2018	Avalanche	N/A	N/A	Mono
Avalanche occurred at Mammoth Mountain Ski Area. Six people were partially caught but freed themselves with only minor injuries.				
March 17, 2018	Avalanche	N/A	N/A	Tamarack Peak
This slide was triggered by the seventh person to ski the slope. The person was carried by the avalanche and lost skis and poles. When the slide stopped moving the person ended up only partially buried and was able to self-rescue.				
March 22, 2018	Avalanche	N/A	N/A	Mono
Avalanche occurred on McGee Mountain. No injuries or deaths reported.				

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties/Areas Impacted
December 2, 2018	Avalanche	N/A	N/A	Red Lake Peak, Above Crater Lake
As a skier went down the mountain, it released a 60-foot-wide slab avalanche; however, no injuries were reported.				
December 9, 2018	Avalanche	N/A	N/A	Mt. Tallac
A skier set off a small slab avalanche and knocked him off his feet. The skier fell 200 feet and was seriously injured.				
December 16, 2018	Avalanche	N/A	N/A	Frog Lake into Red Lake
Avalanche triggered by a snowboard, setting off a wind slab that dropped into Red Lake.				
March 23, 2019	Avalanche	N/A	N/A	Mono
A full course slab avalanche was accidentally triggered by two skiers, both of whom survived.				
April 1, 2019	Avalanche	N/A	N/A	West Slope Northern Sierra Nevada
An avalanche closed Hwy 50 at Echo Summit.				
January 17, 2020	Avalanche	N/A	N/A	Greater Lake Tahoe Area
A large avalanche occurred at Alpine Meadows Resort, causing one death.				
January 17, 2020	Avalanche	N/A	N/A	Greater Lake Tahoe Area
A full burial slab avalanche occurred along the north side of Independence Lake. One skier was buried but survived with minor injuries.				
January 27, 2021	Blizzard	N/A	N/A	Mono/Greater Lake Tahoe Area
Avalanche occurred on U.S. 395 within Walker River Canyon.				
January 28, 2021	Avalanche	N/A	N/A	Mono
Multiple avalanches occurred in Walker River Canyon with up to 15 feet of debris covering U.S. 395.				
February 3, 2021	Avalanche	N/A	N/A	Western Siskiyou County
An avalanche near Etna Summit buried two skiers, killing one of them.				
December 11, 2021	Avalanche	N/A	N/A	Base of Elephants Back
A skier triggered a wind slab; two people were caught in the incident.				
December 18, 2021	Avalanche	N/A	N/A	Stevens Peak
A skier triggered a slow-moving avalanche that pulled another skier down approximately 30 feet, burying one leg.				
January 3, 2022	Avalanche	N/A	N/A	Stanford Rock
Small avalanche caught one skier.				

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties/Areas Impacted
April 15, 2022	Avalanche	N/A	N/A	Andesite Peak
Heavy snow and moderate avalanche conditions; two skiers were caught in the avalanche.				
May 7, 2022	Avalanche	N/A	N/A	Alpine/Keyhole Area
A skier was caught in about 20 feet of snow and was able to dig out.				

Sources: (Mount Shasta Avalanche and Climbing Information 2022); (Sierra Avalanche Center 2022a); (Bridgeport Avalanche Center 2022)

17.4. PROBABILITY OF FUTURE HAZARD EVENTS

17.4.1. Overall Probability

California's record of more than 100 avalanche events between 2009 and 2022 represent an average of more than seven events per year. The State is expected to continue to experience a similar number of avalanches each year.

17.4.2. Climate Change Impacts

Scientists have only recently begun examining the effects climate change might have on avalanches. According to some experts, greater variability in weather patterns will cause layers of rain to fall after light layers of snow, and this sequence can destabilize snowpack and increase the frequency and severity of avalanches (USFS 2019a). Some experts believe that an overall reduction in snowpack could lead to fewer avalanches in winter but changing precipitation patterns could make avalanches more frequent in the springtime instead (Peitzsch, et al. 2021).

17.5. IMPACT ANALYSIS

17.5.1. Severity

The fact that avalanches take place in remote settings far from large population centers means they do not pose the same degree of danger to life and property as other hazards do. The people most vulnerable to avalanches tend to be skiers, snowboarders, and others engaged in recreational activities in snow-covered, mountainous areas. Transportation infrastructure and structures that serve those areas also are vulnerable.

17.5.2. Warning Time

The North American Avalanche Danger Scale is a tool used by avalanche forecasters to communicate the potential for avalanche occurrence and the general size and distribution of avalanches if they occur (Avalanche.org 2022b). The scale is a five-category estimation of the avalanche danger: low, moderate, considerable, high, and extreme. The scale is presented in Figure 17-1.

Figure 17-1. North American Avalanche Danger Scale

Danger Level		Travel Advice	Likelihood of Avalanches	Avalanche Size and Distribution
5 Extreme	4 5	Avoid all avalanche terrain.	Natural and human-triggered avalanches certain.	Large to very large avalanches in many areas.
4 High	4 5	Very dangerous avalanche conditions. Travel in avalanche terrain **not** recommended.	Natural avalanches likely; human-triggered avalanches **very** likely.	Large avalanches in many areas; or very large avalanches in specific areas.
3 Considerable	3	Dangerous avalanche conditions. Careful snowpack evaluation, cautious route-finding and conservative decision-making essential.	Natural avalanches possible; human-triggered avalanches likely.	Small avalanches in many areas; or large avalanches in specific areas; or very large avalanches in isolated areas.
2 Moderate	2	Heightened avalanche conditions on specific terrain features. Evaluate snow and terrain carefully; identify features of concern.	Natural avalanches unlikely; human-triggered avalanches possible.	Small avalanches in specific areas; or large avalanches in isolated areas.
1 Low	1	Generally safe avalanche conditions. Watch for unstable snow on isolated terrain features.	Natural and human-triggered avalanches unlikely.	Small avalanches in isolated areas or extreme terrain.
Safe backcountry travel requires training and experience. You control your own risk by choosing where, when and how you travel.				
No Rating		Watch for signs of unstable snow such as recent avalanches, cracking in the snow, and audible collapsing. Avoid traveling on or under similar slopes.		

Source: (Avalanche.org 2022b)

The National Weather Service provides current weather conditions and forecast information to regional avalanche forecast centers that in turn issue avalanche forecasts. Avalanche warnings and special advisories are included on NWS websites and broadcast over NOAA Weather Radio (NWS 2021). In California, several avalanche centers provide forecasts, advisories, and warnings. Each center employs avalanche forecasters to provide daily avalanche advisories and field observations (Sierra Avalanche Center 2022); (Avalanche.org 2022a).

17.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with snow avalanche:

- The most significant cascading impacts from snow avalanches are the closure of transportation corridors, which can isolate populations and interrupt commodity flows.
- Avalanches tend to occur independently of other types of hazards, although it is possible for avalanches to be triggered by severe weather and earthquakes. There may be occasions where avalanches contribute to the presence of other hazards (Colorado Department of Local Affairs n.d.), such as flash floods resulting from mountainside erosion.
- Avalanches might cause erosion on sloped terrain, thereby increasing the likelihood of future landslides. In addition, debris deposited in a river or stream because of avalanches might alter its flow and contribute to flooding later.

17.5.4. Environmental Impacts

The effects avalanches have on wildlife and natural ecosystems are considered to be beneficial (Muller and Straub 2016). For example, the chutes and debris created by avalanches help provide favorable habitat for a variety of flora and fauna. Avalanches can also form firebreaks that help limit wildfires in wooded areas. Moreover, a self-regulating feedback loop occurs between avalanches and the trees in a forest. Trees that experience avalanches become stronger and more resilient, and these more robust trees in turn reduce the frequency of avalanches by reinforcing the snowpack and reducing the effects of strong winds.

17.5.5. Local Hazard Impacts

LHMP Rankings

Five of the hazard mitigation plans prepared for California's 58 counties list landslide as a hazard of concern; all of them rank it as a medium-impact hazard:

- Fresno
- Inyo
- Lassen
- Mono
- Placer

LHMP Estimates of Potential Loss

A review of the LHMPs in the counties (as called for in FEMA's Standard State Mitigation Planning Requirement S6.b) found no quantitative risk analysis that identifies population or structures exposed to this hazard. This can be attributed to the lack of extent and location hazard mapping to use for such an analysis. Therefore, no summary of risk for local plan reviews is provided for this hazard.

17.6. VULNERABILITY ANALYSIS

17.6.1. Exposure of State-Owned or -Leased Facilities, Critical Facilities, and Community Lifelines

With no mapping of avalanche hazard zones available, there is no valid way to quantify the exposure of State assets to this hazard. Given the remoteness of avalanche areas, it is unlikely that State-owned or -leased facilities are directly exposed. Critical infrastructure such as roads are more likely to be exposed. Impacts on these lifelines could isolate populations and interrupt commodity flows.

17.6.2. Estimates of Loss

Snow avalanche events are not likely to result in any losses associated with damage or impairment to State assets. All losses from this hazard would be associated with impacts on the economy, based on limitations on activities in avalanche risk areas.

17.6.3. Buildable Land

Areas of snow avalanche susceptibility are typically not well suited for development due to the steepness of slope in these areas. However, the run-out areas down-slope can be targets for developments. Most the lands identified as susceptible to snow avalanches are either State or national forest or have existing uses associated with winter sport recreation. Therefore, the buildable land exposure for this hazard is considered to be low.

17.6.4. Equity Priority Communities

In determining whether equity priority populations are exposed to the threat of avalanches, the best method available at the time of this Plan update is to consider how the counties in which avalanches take place score on existing social vulnerability indexes. Table 17-2 summarizes relevant scores.

Table 17-2. SVI in Counties with Avalanches

County	FEMA National Risk Index Social Vulnerability Score	County	FEMA National Risk Index Social Vulnerability Score
Alpine	40.68 out of 100—relatively moderate	**Mono**	33.70 out of 100—relatively low
Amador	35.63 out of 100—relatively moderate	**Nevada**	36.89 out of 100—relatively moderate
Butte	42.14 out of 100—relatively moderate	**Placer**	25.90 out of 100—relatively low
Calaveras	37.92 out of 100—relatively moderate	**Plumas**	46.63 out of 100—relatively high
El Dorado	26.69 out of 100—relatively low	**San Diego**	32.20 out of 100—relatively low
Fresno	49.70 out of 100—relatively high	**San Bernardino**	40.28 out of 100—relatively moderate
Inyo	48.48 out of 100—relatively high	**Shasta**	43.20 out of 100—relatively moderate
Lassen	9.78 out of 100—very low	**Sierra**	46.67 out of 100—relatively high
Los Angeles	44.90 out of 100—relatively high	**Siskiyou**	48.48 out of 100—relatively high
Madera	48.99 out of 100—relatively high	**Tulare**	51.28 out of 100—relatively high
Mariposa	46.24 out of 100—relatively high	**Tuolumne**	42.14 out of 100—relatively moderate
Modoc	49.07 out of 100—relatively high	**Yuba**	39.81 out of 100—relatively moderate

Many counties in California are large and encompass a variety of demographically diverse and geographically dispersed communities. This means that the county-level data may not reflect equity priority in separate communities within a specific county. Nevertheless, this is the most appropriate data available at the time of this Plan update.

17.6.5. NRI Scores

According to the NRI, 19 of the State's counties have avalanche risk, rated from relatively low to relatively moderate. Table 17-3 shows scores for the six counties with the highest rating. See Section 4.1.3 for a description of the components of the NRI.

Table 17-3. NRI Scoring of Counties for Avalanche

County	Expected Annual Loss	Social Vulnerability Rating	Community Resilience Rating	Community Risk Factor	Risk Value	Score
Placer	$682,573	Very Low	Very High	0.91	$607,950	83.17
Alpine	$386,644	Relatively Moderate	Relatively Moderate	1.35	$521,920	81.25
Inyo	$368,508	Relatively Moderate	Relatively Low	1.31	$432,020	77.4
Mono	$373,333	Relatively moderate	Relatively High	1.17	$431,803	76.92
Nevada	$386,664	Relatively Low	Relatively High	0.98	$424,655	76.44
El Dorado	$424,586	Relatively Low	Relatively High	1.02	$397,395	75.00

17.7. MITIGATING THE HAZARD

17.7.1. Existing Measures to Mitigate the Hazard

Each of the three main avalanche areas of California has an avalanche center, a non-profit institution that operates as a partner of the U.S. Forest Service for monitoring avalanches and educating the public about them:

- The Eastern Sierra Avalanche Center (Eastern Sierra Avalanche Center 2022)
- The Sierra Avalanche Center (Sierra Avalanche Center n.d.)
- The Mount Shasta Avalanche Center (Mount Shasta Avalanche Center n.d.)

The establishment of avalanche centers in these areas means that avalanches are consistently detected and documented therein.

17.7.2. Opportunities for Mitigating the Hazard

In areas affected by avalanches, the threat can be reduced through ongoing control programs, installing protection structures, and public outreach. A range of potential alternatives for mitigating the snow avalanche hazard is provided in Table 17-4.

17.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address snow avalanche:

- Action 2018-001: Support Legislative Efforts that Formalize California's Comprehensive Mitigation Program.
- Action 2018-006: Enhance Collaboration on the Development and Sharing of Data Systems and GIS Modeling.
- Action 2018-008: Develop a database containing a description of the specific natural hazard event for which each project was designed to mitigate.

Table 17-4. Potential Opportunities to Mitigate the Snow Avalanche Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ None **Reduce exposure and vulnerability:** ▪ Monitor avalanche reports before any winter-related outdoor activities ▪ Avoid avalanche areas ▪ Monitor avalanche reports before any winter-related outdoor activities **Build local capacity:** ▪ None	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ None **Build local capacity:** ▪ None	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Controlled avalanches as necessary (i.e., triggering an avalanche through detonation ▪ Install static defense structures in avalanche areas ▪ Identify and map avalanche paths and avalanche areas in the State ▪ Construct snow sheds over highways and railroads that cross potential avalanche paths ▪ Have proper equipment to support rescue, mitigate head injuries, and create air pockets (avalanche beacon, portable shovel, avalanche probe in backpack, helmet, and avalanche airbags) **Build local capacity:** ▪ Identify and map avalanche paths and avalanche areas in the State
Nature-based opportunities ▪ Restrict or prohibit new development downslope of areas susceptible to avalanche and preserve these areas for open space/recreational uses ▪ Preserve forest ecosystems in avalanche-prone areas to provide a resistance buffer area to absorb impacts from avalanches		

SUBSIDENCE

Climate Impacts:

Subsidence impacts can be directly tied to prolonged periods of drought and extreme heat; changes in precipitation, reduced snowpack, and more frequent droughts are likely to increase the demand on groundwater sources, risking overdraft, ground subsidence, and decreased water quality

Equity Impacts:

32.9% of exposed population (those living in subsidence susceptible counties) identified as living in equity priority communities

State Facilities Exposed:

10,713 State facilities located in subsidence susceptible counties

Community Lifelines Exposed:

462 community lifelines located in subsidence susceptible counties

Impact Rating: Medium (18)

18. SUBSIDENCE

Subsidence has been identified as a medium-impact natural hazard of interest based on the hazard impact rating protocol applied for this SHMP. These events are likely to occur in some regions of the State within the next 100 years. An estimated 41.4 percent of State-owned or -leased facilities and community lifelines are exposed to this hazard. Less than 25 percent of the population resides in areas considered to be susceptible to subsidence; over 32.9 percent of that population has been identified as living in equity priority communities. Less than 6 percent of buildable land in the State is in regions that are susceptible to subsidence. The frequency and severity of subsidence is anticipated to increase over the next 30 years due to the impacts from climate change.

18.1. HAZARD OVERVIEW

DWR defines land subsidence as "the sinking of the land surface due to excessive groundwater pumping" (DWR 2022j). The sinking may be gradual or sudden. Subsidence happens either due to natural processes or as a result of human activities.

Effects of land subsidence in California include increased flood risk in low-lying areas, damage to buildings and infrastructure, loss of groundwater aquifers, and damage to aquatic ecosystems. Figure 18-1 shows typical physical signs of subsidence activity.

18.2. HAZARD LOCATION

Figure 18-2 shows known areas of subsidence risk in California today. Figure 18-3 shows the critically over-drafted groundwater basins in California. The areas shown are potentially more susceptible to subsidence. Table 18-1 describes areas of historically significant subsidence across the State. The sections below describe the conditions that typically lead to subsidence in specific regions of California.

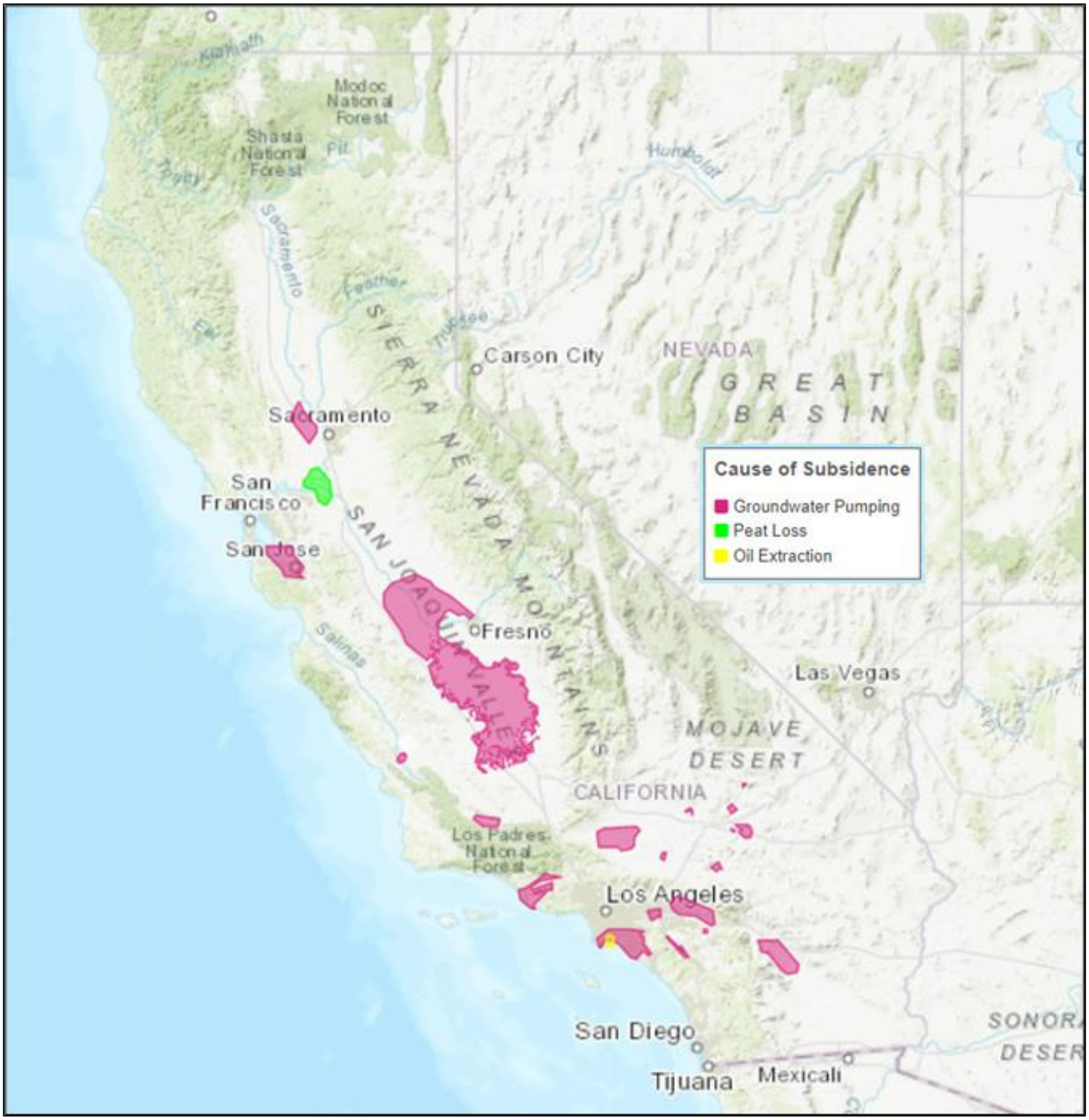
Figure 18-1. Physical Signs of Subsidence

Source: (USGS 2018e)

Source: (USGS 2018c)

Source: (USGS 2017)

Figure 18-2. Areas of Land Subsidence in California



Source: (USGS 2023)

Figure 18-3. Critically Over-Drafted Groundwater Basins in California

Source: (DWR 2020a)

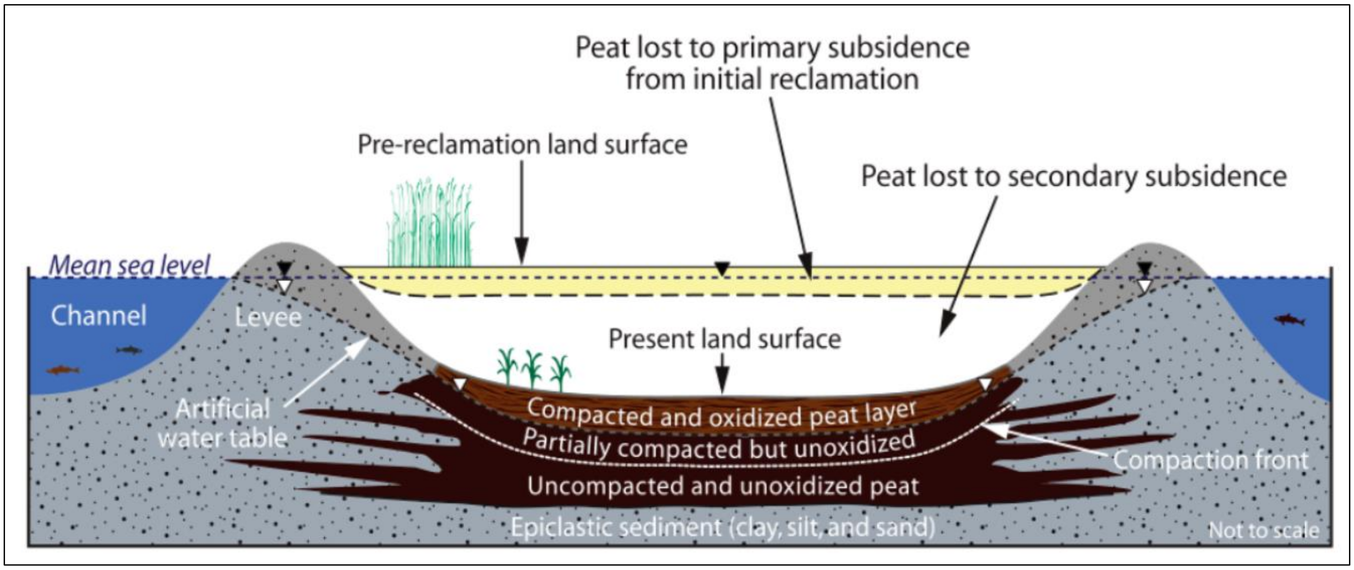
Table 18-1. Significant Locations and Causes of Subsidence in California

Causes	Measured Subsidence	Comments
Sacramento Valley (DWR 2014); (DWR 2019a)		
Although the Sacramento Valley has a large supply of surface water, drought periods have led communities to rely more heavily on groundwater	0.73 to 3.9 feet since 1949 2.14 feet from 2008 through 2017 in the Arbuckle area	Caused damage to irrigation wells and increased the extent of flooding in certain areas
Antelope Valley (Siade, et al. 2014)		
Groundwater pumping; groundwater level declines of more than 270 feet in some parts of the groundwater basin	More than 6 feet in some areas	Growth and limits on imported water may increase future reliance on groundwater.
Oxnard Plain (Borchers and Carpenter 2014)		
Groundwater withdrawal and oil and gas production are probably major causes; tectonic activity is likely a minor cause	—	First measured in 1939. Subsidence occurred primarily in the upper-aquifer system prior to 1959; some subsidence occurred in the lower-aquifer system during 1959-1993, owing to an increase in groundwater extraction
Greater Los Angeles Metropolitan Area (Borchers and Carpenter 2014)		
Tectonic deformation, oil field operations, and groundwater extraction and injection occur in overlapping proximity; separate cases of subsidence have been attributed to groundwater pumping, oil extraction, and tectonic movement	—	Given the expansive infrastructure and population density in this region, the effects of land subsidence are potentially catastrophic; however, the rate of subsidence is presently not high enough to cause major concern
Mojave and Morongo Groundwater Basins (California Water Science Center 2018a)		
		Land subsidence has been ongoing in the dry lakebeds here since the 1960s
Yucaipa and Coachella Valleys (USGS 2018d)		
Primarily due to excessive groundwater pumping, as neither region has adequate surface water to support its domestic and non-domestic uses	As much as 50 feet between the early 1920s and the late 1940s before the importation of Colorado River water in 1949	
San Joaquin Valley (USGS 2018f)		
Over-pumping caused groundwater level declines and associated aquifer system compaction and land subsidence that resulted in permanent aquifer-system storage loss	By 1970, significant land subsidence (more than 1 foot) had occurred in about half of the San Joaquin Valley, or about 5,200 square miles, and locally some areas had subsided by as much as 28 feet	As the largest and most productive agricultural region in California, the San Joaquin Valley does not have sufficient surface water to support farming or domestic uses. Beginning around the 1920s, farmers relied upon groundwater for water supply.

18.2.1. Organic Soil Decomposition in the Sacramento-San Joaquin Delta

The Sacramento-San Joaquin Delta was once a great tidal freshwater marsh. It is blanketed by peat and peaty alluvium deposited where streams originating in the Sierra Nevada, Coast Ranges, and South Cascade Range enter San Francisco Bay. The dominant cause of land subsidence in the Delta is decomposition of organic carbon in the peat soils (see Figure 18-4). Under natural waterlogged conditions, the soil was anaerobic (oxygen-poor), and organic carbon accumulated faster than it could decompose. Drainage of peat soils for agriculture led to aerobic (oxygen-rich) conditions. Under aerobic conditions, microbial activity rapidly oxidizes the carbon in the peat soil. Most of the carbon loss from the soil occurs as a flux of carbon-dioxide gas to the atmosphere.

Figure 18-4. Land Subsidence Due to Decomposition of Organic Soils



Source: (USGS 2014)

18.2.2. Aquifer Compaction Due to Groundwater Pumping

Fine-grained sediments (clays and silts) in an aquifer system are the main causes of land subsidence due to groundwater pumping. Such sediments tend to be deposited in random orientations with a lot of room between them to store water. However, when groundwater levels fall, the sediments are rearranged into stacks that occupy less space and have less space between them to store water (USGS 2018).

Such compaction affects manmade infrastructure as well as natural systems. The greatest effects occur to infrastructure that crosses a subsiding area, such as water conveyance structures in the San Joaquin Valley. Many water conveyance structures, including long stretches of the California Aqueduct, are gravity driven with only very small gradients; even minor changes in these gradients can cause reductions in designed flow capacity.

Canal managers—such as DWR, the San Luis Delta-Mendota Authority, the Bureau of Reclamation, and the Central California Irrigation District—have to repeatedly retrofit the canals to keep the water flowing. Damage to roads, railways, bridges, pipelines, buildings, and wells also can occur.

18.3. PREVIOUS HAZARD OCCURRENCES

18.3.1. Disaster and Emergency Declarations

The following disaster declarations or emergency proclamations related to subsidence have been issued for California (see Appendix F for details):

- Federal DR or EM declaration, 1953 – 2022: none
- California Emergency Proclamations, 1950 – 2022: one event, classified as "sinkhole"
- USDA agricultural disaster declarations, 2012 – 2022: None

18.3.2. Event History

In California, large areas of land subsidence were first documented by USGS scientists in the first half of the 20th century. In 1976 the USGS identified peat loss as a leading cause of subsidence in the San Joaquin Delta. In 1988 the USGS identified oil extraction as a leading cause of subsidence in and around the Long Beach area of Los Angeles. However, most of this subsidence was a result of excessive groundwater pumping. The following are key findings regarding past land subsidence in California (additional historical information is provided in Table 18-1):

- More than 2,000 square miles in the Tulare Lake Hydrologic Region experienced subsidence of 0.25 foot (3 inches) to 3 feet, with a maximum rate of 1.5 feet per year.

- Nearly 900 square miles in the San Joaquin River Hydrologic Region experienced subsidence ranging from 0.25 foot (3 inches) to 2.25 feet, with a maximum rate of almost 1 foot per year.
- More than 20 square miles of the Sacramento River Hydrologic Region experienced subsidence ranging from 3 inches to 9 inches.

Operational- and drought-related reductions in surface water deliveries and an increase in crop acreage in areas with only groundwater supplies have resulted in increased groundwater pumping and associated groundwater level declines and land subsidence. For more information on drought impacts in the State, see Chapter 13. The completion of State and federal water projects helped some groundwater aquifers recover and decreased subsidence in some areas. However, subsidence continues today across the State (USGS 2022); (Thomas and Phoenix 1976).

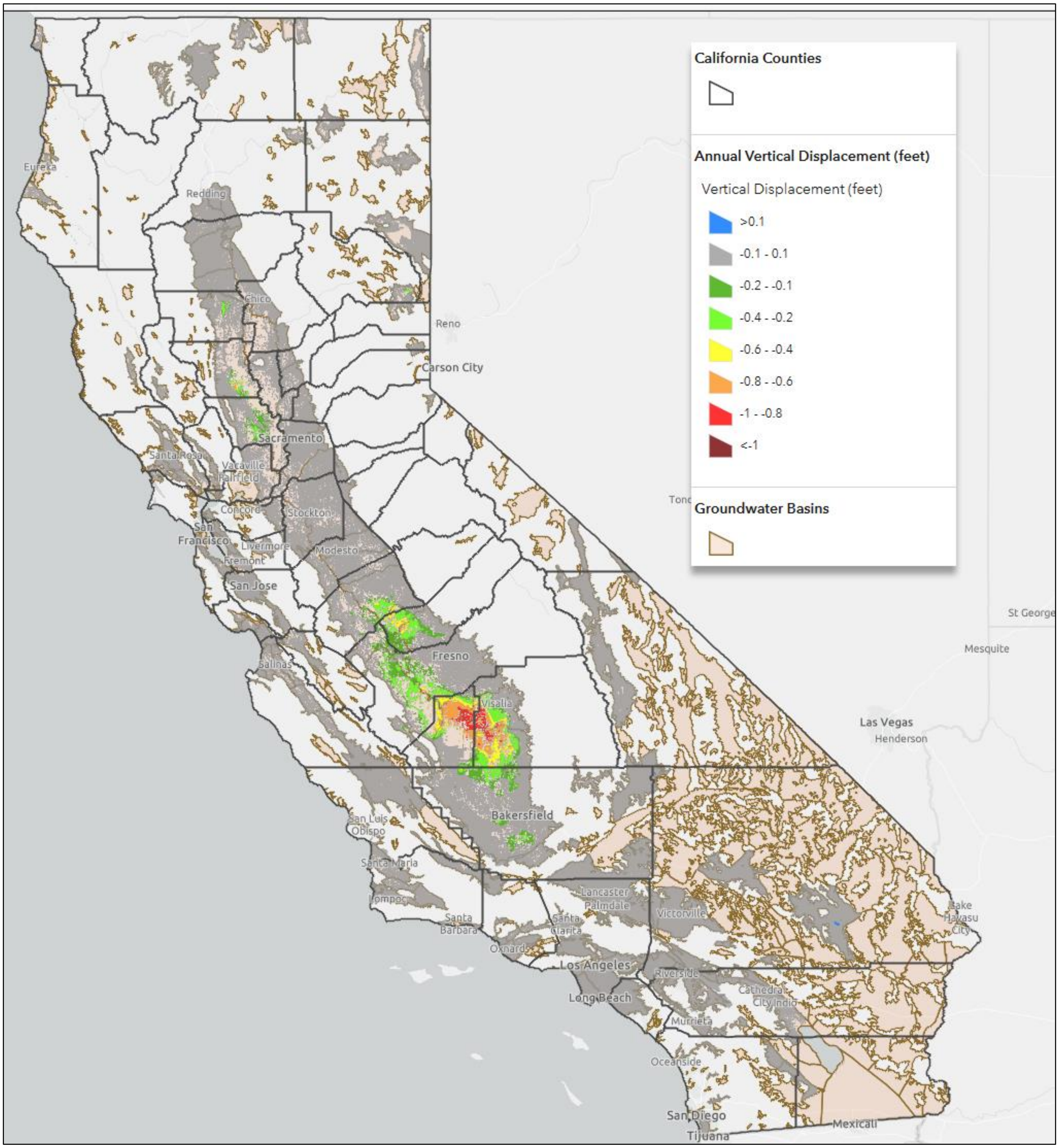
Portions of the Central Valley have been experiencing land subsidence at differing rates since the 1920s. Some areas are estimated to have subsided as much as 28 feet. From 2015 through 2018, which included the last two years of the most recent severe statewide drought (2012-2016), significant amounts of land subsidence occurred, primarily in the San Joaquin Valley. The statewide land subsidence from June 2015 through June 2018 is presented in Figure 18-5.

18.4. PROBABILITY OF FUTURE HAZARD EVENTS

18.4.1. Overall Probability

California's land subsidence is tied to prolonged droughts and simultaneous record-breaking heat. When the State endures prolonged periods of drought, surface water stores are depleted, and the reliance on groundwater for water supply is increased. Given the frequency and duration of these types of events, it is reasonable to assume an increase in probability of subsidence events as well. Subsidence is a continuing hazard in California; therefore, the probability of occurrence is high. As more areas are developed, the strain on the aquifers can increase. This can lead to a higher probability of subsidence occurring in those areas.

Figure 18-5. Statewide Land Subsidence From October 2020 Through September 2021



Source: (DWR 2022d)

18.4.2. Climate Change Impacts

Changes in precipitation, reduced snowpack, and more frequent droughts are likely to increase the demand on groundwater sources, risking overdraft, ground subsidence, and decreased water quality.

A recent study found that a large part of the California coast is sinking due to ground subsidence, linked to extreme heat and prolonged droughts. Combined with rising sea levels, the fate of California's coastal regions is at risk. In addition to rising sea levels, California is experiencing vertical land motion—that is, the rising (uplift) and sinking (subsidence) of land. California's land subsidence is intrinsically tied to prolonged droughts and simultaneous record-breaking heat. To compensate for the lack of rainwater during the droughts, the region has been depleting local aquifers at alarming rates to sustain its $50 billion agricultural industries. So much water has been pumped out that the Central Valley region is sinking at rates of up to 25 centimeters per year. This combination of land subsidence and rising sea levels increases the relative sea-level rise, heightening the risk of coastal flooding, saltwater intrusion, infrastructure damage, and loss of wetland and biodiversity.

18.5. IMPACT ANALYSIS

18.5.1. Severity

The U.S. Geological Survey recognizes that in spite of projects moving water from wet parts of California to drier areas, the State still is not immune to "nearly historically high [subsidence] rates of more than 1 foot/year" (USGS 2022). As noted in Table 18-1, subsidence of up to 50 feet over a period of decades has been recorded in the Yucaipa and Coachella Valleys.

Subsidence has caused impacts on critical water infrastructure, including reduced conveyance capacity in local, State, and federal conveyance facilities, reduced levee heights, and damaged well casings (Borchers and Carpenter 2014). Throughout California, subsidence has damaged buildings, aqueducts, well casings, bridges, and highways.

Subsidence and the California Aqueduct

Subsidence along the California Aqueduct, the cornerstone of the State Water Project, has caused the canal to slump, putting reliable water delivery at risk. The damage has resulted in higher operational and power costs and increased water delivery outages and major repairs. The State Water Project has lost more than 20 percent of its capacity due to subsidence. The impacts of this subsidence are felt far beyond the Central Valley. The reduced capacity for conveyance can hinder climate change adaptation efforts that deliver and store water when conditions are wet.

(California Municipal Utilities Association 2021a)

18.5.2. Warning Time

Subsidence can occur slowly and continuously over time, or it can happen abruptly without warning.

18.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with subsidence:

- As the land sinks, it can experience increased flooding and adverse impacts on sewer lines and stormwater drainage (Water Education Foundation 2022a).
- As subsidence progresses, areas protected by levees are impacted. The levees in the Sacramento-San Joaquin Delta must be regularly maintained and periodically raised and strengthened to support the increasing stresses on them that result when the Delta islands subside.
- Compaction of the aquifer system may permanently decrease its capacity to store water.
- Subsidence can lead to damage to critical infrastructure and facilities.

18.5.4. Environmental Impacts

Subsidence can cause permanent inundation of land, increase flooding, change the topography of land, and reduce the capacity of aqueducts to store water (Holzer and Galloway 2005).

18.5.5. Local Hazard Impacts

LHMP Rankings

Four of the hazard mitigation plans prepared for California's 58 counties—San Luis Obispo, Santa Cruz, Tuolumne, and Yolo—list subsidence as a hazard of concern. Yolo County ranks it as a high-impact hazard; the others rank it low impact. In addition, some plans address subsidence under the title of "mass movements," which also includes landslide and debris flows.

LHMP Estimates of Potential Loss

Table 18-2 summarizes potential losses to vulnerable structures based on estimates from the local risk assessments (as called for in FEMA's Standard State Mitigation Planning Requirement S6.b). Due to variances in approaches to assessing risk at the local level as well as the hazards assessed and the age of each assessment reviewed, this data is considered approximate.

Table 18-2. Subsidence Risk Exposure Analysis for LHMP Reviews

Estimated Total Population Exposed	8,867,827
Estimated Number of Structures at Risk	20,000+
Estimated Value of Structures at Risk	< $4 billion

18.6. VULNERABILITY ANALYSIS

Based on the mapping shown in Figure 18-5, 17 of the State's 58 counties are susceptible to subsidence risk:

- Contra Costa
- Fresno
- Kern
- Kings
- Los Angeles
- Madera
- Merced
- Orange
- Riverside
- Sacramento
- San Joaquin
- San Luis Obispo
- San Mateo
- Santa Barbara
- Santa Clara
- Tulare
- Ventura

The vulnerability assessment focuses on these counties.

18.6.1. Exposure of State-Owned or -Leased Facilities

Table 18-3 and Table 18-4 summarize the State-owned assets located in the subsidence-susceptible counties. Appendix I provides detailed results by county.

Table 18-3. State-Owned or -Leased Facilities Exposed to Subsidence

Type of Facility	Number of Structures	Total Area (sq. ft.)	Replacement Cost Value		
			Structure	Content	Total
State-Owned Facilities	9,571	142,280,818	$11,151,339,008	$10,799,474,260	$21,950,813,268
State-Leased Facilities	1,142	N/A*	$7,033,990,440	$7,163,442,648	$14,197,433,088
Total Facilities	**10,713**	**N/A***	**$18,185,329,448**	**$17,962,916,908**	**$36,148,246,356**

* The inventory of State assets does not include building area for State-leased facilities, so no total area for all State facilities is provided; the building area of vulnerable assets is shown for State-owned facilities only.

Table 18-4. State-Owned or -Leased Infrastructure Exposed to the Subsidence Hazard

Type of Facility	State-Owned Infrastructure in the Mapped Hazard Area
Bridges	7,254
Highway (miles)	11,988
Dams	13
Water Project (miles)	0

The following are significant results of the analysis of State-owned assets in the subsidence susceptible counties:

- For facilities that the State owns within the subsidence-susceptible counties, the average building area is 14,866 square feet, with an average replacement cost value of $2.3 million (structure and contents).
- The average replacement cost value for State-leased facilities within the subsidence-susceptible counties is $12.4 million (structure and contents).

Transportation routes, including bridges and highways, are vulnerable to subsidence and have the potential to be wiped out, creating isolation issues. Those that are most vulnerable are those that are already in poor condition.

18.6.2. Exposure of Critical Facilities and Community Lifelines

Table 18-5 summaries the number of critical facilities, by community lifeline, located in the subsidence-susceptible counties. Appendix I provides detailed results by county. Critical facilities and community lifelines are likely to experience functional downtime associated with impacts from subsidence. This loss of function could be permanent based on it not being feasible to rebuild a damaged facility at a location due to the change in ground elevation. This would require relocation of these facilities, which could have cascading impacts on a region.

Table 18-5. Critical Facilities and Community Lifelines Exposure to Subsidence

Lifeline Category	Total Number of Facilities	Number of Facilities in Hazard Area	% of Total Facilities
Communications	42	36	85.7%
Energy	176	117	66.5%
Food, Water, Shelter	257	151	58.8%
Hazardous Material	56	37	66.1%
Health & Medical	47	28	59.6%
Safety & Security	46	28	60.9%
Transportation	131	65	49.6%
Total	**755**	**462**	**61.2%**

18.6.3. Estimates of Loss

Although subsidence can cause significant damage to State assets, there are no standard generic formulas for estimating associated losses. Instead, loss estimates were developed representing 10 percent, 30 percent, and 50 percent of the replacement cost value of all State-owned facilities in the subsidence-susceptible counties (see Table 18-6). This allows the State to select a range of potential economic impacts based on an estimate of the percentage of damage to these assets. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure.

Table 18-6. Estimates of Loss From Subsidence

Asset	10% Damage	30% Damage	50% Damage
State-Owned Assets	$2,195,081,327	6,585,243,981	$10,975,406,634
State-Leased Assets	$1,243,208	$3,729,623	$6,216,039
Total	**$2,196,324,535.00**	**$6,588,973,604.00**	**$10,981,622,673.00**

18.6.4. Buildable Land

An estimated 11.7 million acres of land is available for development in California. Any development of subsidence-susceptible areas will be susceptible to damage and impacts from such events.

18.6.5. Equity Priority Communities

The risk analysis for subsidence found that 32.9 percent of people in the subsidence-susceptible counties live in equity priority communities (8,867,827 people). A breakdown of exposed equity priority communities by county is included in Appendix I. Additionally, subsidence may impact the availability of safe drinking water in low-income communities and communities of color.

18.6.6. NRI Scores

The National Risk Index does not provide rankings for the subsidence hazard.

18.7. MITIGATING THE HAZARD

18.7.1. Existing Measures to Mitigate the Hazard

There have been significant improvements in the State's subsidence monitoring network, most notably in the processing and reporting of satellite-based Interferometric Synthetic Aperture Radar, or InSAR, data, which now provides monthly subsidence data for more than 160 groundwater basins.

18.7.2. Opportunities for Mitigating the Hazard

A range of potential opportunities for mitigating the subsidence hazard is provided in Table 18-7. See Section 1.2.3 for a description of the different types of alternatives.

Table 18-7. Potential Opportunities to Mitigate the Subsidence Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: Reduce reliance on groundwater ▪ Practice groundwater recharge techniques **Reduce exposure and vulnerability** ▪ Relocate vulnerable property ▪ Harden vulnerable assets **Build local capacity** ▪ Learn and understand the Risk ▪ Practice water conservation ▪ Carry out regular inspections of your property, paying particular attention to pipework, gutters, and drainage systems in case of leaks or blocks. ▪ Maintain trees close to your home as they can contribute to causes for subsidence	**Manipulate the hazard:** ▪ Reduce reliance on groundwater ▪ Practice groundwater recharge techniques ▪ Deploy onsite detention of stormwater runoff **Reduce exposure and vulnerability** ▪ Relocate vulnerable property ▪ Harden vulnerable assets **Build local capacity** ▪ Learn and understand the risk ▪ Enhance monitoring capability ▪ Understand your soil type ▪ Practice water conservation	**Manipulate the hazard:** ▪ Reduce reliance on groundwater ▪ Groundwater injection ▪ Increase surface water storage capacity **Reduce exposure and vulnerability** ▪ Acquire vulnerable property ▪ Harden vulnerable assets **Build local capacity** ▪ Communicate the risk ▪ Enhance Monitoring Capability ▪ Identify vulnerable soil types in areas of high groundwater extraction ▪ Promote water conservation
Nature-based opportunities ▪ Take steps to facilitate the recharge of groundwater, which can mitigate impacts from subsidence ▪ Use green infrastructure measures in regions known to be susceptible to subsidence		

18.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address subsidence:

- Action 2018-001: Support Legislative Efforts that Formalize California's Comprehensive Mitigation Program.
- Action 2018-006: Enhance Collaboration on the Development and Sharing of Data Systems and GIS Modeling.
- Action 2018-008: Develop a database containing a description of the specific natural hazard event for which each project was designed to mitigate.

VOLCANO

Climate Impacts:
Volcanic events may impact climate change, climate change is not known to increase the probability of volcanic events

Equity Impacts:
11.5% of exposed population (those living in volcanic hazard areas) identified as living in equity priority communities

State Facilities Exposed:
1,079 State facilities in the volcanic hazard area; $499.7 million in total replacement cost value for facilities in the volcanic hazard area

Community Lifelines Exposed:
37 community lifelines in the volcanic hazard area

Impact Rating: Low (10)

19. VOLCANO

Volcano has been identified as a low-impact natural hazard of interest based on the hazard impact rating protocol applied for this SHMP. These events happen infrequently and predominantly in the northern part of the State where the Cascade Mountain range terminates. Less than 5 percent of State-owned or -leased facilities and community lifelines are exposed to this hazard. Less than 1 percent of the population resides in counties considered to be susceptible to volcanoes; and 11.5 percent of that population has been identified as living in equity priority communities. Less than 1 percent of buildable land in the State is in counties considered to be susceptible to this hazard. The frequency and severity of volcano events is not anticipated to be impacted by climate change.

19.1. HAZARD OVERVIEW

Many of California's volcanoes pose a threat to people and property. A new effort to identify, prepare for, and mitigate volcanic hazards within California is underway. Cal OES, the USGS California Volcano Observatory, and CGS are working to produce the first statewide assessment of California's exposure and vulnerability to future volcanic hazards (Ewert, Kiefenbach and Ramsey 2018).

19.1.1. Types of Volcanoes

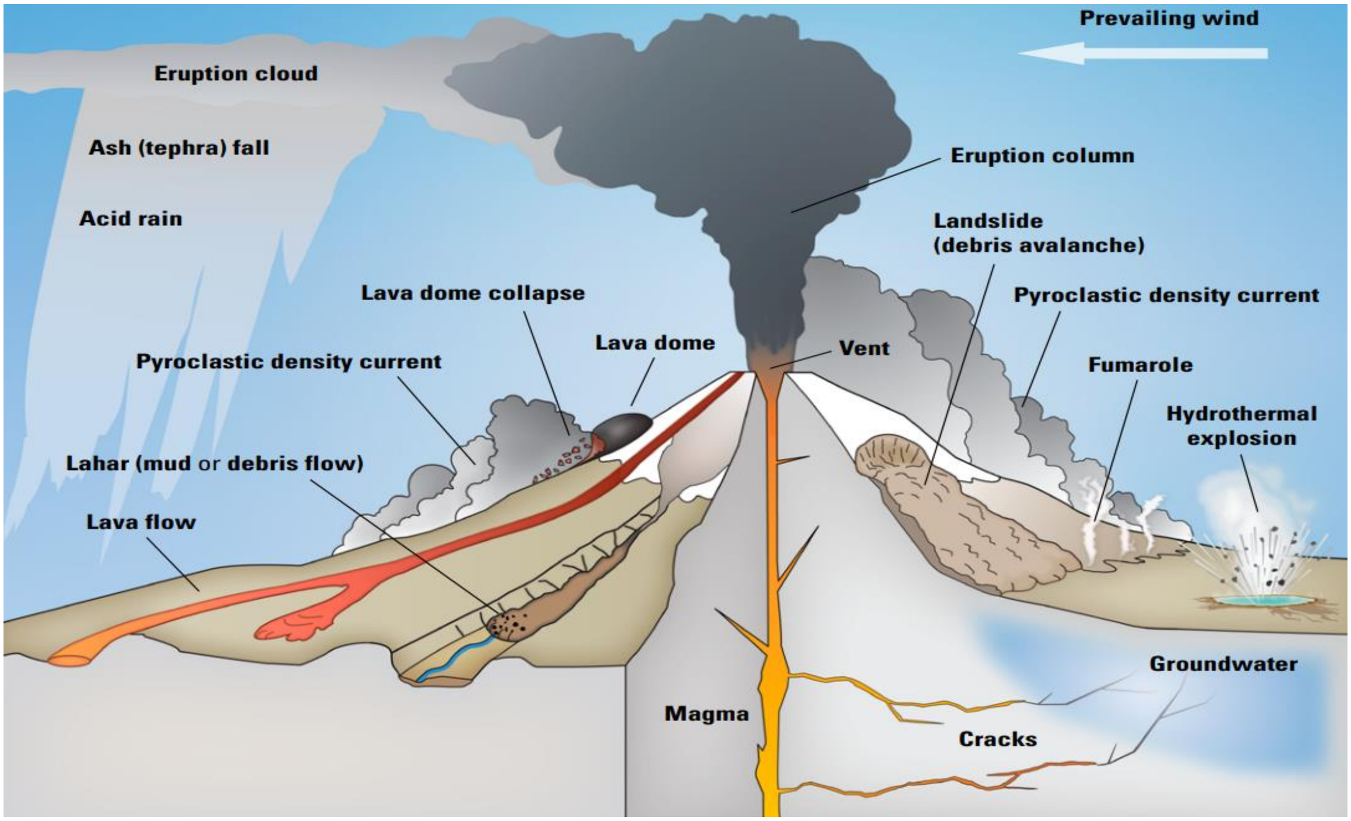
Caldera Systems

Caldera systems are large volcanic centers usually characterized by a massive central crater, like at Long Valley. Calderas are formed when a volcano erupts, and its walls collapse inward. A volcanic caldera can be more than 60 miles in diameter (National Geographic 2023).

Stratovolcanoes

Stratovolcanoes (Figure 19-1) are tall, cone-shaped, volcanoes that tend to erupt explosively. Magma (underground molten rock) rises from deep below the volcano, and explosive eruptions blast volcanic debris into the sky, forming an eruption column and cloud.

Figure 19-1. Stratovolcano Hazard Components



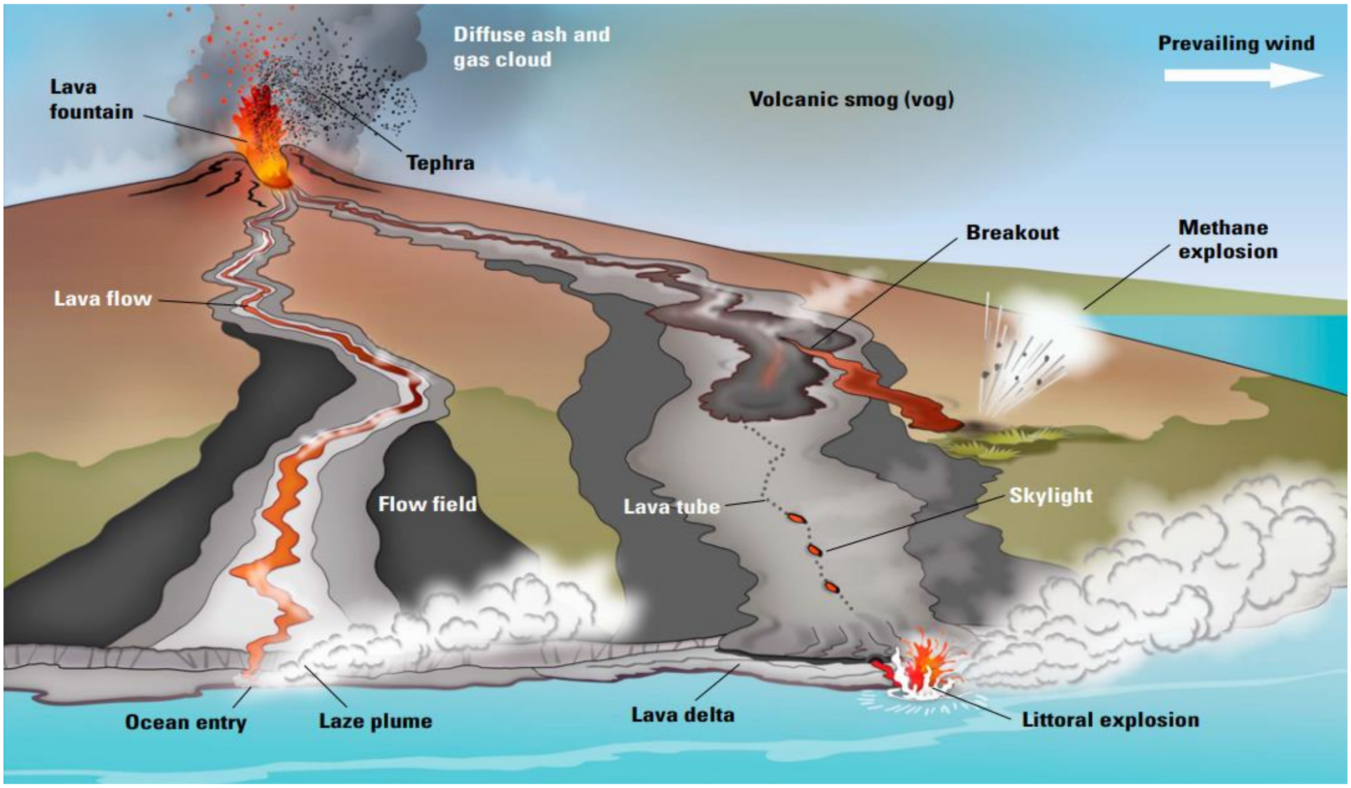
Source: (USGS 2019c)

Ash in the eruption cloud, carried by the prevailing winds, may remain suspended for thousands of miles before settling to the ground (USGS 2019c). Lava flows move downslope or form lava domes at the erupting vent. Eruption columns, lava flows, or lava domes collapse, creating hot currents that can melt snow and ice or enter rivers.

Shield Volcanoes

Shield volcanoes (Figure 19-2) have a broad, shield shape and tend to erupt lava that can travel many miles; violent explosive eruptions are also possible. Most eruptions begin as a vertical sheet of rising magma that discharges from groups of vents that can extend for miles. Low lava fountains jet skyward, and fragments cool as they fall.

Figure 19-2. Shield Volcano and Lava Field Components



Source: (EarthHow 2023)

Lava can pour from a vent for months or years to form a lava flow field that can feed breakouts of new lava flows. Lava entering a body of water creates new, unstable land called a lava delta that can explosively collapse into the water. Lava entering cold water typically causes explosions of hot water and acidic clouds of gas, steam, and volcanic glass (USGS 2019c).

During and after an eruption, loose volcanic debris on the flanks of the volcano can be mobilized by heavy rainfall or melting snow and ice, forming floods of mud and rock resembling rivers of wet concrete. These can rush down valleys and stream channels, destroying roads and bridges and carrying away entire buildings. Flooding can also occur due to melting of ice and snow or by diversion of streams blocked by debris.

"California is the most geologically diverse state in the nation. We are known for our earthquakes, landslides, and flood hazards. But a nearly forgotten hazard is our volcanoes."

John Parrish, State Geologist of California, February 9, 2012 (SSC 2022)

19.1.2. Common Impacts of Volcanoes

Table 19-1 describes the common characteristics and impacts of volcanoes in California.

Table 19-1. Characteristics and Potential Impacts of California Volcano Hazards

Characteristics	Impact
Pyroclastic Flow	
Sudden eruption of hot gas-pressurized flows of ash and lava fragments that rush outward from the volcano with great force at ground speeds greater than 50 mph. Typically follow valleys but can overtop ridges and travel 30 miles or more from the volcano.	Pyroclastic flows travel much too fast for people to outrun and are thus a main cause of eruption-related fatalities. Flows knock down, shatter, bury, or carry away nearly all objects and structures. Extreme temperatures burn forests, crops, buildings, furnishings, and vehicles.
Lava Flow	
Gradual inundation by lava from sustained low-level eruptions moving at speeds of less than 30 mph. Lava may pile up near the vent in a lava dome or move across the landscape for many miles as rivers of molten rock.	Everything in the path of slow speed lava flows will be knocked down, buried, or burned. The flows generally travel slowly enough that people, possessions, and transportable infrastructure can be moved out of the way. The flows often ignite wildfires, and areas inundated by flows can be buried by 10 feet or more of hardened rock, making it impossible to rebuild or repair structures.
Debris Flows	
Slurry-like floods of volcanic ash, rock, and water that look like wet concrete. Large flows may carry boulders 30 feet across and travel through valleys and stream channels at speeds of 20 to 40 mph. Flows can be hot, with temperatures close to boiling.	Most debris flows travel much too fast for people to outrun and are thus a main cause of eruption-related fatalities. Debris flows can destroy buildings and bridges and bury vast areas with deposits of mud and rock up to 160 feet thick as far as 65 miles from the volcano.
Lahar Flows	
Eruptions may trigger lahars by melting snow and ice or by ejecting water from a crater lake. Pyroclastic flows can generate lahars when extremely hot, flowing rock debris erodes, mixes with, and melts snow and ice as it travels rapidly down steep slopes.	Large lahars can crush, abrade, bury, or carry away almost anything in their paths. Buildings and valuable land may be partially or completely buried. By destroying bridges and roads, lahars can also trap people in areas vulnerable to other hazardous volcanic activity, especially if the lahars leave fresh deposits that are too deep, too soft, or too hot to cross.
Ballistics	
Ballistic ejection of coarse, hot fragments of lava from the volcanic vent, usually softball size or smaller.	The impact of coarse air fall is limited to the immediate area of the volcanic vent. Structures may be damaged by accumulation of falling lava

Characteristics	Impact
	fragments or burnt by their high heat. Wildfires may be ignited.
Ash Fall	
Fine fragments of lava—sand size and smaller—deposited from drifting ash clouds. Impact zone may be hundreds of miles from the volcano.	Fine ash fall is the most widespread and disruptive volcanic hazard. People exposed to fine ash experience eye, nose, and throat symptoms. Ash covers surfaces and infiltrates openings in machinery, buildings, and electronics. It can reduce visibility to zero. When wet, it can make paved surfaces slippery. Fine ash is abrasive, damaging surfaces and mechanical parts. Ash may result in short-term physical and chemical changes in water quality. Close to the volcano, heavy ash fall may cause roofs to collapse, wastewater systems to clog, and power systems to shut down. Fine ash can damage crops and sicken livestock.
Floods	
Sudden melting of snow or ice by volcanic heat, or diversion of water by blocked drainages or breached embankments.	Impacts are similar those of non-volcanic floods, but the onset is usually sudden.
Volcanic Gas	
Large eruptions can release enormous amounts of gas in a short time.	Significant amounts of carbon dioxide, sulfur dioxide, hydrogen sulfide and hydrogen halides can also be emitted from volcanoes. Depending on their concentrations, these gases are all potentially hazardous to people, animals, agriculture, and property.

Source: (Cal OES 2018a)

19.2. HAZARD LOCATION

Table 19-2 lists potentially hazardous volcanoes in California as identified by the USGS.

Table 19-2. Potentially Hazardous Volcanoes in California

County	Volcano
Imperial	Salton Buttes
Inyo	Coso Volcanic Field Ubehebe Crater
Lake	Clear Lake Volcanic Field
Madera	Mammoth Mountain

County	Volcano
Mono	Long Valley Caldera Mono-Inyo Craters Mono Lake Volcanic Field Mammoth Mountain
Shasta	Lassen Volcanic Center
Siskiyou	Mount Shasta Medicine Lake
Tulare	One other young volcano in California, with lower threat ranking, is identified in the 2018 USGS report: Golden Trout Creek Volcanic Field.

Source: (Ewert, Kiefenbach and Ramsey 2018)

Figure 19-3 and Figure 19-4 show the volcanoes by threat ranking and eruption hazard. The threat rankings are derived from a combination of factors:

- Age of the volcano
- Potential hazards (the destructive natural phenomena produced by a volcano)
- Exposure (people and property at risk from the hazards)
- Current level of monitoring (real-time sensors in place to detect volcanic unrest)

Threat rankings are periodically re-evaluated and revised, if necessary, as ongoing research provides new information on potential hazards or exposure is altered by changes in population and regional aviation (Ewert, Kiefenbach and Ramsey 2018).

19.3. PREVIOUS HAZARD OCCURRENCES

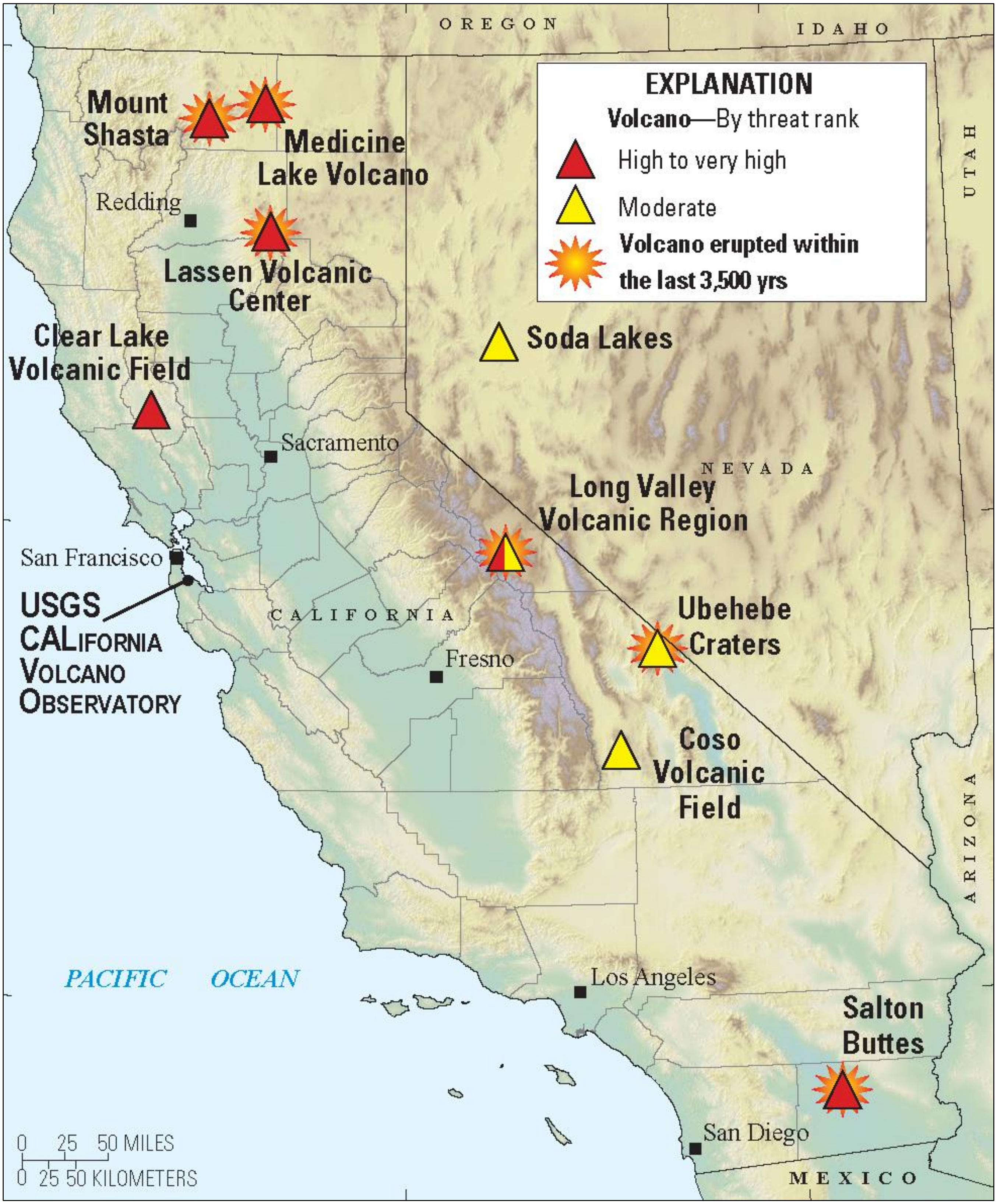
19.3.1. Disaster and Emergency Declarations

No FEMA, USDA, or State disaster declarations or proclamations related to volcano have been issued relevant to California or any of its counties.

19.3.2. Event History

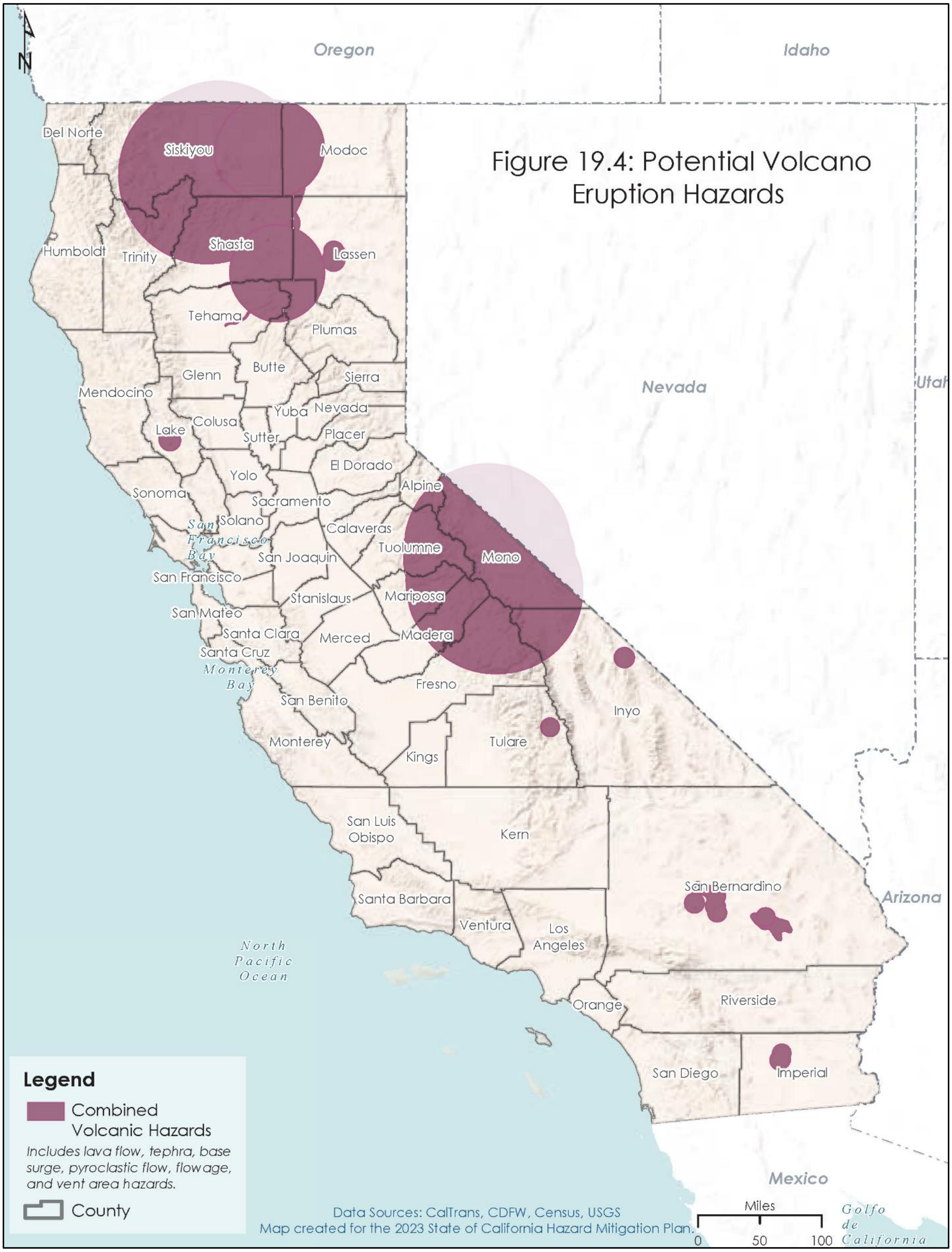
California is susceptible to volcanic-related events, though they are infrequent. At least 76 volcanic vents have erupted, some repeatedly, during the last 10,000 years (SSC 2022).

Figure 19-3. Potentially Hazardous Volcanoes in California



Source: (USGS 2022a)

Figure 19-4. Potential Volcano Eruption Hazards



Only one volcanic eruption is on record—the eruption of Mount Lassen from 1914 through 1917. The first steam explosion occurred in May 1914 and more than 180 subsequent steam explosions enlarged the crater over the next 11 months. By May 2015, a lava dome filled the crater and exploded. The hot lava blocks caused a giant mudflow of volcanic materials. Residents suffered minor injuries, and many fish in the waterways were killed by the muddy water. A powerful explosion on May 22, 1915, resulted in a pyroclastic flow that devastated 3 square miles. A layer of pumice and volcanic ash spread for 25 miles to the northeast. Vigorous steam explosions occurred in May 1917 (USGS n.d.-c).

19.4. PROBABILITY OF FUTURE HAZARD EVENTS

19.4.1. Overall Probability

At least seven California volcanoes—Medicine Lake Volcano, Mount Shasta, Lassen Volcanic Center, Clear Lake Volcanic Field, Long Valley Volcanic Region, Coso Volcanic Field, and Salton Buttes—have partially molten rock (magma) deep within their roots, and research on past eruptions indicates they will erupt again in the future (Mangan, et al. 2019).

Based on the record of volcanic activity over the last five millennia, the probability of another small- to moderate sized eruption in California in the next 30 years is estimated to be about 16 percent (USGS 2019). This is similar to the forecast for a magnitude 6.7 or greater earthquake specific to the San Andreas Fault in the San Francisco Bay region, which is estimated to be about a 22 percent probability in 30 years, starting from 2014.

Volcanic eruptions occur in the State about as frequently as the largest San Andreas Fault Zone earthquakes; at least 10 eruptions have occurred in California in the last 1,000 years and only one has occurred since 1917 (Mangan, et al. 2019). The probability in any given year of renewed volcanism in the State is on the order of one in a few hundred to one in a few thousand.

19.4.2. Climate Change Impacts

Climate change is not expected to increase the probability of volcanic events. However, when volcanic eruption does occur, climate change could impact the consequences of volcanic events. As the atmosphere warms due to climate change, the plumes of ash and gas emitted by large volcanic eruptions will rise higher. Climate change will also accelerate the transport of volcanic material—in the form of small, shiny droplets called volcanic sulfate aerosols—from the tropics to higher latitudes. For large eruptions, the combined effect of these phenomena will cause the haze created by volcanic aerosols to block more sunlight from reaching Earth's surface, ultimately amplifying the temporary cooling caused by volcanic eruptions (University of Cambridge 2021).

19.5. IMPACT ANALYSIS

19.5.1. Severity

Low-energy eruptions are destructive, but generally not life threatening. High-energy explosive eruptions are both destructive and life threatening. Volcanic areas can be hazardous even when the volcano is not erupting, with unstable ground, noxious gas emissions, intense heat, and steaming ground (USGS 2019c).

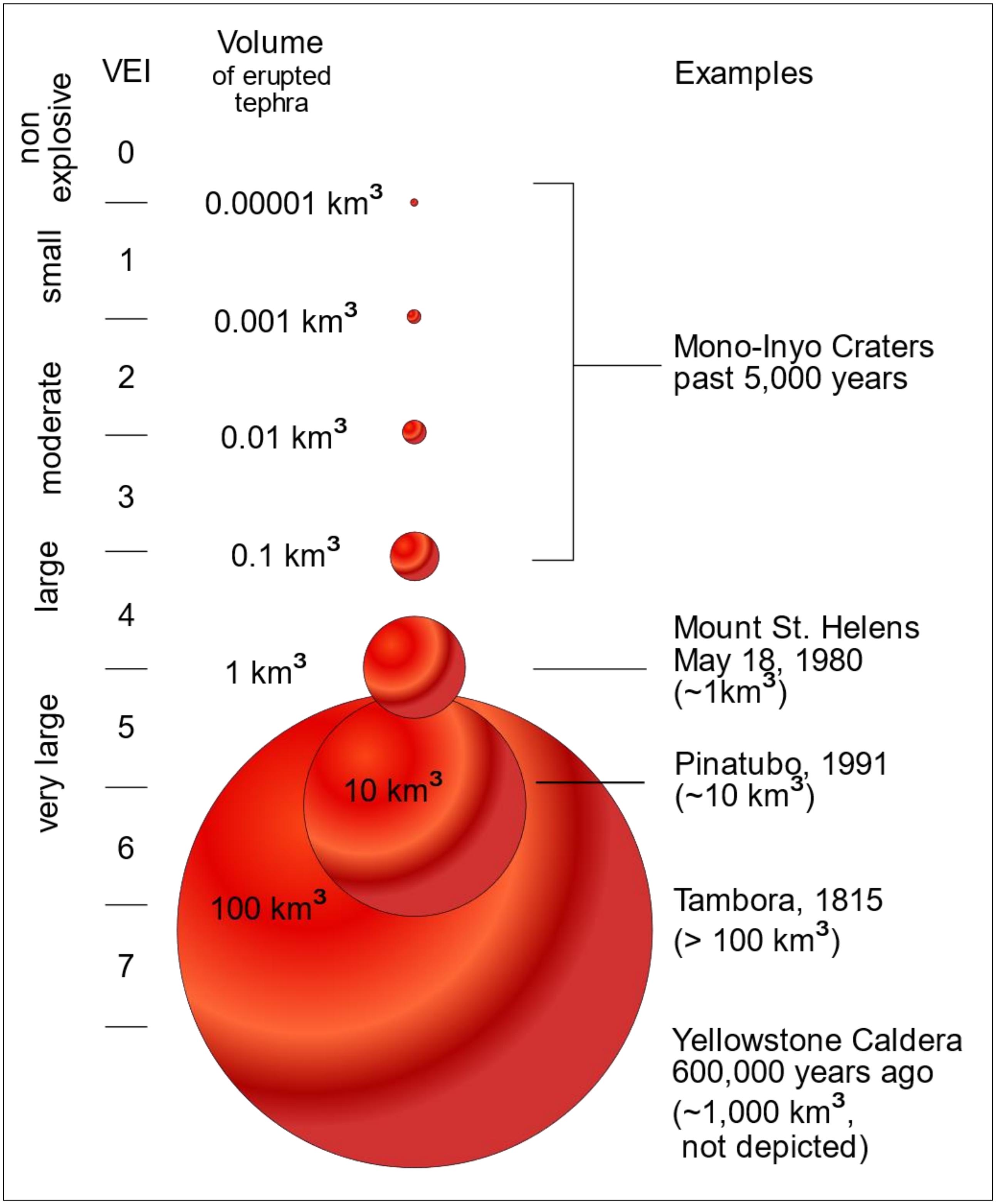
Timely warnings reduce the risk of fatalities, but depending on hazard type, destruction and disruptions to the community can extend many miles from the volcano. In addition, some post eruption hazards—rain remobilized debris flows, re-suspended ash, and seeping volcanic gas—may disrupt human activities or cause annoyances for years, even decades after an eruption has stopped (USGS 2019c).

The volcanic explosivity index is a measure of the explosiveness of volcanic eruptions, based on volume of product, eruption cloud height, and qualitative observations (using terms ranging from "gentle" to "mega-colossal"). A value of zero is given for non-explosive eruptions, defined as less than 350,000 cubic feet of tephra ejected; and a value of 8 represents a mega-colossal eruption that can eject 240 cubic miles of tephra and have a cloud column height of over 66,000 feet. The scale is logarithmic, with each interval representing a tenfold increase in observed criteria. Figure 19-5 shows the volcanic explosivity index and product volume correlation.

19.5.2. Warning Time

Eruption hazards are most severe within a few miles of the vent, with life-threatening or highly destructive phenomena evolving rapidly, often within seconds to minutes, leaving little time to mount evasive actions. The time available to issue warnings increases as distance from the vent increases.

Figure 19-5. Volcanic Explosivity Index and Product Volume Correlation



Source: (USGS 2022e)

Seismic activity beneath the volcanic area is an important warning sign of an impending volcanic eruption. Seismologists can interpret differences between earthquakes related to the rise of magma and those caused by tectonic faulting. Other warning signs of magma rising into the shallow subsurface might include increased release of volcanic gases from openings and changes in the gas composition. Deformation of the ground surface in the vicinity of a volcano may also indicate that magma is approaching the surface. Typically, these warning signs appear a few weeks to months before an eruption, but they can last for decades or even centuries without leading to an eruption (USGS 2005).

19.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with volcanoes:

- Mudflows, floods, landslides, and possibly seismic activity can occur in the region of the eruption.
- Tephra can damage vegetation by direct burial, heat, or breakage.
- Tephra modifies hydrology and lowers air quality, affecting human health both directly—through inhalation or the abrasion of skin and eyes—and indirectly—through impacts on terrestrial and aquatic environments.
- Post-eruptive processes extend the area of influence of a volcanic eruption some distance from the initial deposition area and can last for years.
- Volcanic eruptions can substantially disrupt hydrologic systems, most notably by altering stream flow and choking waterways with ash and volcanic debris.
- Volcanic events can severely impact ground transportation on roads and railways, disrupting daily activities, commerce, and response capabilities.
- Exposure of crops, pastures, and livestock to volcanic ash fall can be serious, even for a light dusting. Ash falls on forage most commonly results in digestive tract problems in livestock, including gastrointestinal tract obstruction, and it is common for dairy production to drop significantly owing to cows off feed.
- Volcanic eruptions can result in heightened health concerns, including infectious disease, respiratory illness, burns, injuries from falls, and motor vehicle crashes related to poor visibility.

19.5.4. Environmental Impacts

The environment is highly exposed to the effects of a volcanic eruption, including deterioration of water quality, fewer periods of rain, crop damages, and the destruction of vegetation (Zuskin, et al. 2007).

19.5.5. Local Hazard Impacts

LHMP Rankings

Eighteen of the hazard mitigation plans prepared for California's 58 counties list volcano as a hazard of concern, and five counties rank it as a high-impact hazard:

- Colusa
- Lake
- Yolo
- Imperial
- Modoc

An additional five counties identified volcano as a medium-impact hazard.

LHMP Estimates of Potential Loss

A review of the LHMPs in the counties (as called for in FEMA's Standard State Mitigation Planning Requirement S6.b) found no quantitative risk analysis that identifies population or structures exposed to this hazard. This can be attributed to the lack of extent and location hazard mapping to use for such an analysis. Therefore, no summary of risk for local plan reviews is provided for this hazard.

19.6. VULNERABILITY ANALYSIS

19.6.1. Exposure of State-Owned or -Leased Facilities

Table 19-3 and Table 19-4 summarize State-owned or -leased assets within the volcanic hazard zone shown in Figure 19-4. Figure 19-6 summarizes the exposed assets as a percentage of total assets statewide. Appendix I provides detailed results by county.

Table 19-3. State-Owned or -Leased Facilities Exposed to the Volcanic Hazard

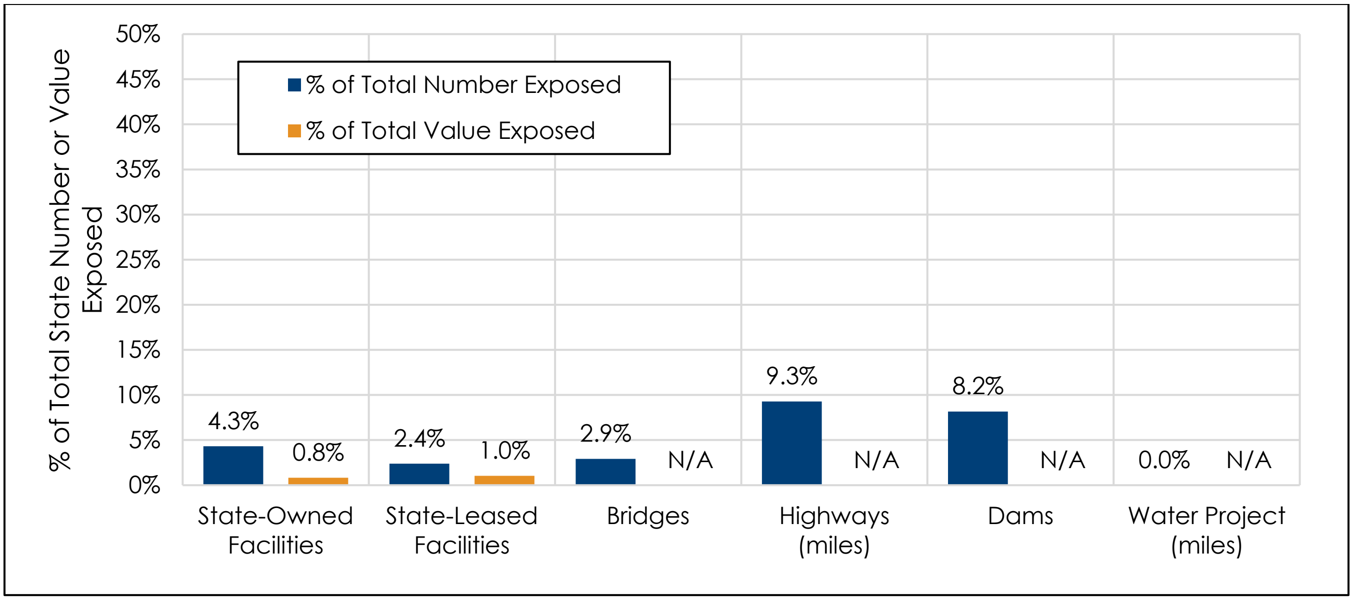
Type of Facility	Number of Structures	Total Area (sq. ft.)	Replacement Cost Value		
			Structure	Content	Total
State-Leased Facilities	45	—	$85,656,022	$109,681,124	$195,337,146
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	0	0	$0	$0	$0
Development Center	0	0	$0	$0	$0
Hospital	0	0	$0	$0	$0
Migrant Center	2	77,750	$9,914,238	$4,957,119	$14,871,357
Special School	0	0	$0	$0	$0
All Other Facilities	1,032	1,951,261	$148,144,003	$141,361,842	$289,505,844
Total State-Owned	***1,034***	***2,029,011***	***$158,058,241***	***$146,318,961***	***$304,377,202***
Total Facilities	***1,079***	**N/A***	***$243,714,263***	***$256,000,085***	***$499,714,348***

* The inventory of State assets does not include building area for State-leased facilities, so no total area for all State facilities is provided; the building area of vulnerable assets is shown for State-owned facilities only.

Table 19-4. State-Owned or -Leased Infrastructure Exposed to the Volcanic Hazard

Type of Facility	State-Owned Infrastructure in the Mapped Hazard Area
Bridges	384
Highway (miles)	2,794.9
Dams	4
Water Project (miles)	0

Figure 19-6. State Assets Exposed to Volcanic Hazards as % of Statewide Total



The following are noteworthy statistics on State-owned or -leased facilities in the volcanic hazard areas:

- For facilities that the State owns within the volcanic hazard area, the average building area is 1,962 square feet, with an average replacement cost value of $294,369.
- The five State agencies with the most State-owned facilities within the volcanic hazard area are State Parks (274), Caltrans (227), CDFW (207), CAL FIRE (198), and the District Agriculture Associations (108).
- The State agency with the highest total replacement cost for State-owned or -leased facilities within the volcanic hazard area is Caltrans at $88.3 million.

19.6.2. Exposure of Critical Facilities and Community Lifelines

Table 19-5 summarizes the total number of critical facilities, by community lifeline, located in the volcano hazard areas statewide. The county with the largest percentage of these facilities is Mono (29.7 percent) followed by Shasta and Siskiyou (18.9 percent each). Appendix I provides detailed results by county.

Table 19-5. Critical Facilities and Community Lifelines Exposure to Volcano Hazard Areas

Lifeline Category	Total Number of Facilities	Number of Facilities in Hazard Area	% of Total Facilities
Communications	42	0	0.0%
Energy	176	21	11.9%
Food, Water, Shelter	257	14	5.4%
Hazardous Material	56	0	0.0%
Health & Medical	47	0	0.0%
Safety & Security	46	0	0.0%
Transportation	131	2	1.5%
Total	**755**	**37**	**4.9%**

Critical facilities and community lifelines that are exposed to volcano are likely to experience functional downtime following these events, which could increase the net impact of these events in a region.

19.6.3. Estimates of Loss

As shown in Table 19-3, the analysis conducted for volcanic events identified 1,034 State-owned buildings and 45 State-leased buildings in the volcanic hazard area with a replacement cost value of $499.7 million. In addition to impacting State assets, volcanic events can have major economic impacts on a community from the loss of and damage to structures and subsequent economic losses.

19.6.4. Buildable Land

Throughout the State, there are over 11.7 million acres of land available for development. Of that, 9.5 percent (1.1 million acres) is within the volcanic hazard area. Any type of development in these areas will be susceptible to damages associated with volcanic hazards.

19.6.5. Equity Priority Communities

The communities and populations especially vulnerable to volcanic eruptions include low-income communities, migrant populations, populations whose primarily language is not English, Indigenous populations, communities of older adults, and those with respiratory and other health concerns. These populations may be more susceptible to transport and communication challenges.

Vulnerable populations may also be impacted by the effects of toxic volcanic ash and problems of the respiratory system, eyes, and skin. Psychological effects, injuries, waste disposal and water supplies issues, collapse of buildings and power outage are all likely to impact vulnerable populations (Zuskin, et al. 2007).

The risk analysis for volcano found that 11.5 percent of people exposed to the volcano hazard live in equity priority communities (24,595 people). A breakdown of exposed equity priority communities by county is included in Appendix I.

19.6.6. NRI Scores

According to the NRI, 16 of the State's counties have volcano risk, rated from very low to relatively high. Table 19-6 shows scores for the six counties with the highest rating. See Section 4.1.3 for a description of the components of the NRI.

Table 19-6. NRI Scoring of Counties for Volcano

County	Expected Annual Loss	Social Vulnerability Rating	Community Resilience Rating	Community Risk Factor	Risk Value	Score
Shasta	$3,913,963	Relatively High	Relatively Moderate	1.26	$5,031,894	87.64
Siskiyou	$1,146,556	Relatively High	Relatively Moderate	1.39	$1,534,741	78.65
Butte	$857,541	Very High	Relatively High	1.25	$1,075,947	71.91
Tehama	$360,874	Very High	Relatively Low	1.52	$537,733	67.42
Trinity	$181,623	Very High	Relatively Low	1.45	$270,985	64.04
Lassen	$192,884	Relatively High	Relatively Moderate	1.14	$221,510	60.67

19.7. MITIGATING THE HAZARD

19.7.1. Existing Measures to Mitigate the Hazard

The USGS California Volcano Observatory obtains and interprets data from real-time monitoring sensors installed on California's very high, high, and moderate threat volcanoes, although network coverage is minimal at some locations (USGS n.d.). Information is relayed to emergency response agencies and the public. The Volcano Notification Service is a free service that sends notification emails about volcanic activity to subscribers (USGS n.d.-b). Volcano monitoring networks and warning systems can save lives and reduce property losses.

19.7.2. Opportunities for Mitigating the Hazard

Volcanic events cannot be prevented, but there are mitigation measures the State can implement to reduce their severity. A range of potential opportunities to mitigate the volcano hazard is provided in Table 19-7. See Section 1.2.3 for a description of the different types of alternatives.

19.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address the volcano hazard:

- Action 2018-001: Support Legislative Efforts that Formalize California's Comprehensive Mitigation Program.
- Action 2018-006: Enhance Collaboration on the Development and Sharing of Data Systems and GIS Modeling.
- Action 2018-039: Volcano Hazard Vulnerability Assessment.

Table 19-7. Potential Opportunities to Mitigate the Volcano Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ None **Reduce exposure and vulnerability:** ▪ Locate outside of hazard area **Build local capacity:** ▪ Develop and practice a household evacuation plan	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Locate outside of hazard area ▪ Protect corporate critical facilities from potential impacts of severe ash fall (air filtration capability) **Build local capacity:** ▪ Develop and practice a corporate evacuation plan ▪ Inform employees through corporate sponsored outreach	**Manipulate the hazard:** ▪ Limited success has been experienced with lava flow diversion structures **Reduce exposure and vulnerability:** ▪ Locate outside of hazard area ▪ Protect critical facilities and utilities from potential problems associated with ash fall ▪ Build redundancy for critical facilities and functions **Build local capacity:** ▪ Public outreach, awareness ▪ Tap into State volcano warning system to provide early warning to residents of potential ash fall problems
Nature-based opportunities ▪ Volcanic ash could be used to supply nutrients and reduce carbon dioxide from the atmosphere		

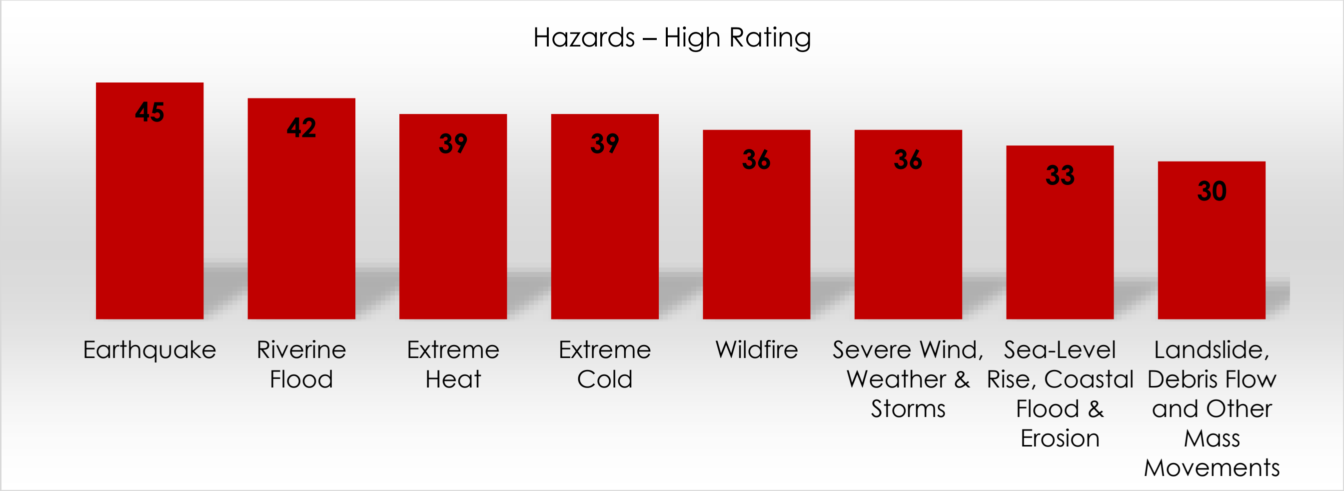
20. Risk Assessment Summary for Natural Hazards

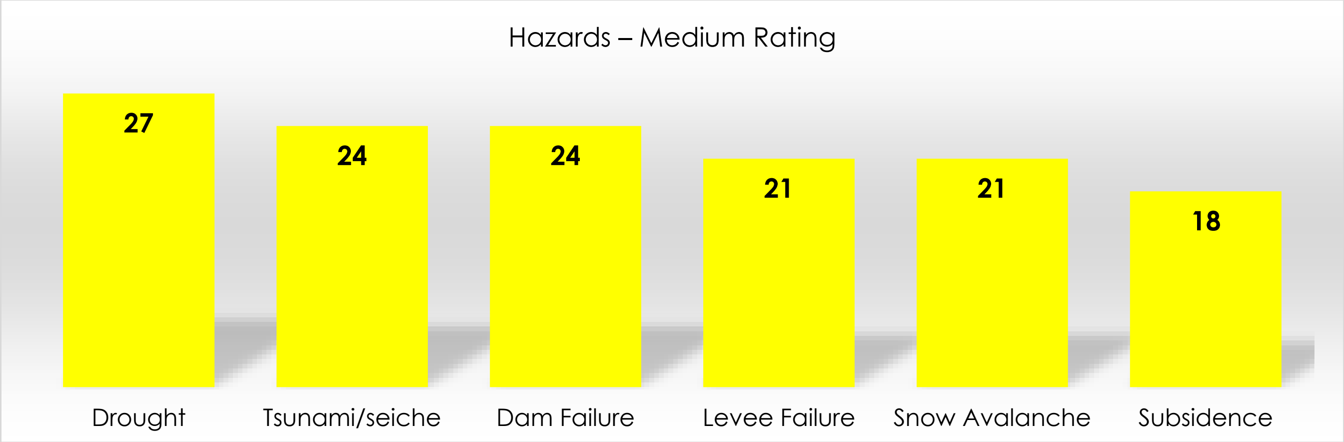
This SHMP assessed 15 natural hazards of interest, which are the hazards that are typically assessed in local hazard mitigation planning efforts in California and that are eligible for mitigation grant funding under FEMA's Hazard Mitigation Assistance (HMA) programs. Identifying these hazards as a distinct category in the SHMP establishes those hazards as a baseline for local risk assessments and planning efforts. However, none of these hazards are binding on local planning efforts. Local communities should determine the hazards of concern to be addressed for their plans through a planning process. The role of the SHMP is to provide guidance and alternatives to support these planning processes.

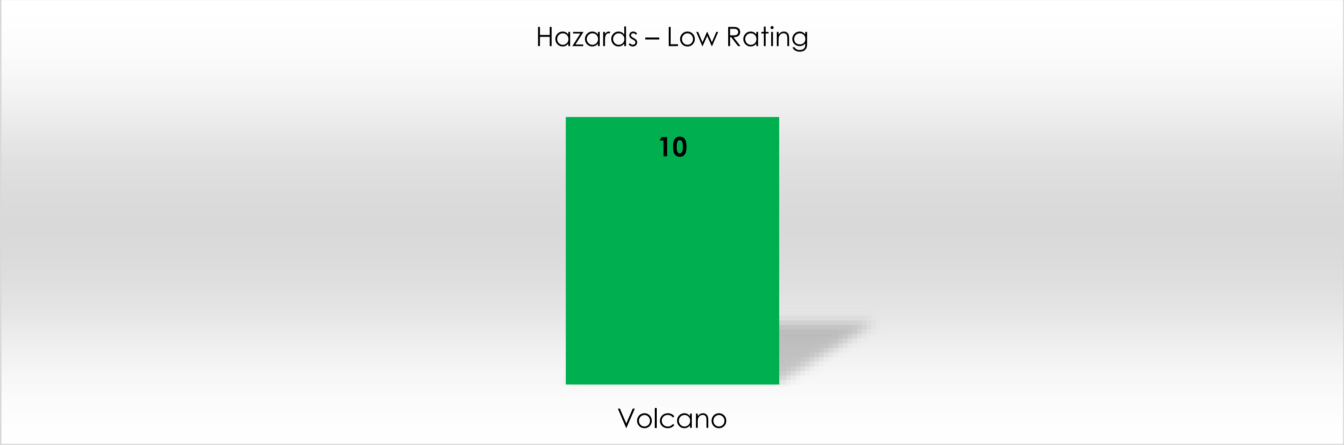
Of the 15 natural hazards of interest assessed in this SHMP, eight were identified as high-impact hazards, six were identified as medium-impact, and one was identified as low-impact, as shown in Figure 20-1. The parameters for these ratings are discussed in detail in Appendix I.

These rankings are based on impacts on State-owned or -leased facilities or identified critical facilities and lifelines that are essential to the State's ability respond to and recover from hazard events. The rankings should not be interpreted as applicable locally. Local planning efforts should assess and rank risk individually, based on the impacts of these hazards on the defined planning areas for local planning efforts. The metrics to measure those impacts should be determined locally by the local hazard mitigation planning process.

Figure 20-1. Natural Hazards of Interest Hazard Impact Ratings







Part 3—Profiles for Other Hazards of Interest

21. PROFILING OTHER HAZARDS OF INTEREST

This part of the 2023 State Hazard Mitigation Plan (SHMP) profiles hazards common to California which have been identified as other hazards of interest, listed in the order they are profiled:

- Urban structural fire
- Other potential causes of long-term electrical outage
- Public safety power shutoff (PSPS)
- Terrorism
- Air pollution
- Energy shortage
- Cyber threats
- Tree mortality
- Invasive and nuisance species
- Epidemic, pandemic, and vector-borne disease
- Civil disorder
- Natural gas pipeline hazards
- Hazardous materials release
- Transportation accidents resulting in explosions or toxic releases
- Well stimulation and hydraulic fracturing
- Oil spills
- Electromagnetic pulse attack (EMP)
- Radiological accidents

- Geomagnetic storm (space weather)

These are the hazards that impact California but are not hazards that the Federal Emergency Management Agency (FEMA) will review in its process of approving the 2023 State Hazard Mitigation Plan (SHMP or Plan). The SHMP Working Group process identified these hazards as relevant due to program directives such as Emergency Management Accreditation Program (EMAP) accreditation, State legislative mandates, and public perception and interest. Most are human-caused hazards, although some—such as geomagnetic storms, invasive species, and tree mortality—are naturally occurring. These natural hazards are included among the "other hazards of interest" because they are not among the hazards eligible for FEMA Hazard Mitigation Assistance (HMA) mitigation grant funding.

The chapters on these hazards are arranged in the order of impact (highest to lowest) assigned through the hazard impact rating protocol used for this planning effort (see Appendix I). The Risk Assessments for these hazards are more qualitative than the Risk Assessments for the natural hazards presented in Part 2, because less numerical data is available to perform quantitative assessments for these hazards. The inclusion of these hazards in this SHMP is not binding on future local planning efforts in the State. Hazards assessed at the local level should be chosen at the local level through a local planning process.

URBAN STRUCTURAL FIRE

Climate Impacts:
Potential to alter urban structural fires in size and severity by creating drier conditions and increasing severe wind events that may spread an event from one structure to multiple structures

Equity Impacts:
30.4% of exposed population (all persons in the State are exposed) identified as living in equity priority communities

State Facilities Exposed:
All facilities exposed

Community Lifelines Exposed:
All community lifelines exposed

Impact Rating: High (51)

22. Urban Structural Fire

Urban structural fire has been identified as high-impact based on the hazard impact rating protocol applied for this Plan. These events happen frequently and can impact any structure in the State. All State-owned or -leased facilities and community lifelines are exposed to this hazard. The entire population is exposed to this hazard because a structural fire could happen at any place or time. The equity priority community's exposure to this hazard is higher since there is a high likelihood that these populations occupy sub-standard housing due to social, economic, and situational reasons. All buildable land in the State could be impacted by this hazard, strengthening the importance of strong codes for new development. The frequency and severity of urban structural fires could increase over the next 30 years due to factors that could trigger these events due to climate change impacts.

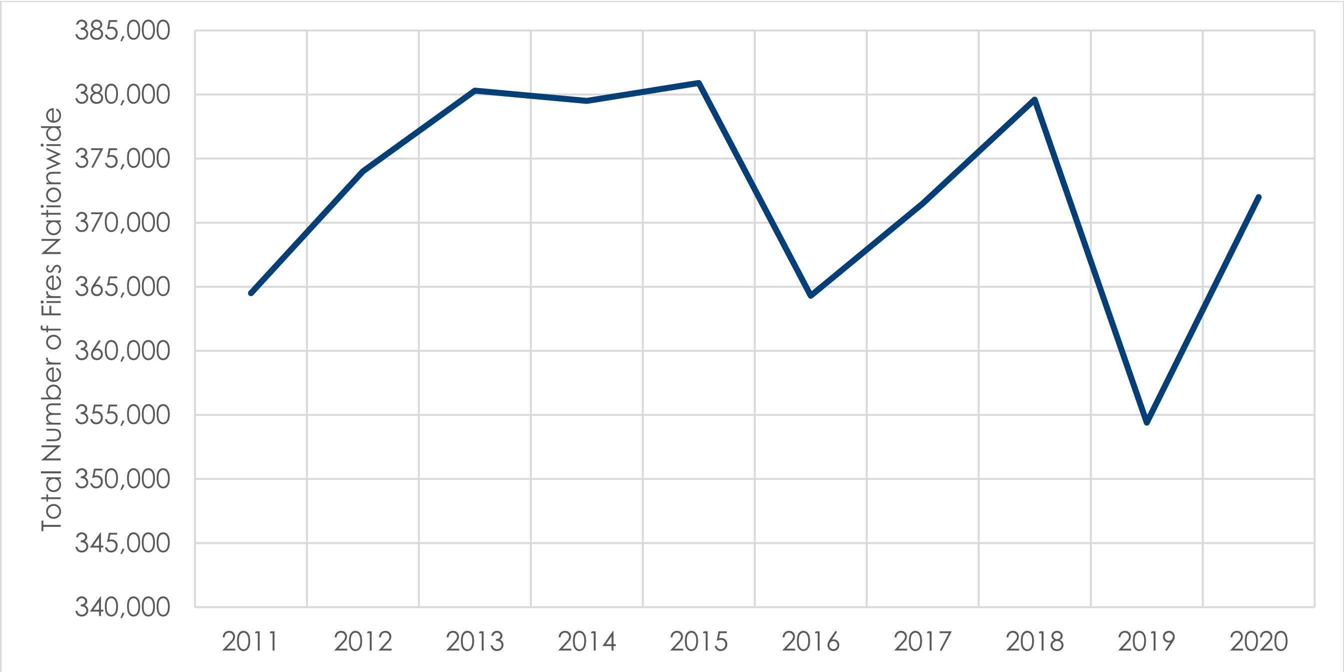
22.1. HAZARD OVERVIEW

Urban structural fires are defined as fires in an urban area originating in and burning any part or all of any building, shelter, or other structure, which may include residential, commercial, or industrial buildings. "Urban" in this definition refers to all higher-density developed areas, including both cities and suburbs. Major urban structural fires such as the following represent a broader community hazard and are the focus of the Risk Assessment presented in this chapter:

- **Urban conflagration**—A large disastrous and destructive fire that spreads beyond natural or artificial barriers (National Fire Sprinkler Association 2020). Urban conflagrations may be started by wildfires or civil unrest.
- **Industrial fire**—A conflagration in an industrial setting.
- **Construction fire**—A fire at a construction or renovation site, often caused by cooking equipment, electrical distribution, or lighting equipment (National Fire Protection Association 2020).

- **Fire following earthquake**—Widespread fires caused when an earthquake's shaking results in the release of flammable gases, liquids, or other combustible materials that come into contact with open flames or electrical arcing from damaged infrastructure (FM Global 2015).
- **Explosion-caused fire**—A large fire at industrial or construction sites where combustible materials and ignition sources cause an explosion, leading to fire (ARCCA 2022).
- Urban fires can be started by a wide range of natural and human causes: lightning strikes, wildfires, earthquakes, buildings not being built to code, buildings under construction, gas leaks, chemical explosions, arson, civil unrest, or ignition sources in a home such as a pot on the stove or unattended candles. The top five cause of residential fires are candles, cooking, electrical, heating, and smoking (National Fire Protection Association 2022). As shown in Figure 22-1, the United States has seen a slight downward trend in the number of residential fires in recent years.

Figure 22-1. Residential U.S. Fires 2011 – 2020



Source: (USFA 2021)

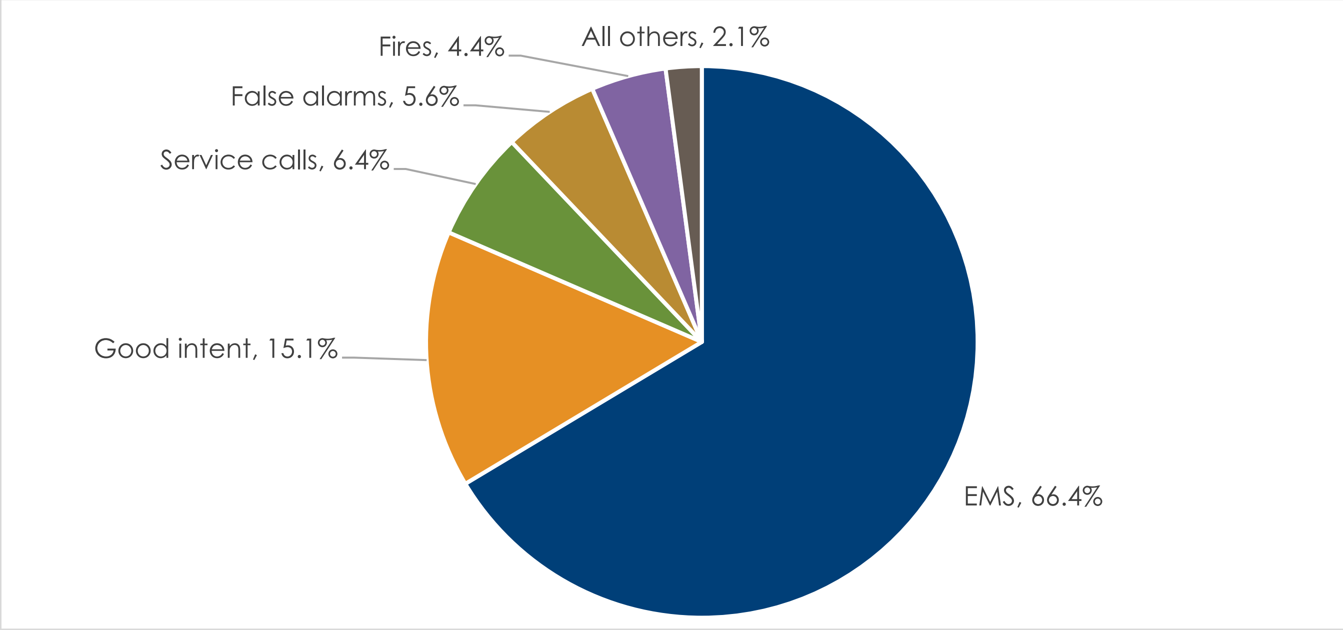
22.2. HAZARD LOCATION

Urban structural fires can occur in any town or city in the State; therefore, the entire State is vulnerable to this hazard. Fire hazard may be greater in large urban cities (population of more than 250,000), not because fires in such cities are more likely to happen but because the demographics of large cities often include more vulnerable populations, including the growing numbers of older adults, people with disabilities, immigrants, and people experiencing poverty (National Fire Protection Association 2022).

22.3. PREVIOUS HAZARD OCCURRENCES

California has nearly 850 registered fire agencies that respond to fire calls—ranging from volunteer fire companies with a single engine to large-city departments with multiple stations, apparatuses, and personnel. Each agency maintains its own records, and the State Health and Safety Code (Section 13110.5) requires reporting on all fire incidents to the State Fire Marshal. The reported data is kept at the California Incident Data and Statistics Program. Statewide, fires represent only a small portion of the calls that fire agencies respond to, as shown in Figure 22-2.

Figure 22-2. California Fire Response Incidents – 2020



Source: (USFA 2023)

The majority of fire agency calls are for emergency medical services rather than fires. This section focuses on major fire events that either resulted in a FEMA declaration or were highly publicized in the news media due to their severity or impact on the community.

22.3.1. Disaster and Emergency Declarations

The following disaster declarations or emergency proclamations related to urban structural fire have been issued for California (see Appendix F for details):

- Federal Major Disaster (DR) or Emergency (EM) declaration, 1953 – 2022: seven events, classified as urban fire, fire due to civil unrest, or wildfire
- California Emergency Proclamations, 1950 – 2022: four events, classified as explosion/accident fire
- U.S. Department of Agriculture (USDA) agricultural disaster declarations, 2012 – 2022: None

22.3.2. Event History

Urban structural fires have occurred in every county in the State. Large urban structural fire events that impacted California between 2018 and 2022 are identified in Table 22-1. For events prior to 2018, refer to Appendix K.

Table 22-1. Noteworthy Urban Structural Fire Events in the State of California (2018 to 2022)

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties Impacted
November 2018	Wildfire/Urban Conflagration	FM-5278	N/A	Butte County
The Camp Fire started in the early morning near the community of Pulga in Butte County. The tinder dry vegetation, strong winds, low humidity, and warm temperatures promoted this fire and caused extreme rates of spread, rapidly burning into Pulga to the east and west into Concow, Paradise, Magalia and the outskirts of east Chico. It burned a total of 153,336 acres, destroying 18,804 structures and resulting in 85 civilian fatalities and several firefighter injuries.				
February 2021	Industrial Fire	N/A	N/A	City of Compton
A massive fire in an industrial area of Compton spread through several businesses and engulfed multiple structures and at least a dozen buses. The fire began in a pallet yard. Several transformers exploded and power lines were downed. A column of smoke could be seen from several miles away, including in downtown Los Angeles.				

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties Impacted
February 2022	Industrial Fire	N/A	N/A	City of Orange
A large-scale fire ripped through an industrial complex in Orange, California, creating a thick plume of black smoke that could be seen for miles.				
April 2022	Construction Fire	N/A	N/A	City of Camarillo
A 165-room hotel and convention center under construction was engulfed in flames and portions of the structure collapsed. Powerlines between the hotel and Highway 101 were threatened by the flames; Highway 101 was closed temporarily in both directions as the powerlines were depowered. No deaths or injuries were sustained, but the property owner estimated damage at $60 million.				
July 2022	Industrial Fire	N/A	N/A	City of Martell
The Ampine lumber mill in Amador County was destroyed by fire, leaving more than 100 people unemployed. The cause of the fire is not known. The fire spread to some nearby vegetation, but fire crews on scene quickly contained those flames.				
September 2022	Storage Facility Fire	N/A	N/A	Monterey County
Tesla Megapack caught fire at a storage facility in Monterey County. The fire did not cause any power outages and there were no fatalities or injuries.				

Sources: (MySafe:LA 2022) (ABC 7 2021) (KCRA 3 2022) (Fire Engineering 2022) (CNN 2018)

22.4. PROBABILITY OF FUTURE HAZARD EVENTS

22.4.1. Overall Probability

Major urban fire events in the State occur many times every year and can be expected to continue at that frequency.

22.4.2. Climate Change Impacts

Climate change has the potential to alter urban structural fires in size and severity by creating drier conditions and increasing severe wind events that may spread an event from one structure to multiple structures.

22.5. IMPACT ANALYSIS

22.5.1. Severity

Impacts of urban structural fires may include economic losses, environmental impact, and loss of life. The impact of even one life lost can be devastating. The loss of a large manufacturing facility or business that employs a large number of people can have extensive impacts on the economy. The effects on the environment from an industrial or commercial fire can take years to measure (DellaSala 2015).

22.5.2. Warning Time

Prolonged drought and severe winds can greatly increase the likelihood of a fire event (Goss, et al. 2020). Severe weather can be predicted, so special attention can be paid during natural hazard events that may contribute to urban fires. There is no way to predict a human-caused urban fire in advance. If an urban fire starts and spreads rapidly, residents, employees, and others may need to evacuate within minutes.

Information received at a dispatch center determines the type of response a fire agency will provide. Response could be a single resource, usually an engine, or an alarm level. Apparatuses that typically respond to urban fires include fire engines, fire trucks (ladder, aerial, tiller, platform), rescue units, or battalion chiefs. Additional resources may include support units (breathing, supply, relief), hazardous materials responders, a mobile command unit, a mobile communication unit, or an ambulance.

22.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with urban fire:

- Air pollution associated with fire smoke is a cascading hazard associated with urban structural fires (Alarie 2008).
- Fires present the potential for causing hazardous materials releases.
- Explosions from natural gas lines or propane tanks are a concern.
- Those who are uninsured or under insured could face displacement from their homes.

Fire Agency Alarm Levels

The number of alarm levels varies among jurisdictions. Increasing an alarm to the next level may be contingent on factors such as location, severity, environment, weather, risk of spreading, or need for specific resources. Below is an example an alarm structure used in urban setting (Stambling 2021):

- **One Alarm Fire**—A one-alarm fire call is the basic response. Depending on the fire department in the location, a one-alarm fire usually calls for a minimum of two fire engines, a rescue unit, a ladder truck, and at least one battalion chief to supervise. Upon arriving at the fire, if the first unit thinks it is necessary, they will call in a second alarm (two alarm fire), which will double the fire department's response—including personnel and equipment.
- **Two Alarm Fire**—A two-alarm fire call summons more trucks, with more firefighters. Specifically, it calls for a hazardous materials vehicle and a support vehicle called a "supply shop." These units provide additional equipment such as oxygen tanks. After a two-alarm fire call goes out, there can be up to 13 emergency vehicles at the scene of the fire.
- **Three Alarm Fire**—A three-alarm fire call will bring triple the number of firefighters, trucks, and equipment to the scene of the fire. Any fire alarm dispatch that goes past two is considered a significant fire that could take considerable time to completely extinguish. Along with the additional firefighters and units that go out for a three-alarm fire, the department may also send out a media relations crew to deal with journalists, and a truck stocked with snacks and electrolyte drinks to keep firefighters sustained.
- **Four Alarm Fire**—A four-alarm fire is a catastrophic fire event that happens only a couple of times a year for most fire departments. If a dispatch call goes out for a four-alarm fire, up to 21 emergency vehicles may respond, including six battalion chiefs.
- **Five Alarm Fire**—Five-alarm fire dispatch calls are rare. If necessary, the commanders on the scene will call a five-alarm fire, which will typically summon 20+ fire engine companies, 11 ladder companies, at least one squad company, and one rescue company, as well as multiple specialized units such as supply shops, air support, hazardous materials vehicles, and snack trucks. The amount of response vehicles varies depending on the city and its fire departments. If a local fire department needs backup, neighboring resources may be drawn in to provide support through mutual aid agreements. A mutual aid agreement between fire departments allows them to help each other across jurisdictional boundaries.

22.5.4. Environmental Impacts

Most fires occurring in the built environment contribute to air contamination from the fire plume (which is likely to cause land and water contamination), contamination from water runoff containing toxic products, and other environmental discharges or releases from burned materials (Fire Protection Research Foundation 2022).

22.5.5. Local Hazard Impacts

Urban structural fires are not typically profiled in hazard mitigation plans. None of the 58 county plans identified urban structural fire as a hazard of concern.

22.6. VULNERABILITY ANALYSIS

22.6.1. Exposure of State-Owned or -Leased Facilities, Critical Facilities, and Community Lifelines

All State-owned or -leased assets, as listed in Table 4-1 and Table 4-2, are exposed to urban structural fires. This includes 23,961 State-owned facilities, and 1,893 State-leased facilities. All 755 State critical facilities and community lifelines, as listed in Table 4-3, are exposed to this hazard as well.

22.6.2. Estimates of Loss

Urban fires damage and destroy buildings, infrastructure, and vehicles, and can impact utilities. Assuming that most State facilities are equipped with fire-suppression systems, structural damage to the facilities can be minimized. However, the fire-suppression systems themselves can cause extensive water damage to facility contents. There are no standard generic formulas for estimating associated losses. Instead, loss estimates were developed representing 10 percent, 30 percent, and 50 percent of the replacement cost value of the contents all State-owned facilities (see Table 22-2). This allows the State to select a range of potential economic impacts based on an estimate of the percentage of damage.

Table 22-2. Loss Potential of State-Owned Asset Contents for Urban Structure Fire

Type of Facility	Total Replacement Cost Value (contents only)	Estimated Loss Potential Based on % Damage		
		10% Damage	30% Damage	50% Damage
Facilities Housing Vulnerable Populations				
Correctional Facility	$2,254,012,157	$225,401,216	$676,203,647	$1,127,006,079
Development Center	$390,885,847	$39,088,585	$117,265,754	$195,442,924
Hospital	$454,638,764	$45,463,876	$136,391,629	$227,319,382
Migrant Center	$341,691,270	$34,169,127	$102,507,381	$170,845,635
Special School	$63,904,858	$6,390,486	$19,171,457	$31,952,429
All Other Facilities	**$14,057,592,693**	**$1,405,759,269**	**$4,217,277,808**	**$7,028,796,347**
Total	**$17,562,725,589**	**$1,756,272,559**	**$5,268,817,677**	**$8,781,362,795**

22.6.3. Buildable Land

An estimated 11.7 million acres of land is available for development in California. Because the entire State is vulnerable to urban structural fire, any type of development of any of this land will be susceptible to damage and impacts from this hazard.

22.6.4. Equity Priority Communities

Many communities and populations are vulnerable to fires, including low-income communities, migrant populations, populations whose primarily language is not English, Indigenous populations, individuals experiencing homelessness, communities of older adults, and those with respiratory and other health concerns. Members of immigrant communities may be concerned about impacts to their immigration status and not seek help. Persons experiencing homelessness who take shelter in vacant buildings may light fires for cooking or heat, which can spread quickly, affecting the surrounding community (U.S. Fire Administration 1997).

When an urban structural fire impacts a community with high rents where multiple families live in one structure, it may be difficult for those not listed on the lease to prove that they were affected by the fire. This could result in lack of access to services or higher insurance rates. Fires in residential areas can increase the price of housing and rent, which further displaces people already affected by the fire. Individuals experiencing homelessness can increase (National Academies Press 2020).

Older adults may have limited mobility or mobility challenges, which can slow or prevent evacuation. More than one-third of the long-term care facilities in California are located in risky areas (Bénichou, Peterson and Pickoff-White 2020).

Because the entire population of the State of California is exposed and vulnerable to urban structural fires, the exposed population in equity priority communities is equal to the statewide percentage: 30.4 percent of the total population (12 million people).

22.7. MITIGATING THE HAZARD

22.7.1. Existing Measures to Mitigate the Hazard

Building code compliance and building inspections can reduce the impact and severity of an urban structural fire. Recent updates to the California Building Code and California Fire Code dictate the required number of alerting devices, sprinklers, and smoke detectors. Local jurisdictions are able to implement additional regulations.

22.7.2. Opportunities for Mitigating the Hazard

Some of the most destructive urban structural fire events have occurred as a result of a wildfire that reached a densely populated area. Similar mitigation measures for wildfires are also applicable for the urban structural fire hazard, including maintenance of defensible space and introducing legislation to mitigate fire hazards. A range of potential opportunities for mitigating the urban structural fire hazard is provided in Table 22-3. See Section 1.2.3 for a description of the different types of alternatives.

Table 22-3. Potential Opportunities to Mitigate the Urban Fire Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ Replace sub-standard wiring and electrical services ▪ Restrict or limit the use of candles ▪ Properly dispose of batteries at a household hazardous waste disposal facility, a universal waste handler, or an authorized recycling facility **Reduce exposure and vulnerability:** ▪ Install and replace smoke detectors (non-profit organizations, such as the Red Cross, provide smoke detector installation) ▪ Install residential fire sprinklers **Build local capacity:** ▪ Cisterns or pools with Fire Department connections in areas not serviced by fire hydrants ▪ Develop an escape plan ▪ Make sure fire insurance coverage is adequate	**Manipulate the hazard:** ▪ Replace sub-standard wiring and electrical services ▪ Maintain a hazardous waste collection program **Reduce exposure and vulnerability:** ▪ Install fire sprinklers ▪ Install fire detections and warning systems ▪ Test and maintain existing fire sprinkler systems ▪ Pre-plan for fire response ▪ Test and replace fire extinguishers ▪ Make sure fire insurance coverage is adequate ▪ Establish alternative water supplies for fire suppression in areas not serviced by fire hydrants	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ None **Build local capacity:** ▪ Provide fire hydrants in areas that have no hydrants ▪ Consider higher regulator standards for new constructions (i.e., residential sprinklers) ▪ Enforce Building Codes and Standards ▪ Enhanced training of fire suppression personnel ▪ Improve ISO PPG classification for fire suppression capability ▪ Establish mutual aid agreements for fire response
Nature-based opportunities ▪ There are no nature-based solutions for mitigating the impacts of urban fire		

22.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address urban structural fire:

- Action 2018-001: Support Legislative Efforts that Formalize California's Comprehensive Mitigation Program.
- Action 2018-003: Broaden Public and Private Sector Mitigation Linkages.
- Action 2018-007: Support and Coordinate Monitoring of Progress on State Goals and Objectives.

Other Potential Causes of Long-Term Electrical Outages

Climate Impacts:
Climate change increases energy demand, changing performance of all energy delivery systems

Equity Impacts:
30.4% of exposed population (all persons in the State are exposed) identified as living in equity priority communities

State Facilities Exposed:
All facilities exposed

Community Lifelines Exposed:
All lifelines exposed

Impact Rating: High (48)

23. Other Potential Causes of Long-Term Electrical Outage

Other potential causes of long-term (days to weeks) electrical outage have been identified as high-impact based on the hazard impact rating protocol applied for this Plan. This hazard occurs frequently in the State and all State-owned or -leased facilities and community lifelines are exposed to it. All the population is exposed to power outages, and over 30 percent of that population has been identified as living in equity priority communities. While all buildable lands within the State are exposed to this hazard, new development is likely to be significantly less vulnerable due to strong codes and standards in place the State. The frequency and severity of these events is anticipated to increase over the next 30 years due to the impacts from climate change.

23.1. HAZARD OVERVIEW

Power outages are the result of many of the hazards addressed in this SHMP—heat waves, windstorms, earthquakes, floods, wildfires, cyber-attacks, PSPSs, and transportation accidents all have the potential to cause widespread electrical system failures. This chapter assesses potential causes of long-term electrical outage other than hazards of concern that are addressed elsewhere in the Plan.

Humans-caused electrical outages are common. Underground wires, cables, and equipment can be disturbed during excavation, resulting in power failures (Bowen 2016). Animals that climb or land on electrical equipment can serve as a conductor of electricity that can short transformers, causing power outages (Los Angeles Department of Power and Water n.d.). Failure of aging power infrastructure is a significant cause of outages (Tara Energy 2022). Outages also include intentional interruptions in the form of unplanned outages. Any of these events can lead to outages for a few hours or several days.

23.2. HAZARD LOCATION

While power outages occur throughout California, the most significant outages occur in major cities and densely populated areas where they can impact the most people in the smallest geographical areas.

23.3. PREVIOUS HAZARD OCCURRENCES

23.3.1. Disaster and Emergency Declarations

No FEMA, USDA, or State disaster declarations or proclamations related to electrical outages have been issued relevant to California or any of its counties. However, power outages were likely cascading impacts from hazard events that were declared by FEMA or the State in the past.

23.3.2. Event History

Each year, thousands of outage events occur in the State of California. Interruption of power can be associated with any hazard assessed by this Plan. According to State regulators' data, the State's three major investor-owned electric utilities reported 2,374 planned power interruptions between October 20, 2017, and October 31, 2019, (Bloom Energy n.d.)

23.4. PROBABILITY OF FUTURE HAZARD EVENTS

23.4.1. Overall Probability

California has experienced significant electrical outages over the years. As infrastructure ages beyond its intended lifespan, it is likely to become less reliable, leading to a higher likelihood of failure. Based on history of occurrence and input from the State, it is reasonable to assume that power outages, of any duration, have a high probability of occurring each year. Long-term power outages will continue to occur as well; however, at what frequency is difficult to determine (DHS 2010); (DHS 2017).

Based on the 2,374 planned power outages reported from October 2017 through October 2019, it is reasonable to expect that California will continue to see thousands of such outages each year.

23.4.2. Climate Change Impacts

A changing climate will have impacts on many of the hazards that can result in electrical outages. Those impacts are described in the chapters of this Plan describing those other hazards of concern. The "other" potential causes addressed in this chapter are not expected to be affected significantly by climate change.

23.5. IMPACT ANALYSIS

23.5.1. Severity

The extent and severity of a power outage depends on the cause, location, duration, and time of year. It can range from a small, localized event to a multi-county outage. This section discusses the different impacts power outages can have on the State, its population, and its infrastructure.

According to State regulator data, 2,374 planned power interruptions reported between October 20, 2017, and October 31, 2019, counted for a collective 4,547 outage days, affecting an equivalent of about 2.3 million utility customers. (Bloom Energy n.d.). The longest planned de-energization event during the reported period lasted six days, but it affected relatively few customers, totaling about 87. An outage that occurred over multiple circuits beginning on October 26, 2019, affected 970,000 customers and lasted for up to five days. The average duration of all outages was about 46 hours, or nearly two full days (Bloom Energy n.d.).

23.5.2. Warning Time

Widespread power outages resulting from the "other" causes addressed in this chapter can occur without warning. Generally, warning times will be short in the case of equipment malfunction, such as a fire at a substation, traffic accident, or human error. Unplanned outages can be known in advance, with warnings provided to customers about their timing and extent.

23.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with long-term electrical outages:

- Disrupting communications, water, gas, and transportation
- Closing retail businesses, grocery stores, gas stations, banks, and other services
- Causing food spoilage and water contamination
- Preventing use of medical devices

23.5.4. Environmental Impacts

The environment is usually not exposed to power outages unless it results in a spill that contaminates water or open land or creates a wildfire.

23.5.5. Local Hazard Impacts

While long-term power outages are not typically profiled in hazard mitigation plans, two counties (Lassen and Tulare) did identify power/energy outages as a hazard of interest.

23.6. VULNERABILITY ANALYSIS

23.6.1. Exposure of State-Owned or -Leased Facilities, Critical Facilities, and Community Lifelines

All State-owned or -leased facilities, critical facilities, and community lifelines as listed in Table 4-1, Table 4-2, and Table 4-3, are vulnerable to the impacts from long-term electrical outages. This includes 23,961 State-owned facilities, 1,893 State-leased facilities, and 755 community lifeline facilities. Critical facilities and community lifelines that are exposed to outages are likely to experience functional downtime, which could increase net impacts of the event.

23.6.2. Estimates of Loss

Long-term electrical outages are not likely to result in any losses associated with damage or impairment to State assets. However, such outages can have other impacts, including disruption of communications, water, and transportation; closing of businesses, grocery stores, gas stations, banks, and other services; food spoilage and water contamination; and the prevention of medical devices. Businesses can experience reduced employment, equipment malfunctions, failure to keep up with sales, and impacts on inventory. Local governments might lose tax revenues, and the finances of private utility companies and the businesses that rely on them would be disrupted.

FEMA has developed standard loss-of-use estimates in conjunction with its benefit-cost analysis (BCA) methodologies to estimate the cost of lost utilities on a per-person, per-use basis, as summarized in Table 23-1.

Table 23-1. FEMA Standard Value for Loss of Service for Utilities and Roads/Bridges

Interruption	Total Economic Impact
Complete Loss of Electric Power	$126 per person per day
Complete Loss of Potable Water Service	$93 per person per day
Complete Loss of Wastewater Service	$41 per person per day
Complete Loss of Road/Bridge Service	$38.15 per vehicle per hour of vehicle delay detour time $0.55 per mile of vehicle delay (or current federal mileage rate)

Source: (FEMA 2021c)

23.6.3. Buildable Land

An estimated 11.7 million acres of land is available for development in California. Because the entire State is vulnerable to long-term electrical outage, any type of development of any of this land will be susceptible to damage and impacts from this hazard.

23.6.4. Equity Priority Communities

Equity priority communities face multiple barriers and challenges when faced with long-term electrical outages. Sections 24.6.4 and 27.6.4 provide additional details about the variety of impacts on these communities resulting from loss of power.

Overall, the entire population of the State of California is exposed and vulnerable to long-term electrical outages. The population exposed to the hazard in equity priority communities is equal to the statewide percentage: 30.4 percent of the total population (12 million people). Additionally, populations dependent on electrically powered medical devices or refrigerated medicine face increased risk.

23.7. MITIGATING THE HAZARD

23.7.1. Opportunities for Mitigating the Hazard

Electrical power is essential for the State, counties, and residents to function. It is necessary for water, transportation, communication systems, and the health and safety of the population. Long-term power outages can have significant impacts and cause complete disruption. However, there are mitigation measures that can be put in place to reduce or eliminate the impacts of long-term power outages. A range of potential opportunities for mitigating the long-term power outage hazard is provided in Table 23-2. See Section 1.2.3 for a description of the different types of alternatives.

23.7.2. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address long-term electrical outage:

- Action 2018-001: Support Legislative Efforts that Formalize California’s Comprehensive Mitigation Program.
- Action 2018-002: Strengthen Inter-agency Coordination Actions Including State, Regional, and Local Linkages.
- Action 2018-003: Broaden Public and Private Sector Mitigation Linkages.

Table 23-2. Potential Opportunities to Mitigate the Long-Term Power Outage Hazard

<table>
<tr><th>Community-Scale</th><th>Organizational Scale</th><th>Government-Scale</th></tr>
<tr>
<td>Manipulate the hazard:
None
Reduce exposure and vulnerability:
Purchase personal home generators
Install solar panels at homes
Have preparedness kits for power outages (candles, flashlights, solar batteries, non-perishable foods, etc.)
Build local capacity:
Be aware of conditions that may cause power outages</td>
<td>Manipulate the hazard:
Have redundancies within the power grid
Reduce exposure and vulnerability:
Remove trees that have potential to impact power lines
Bury power lines
System hardening based on the current and future hazards of concern
Implementing damage prevention activities
Maintain power infrastructure to high standards
Build local capacity:
Utility providers to collaborate with government and customers
Create a power outage continuity plan</td>
<td>Manipulate the hazard:
None
Reduce exposure and vulnerability:
Backup power for critical facilities and community lifelines
System hardening based on the current and future hazards of concern
Implementing damage prevention activities
Develop design criteria and/or standards for critical infrastructure hardening, backup power, black-start capabilities, fuel supply requirements, back-up or redundant communications requirements (including a standardized mobile command center design), food and water considerations, and other requirements that communities and businesses can build to
Build local capacity:
Build strong relationships with utility providers
Educate and public outreach about proper generator use
Conduct regional catastrophic power outage exercises
Create a power outage continuity plan</td>
</tr>
<tr><td colspan="3">Nature-based opportunities
The use of alternative power sources such as wind and solar could lessen the impacts of these types of events</td></tr>
</table>

Public Safety Power Shutoff

Climate Impacts:
Climate change increases energy demand, leading to more frequent PSPS events

Equity Impacts:
30.4% of exposed population (all persons in the State are exposed) identified as living in equity priority communities

State Facilities Exposed:
All facilities exposed

Community Lifelines Exposed:
All lifelines exposed

Impact Rating: High (48)

24. Public Safety Power Shutoff

Public safety power shutoff (PSPS) has been identified as medium-impact based on the hazard impact rating protocol applied for this Plan. This hazard occurs frequently in the State and all State-owned or -leased facilities and community lifelines are exposed. All the population is exposed, and over 30 percent of that population has been identified as living in equity priority communities. While all buildable lands in the State are exposed to this hazard, new development is likely to be significantly less vulnerable due to strong codes and standards in place in the State. The frequency and severity of these events is anticipated to increase over the next 30 years due to the impacts of climate change.

24.1. HAZARD OVERVIEW

In 2012, the California Public Utilities Commission (CPUC) ruled that the California Public Utility Code gives electric utilities the authority to shut off electric power to protect public safety, since power supply systems have the potential to ignite wildfires (CPUC 2022a). Electric utility infrastructure has historically been responsible for less than 10 percent of reported wildfires. However, fires attributed to power lines consist of roughly half of the most destructive fires in California history (CPUC 2022a).

A public safety power shutoff (PSPS) is an event in which a major electric power provider (e.g., Pacific Gas and Electric Company [PG&E], San Diego Gas and Electric Company, or Southern California Edison) temporarily shuts off electrical power to a selected area to prevent power lines from sparking wildfires and threatening human lives. Utilities usually implement these during days with sustained winds or strong gusts, or other factors. The duration of a shutoff event is tied directly to the weather that triggers it; the shutoff typically ends within 24 hours after the weather conditions have subsided. However, PSPS events may extend beyond the 24-hour timeframe, depending on conditions (Pacific Gas & Electric n.d.).

In response to devastating wildfires in 2017, the CPUC revised earlier guidelines on the de-energization of power lines and adopted the most current set of PSPS guidelines on June 24, 2021 (CPUC 2022b).

24.2. HAZARD LOCATION

PSPS events often target wildland areas with high wildfire risk, but they can impact a much wider region. The targeted area is the area at risk due to weather conditions. Given the long, connected nature of power supply systems, a shutoff event targeted to a small at-risk zone can affect power to larger areas beyond. As an example of potentially affected areas, Figure 24-1 shows the PSPS areas mapped by PG&E for its system statewide.

24.3. PREVIOUS HAZARD OCCURRENCES

From 2013 through 2019, California experienced over 57,000 wildfires (averaging 8,000 per year), and the three large energy companies conducted 33 PSPS de-energizations (CPUC 2022b).

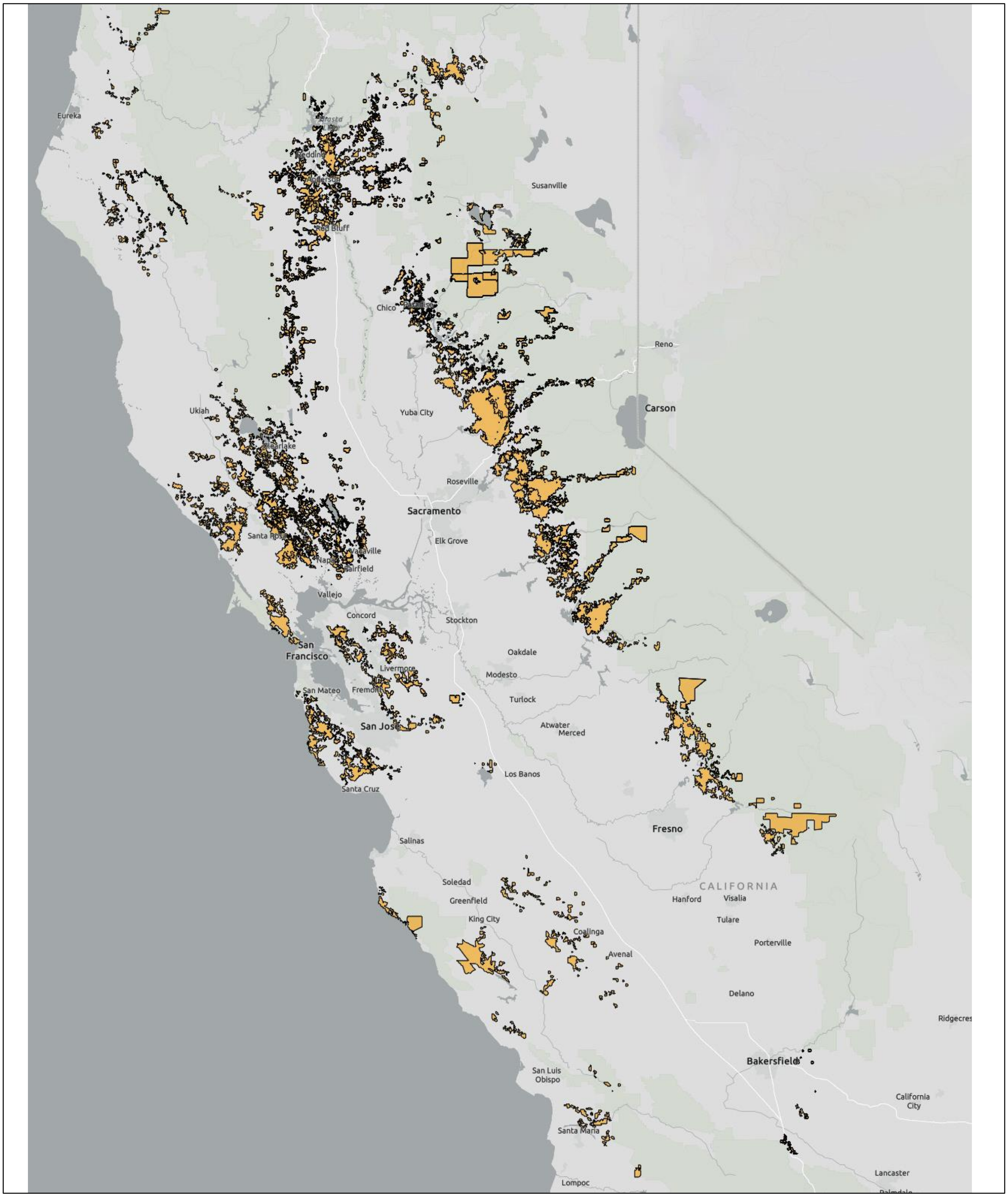
24.4. PROBABILITY OF FUTURE HAZARD EVENTS

24.4.1. Overall Probability

PSPS alerts continue to be based on weather and environmental conditions and are expected to continue into the foreseeable future. The probability of future PSPS occurrences is likely. These events are most likely to occur during summer months with high temperatures, increased wind speeds, drier conditions, and low humidity.

California’s 33 reported PSPS events between 2013 and 2019 represent an average of almost five events per year. The State is expected to continue to experience multiple PSPS events each year.

Figure 24-1. Statewide Potential PSPS Areas Identified by PG&E



Source: (PG&E 2022)

24.4.2. Climate Change Impacts

Conditions for wildfire and extreme temperature are expected to become more common in the future as the climate changes. This will likely increase the probability of PSPS events each year. Under certain severe weather conditions, utility service providers shut off power to help prevent wildfire and keep communities safe. A combination of dry vegetation and high winds can uproot trees, blow branches onto above ground power lines or create sparks if power lines contact one another, requiring a PSPS.

24.5. IMPACT ANALYSIS

24.5.1. Severity

A PSPS can impact the health and well-being of the community. Residents may experience heat illnesses and have food spoil when air conditioning and refrigeration systems cannot function due to the power loss.

Other impacts include food losses due to no refrigeration, which can lead to cascading effects on those who cannot afford to restock their food; food service/restaurant industry (supply loss, spoilage, etc.); and disruption to lifelines and infrastructure.

24.5.2. Warning Time

PG&E and investor-owned electric utilities have different criteria and trigger levels to initiate a PSPS. Table 24-1 shows the weather conditions that are monitored by utility service providers that trigger PSPS events.

Table 24-1. Triggers for PSPS Events

Monitor Factor	Metrics
Red Flag Warning	A warning declared by the National Weather Service that weather conditions could lead to fire and rapid spread.
Low Humidity	20% or lower humidity. Low humidity creates dry vegetation, which fuel fire.
High Winds	Sustained wind speeds above 25 MPH and wind gusts above 45 MPH can cause fire to spread.
Utility Observations	On-the-ground findings from Utility crews.

Forecasts of these conditions can provide some warning of potential upcoming PSPS events. However, since PSPS events can impact areas beyond where the fire-risk weather conditions are being observed, due to the grid nature of electrical power distribution systems, some locations without forecast fire-risk conditions may still be vulnerable to an imminent PSPS. Prior to a PSPS, electric utilities are required to notify customers who may be affected:

- Outages likely—Customers notified up to two days prior to shut off if the customer may be affected by a shutoff
- Outages required—Customers notified 1 to 4 hours before shutoff and can be notified at any time

Many utilities offer notification services through text or email, but the sign-up process for these notifications tends to be voluntary and typically serves customers and clients rather than all consumers.

Advanced warning times from electric providers to government agencies may vary depending on weather and environmental conditions. In advance of a PSPS event, the electric provider usually notifies the emergency management agency for the local operational area. That agency in turn notifies local jurisdictions and public safety providers. Some jurisdictions choose to notify residents, and some electric providers provide information on websites among other places.

24.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with PSPS events:

- Disruption of communications, water, gas, and transportation
- Closure of, grocery stores, gas stations, banks, and other services
- Food spoilage and water contamination
- Inability to use electrical medical devices and assistive technology

24.5.4. Environmental Impacts

Because the duration of PSPS events is often 24 hours, there is minimal, if any, impact on the environment. The net result of PSPS events is the avoidance of wildfires, which may be seen as a positive environmental impact from these type events.

24.5.5. Local Hazard Impacts

Some local jurisdictions have included PSPS as a separate hazard or as a cascading hazard as a result of a primary hazard—severe weather, wildfire, or extreme heat.

24.6. VULNERABILITY ANALYSIS

24.6.1. Exposure of State-Owned or -Leased Facilities, Critical Facilities, and Community Lifelines

All State-owned or -leased assets, as listed in Table 4-1 and Table 4-2, are exposed to this hazard. This includes 23,961 State-owned facilities, and 1,893 State-leased facilities. All 755 State critical facilities and community lifelines, as listed in Table 4-3, are exposed to this hazard as well.

Some of these facilities may have alternate power sources or back-up generators. Electric providers may opt to exclude certain facilities from shutoffs.

24.6.2. Estimates of Loss

PSPS events are not likely to result in any losses associated with damage or impairment to State assets. All losses from this hazard would be associated with impacts on the economy, based on impaired operations due to power outage. Sustained periods of downtime could lead to significant economic impacts.

24.6.3. Buildable Land

An estimated 11.7 million acres of land is available for development in California. Because the entire State is vulnerable to PSPS, any type of development of any of this land will be susceptible to damage and impacts from this hazard.

24.6.4. Equity Priority Communities

A PSPS can leave communities and essential facilities without power, which brings its own risks and hardships, particularly for vulnerable communities and individuals (CPUC 2022b). Throughout the State there may be more vulnerable populations in rural or remote areas, which may be more impacted as a result of a shutdown.

PSPS events can negatively affect people with access or functional needs, including individuals who are power-dependent for life-sustaining medical devices, those who rely on assistive technology, and older adults. Air conditioning, refrigerated medicines, and home medical equipment that relies on power may shut down if a backup battery is not available or sufficient to last during a long power outage. Residents may consume or lose perishable food during a long power outage. Individuals, households, and families experiencing poverty may be especially food insecure and unable to afford to replace spoiled food.

The entire population of the State of California is exposed and vulnerable to PSPS events. The population exposed to the hazard in equity priority communities is equal to the statewide percentage: 30.4 percent of the total population (12 million people).

24.7. MITIGATING THE HAZARD

24.7.1. Existing Measures to Mitigate the Hazard

CPUC requires electric utilities to report their specific plans for Community Resource Centers, critical facilities, PSPS exercises, education and outreach-related surveys and accessibility efforts, notifications, highest risk circuits, and identified lessons learned from the previous year.

24.7.2. Opportunities for Mitigating the Hazard

Electrical power is essential for the State, counties, and residents to function. It is necessary for water, transportation, communication systems, and the health and safety of the population. From maintaining a stable and efficient electric power system to installing and using alternative power sources (e.g., solar, wind, microgrids), there are different mitigation measures that can be taken to reduce or eliminate the impacts from energy shortages.

Table 24-2 provides a range of potential alternatives for mitigating the PSPS hazard. See Section 1.2.3 for a description of the different types of alternatives.

Table 24-2. Potential Opportunities to Mitigate the PSPS Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ None **Reduce exposure and vulnerability:** ▪ Purchase personal home generators ▪ Install solar panels at homes ▪ Have preparedness kits for power outages (candles, flashlights, solar batteries, non-perishable foods, etc.) **Build local capacity:** ▪ Be aware of conditions that may cause power outages	**Manipulate the hazard:** ▪ Have redundancies within the power grid **Reduce exposure and vulnerability:** ▪ Remove trees that have potential to impact power lines ▪ Bury power lines ▪ Harden systems based on the current and future hazards of concern ▪ Implement damage prevention activities ▪ Maintain power infrastructure to high standards **Build local capacity:** ▪ Utility providers to collaborate with government and customers ▪ Utility providers to expand funding for the purchase and delivery of backup power resources for energy dependent Californians ▪ Create a power outage continuity plan	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Backup power for critical facilities and community lifelines ▪ Harden systems based on the current and future hazards of concern ▪ Implement damage prevention activities ▪ Develop design criteria and/or standards for critical infrastructure hardening, backup power, black-start capabilities, fuel supply requirements, back-up communications requirements (including a standardized mobile command center design), food and water considerations, and other requirements that communities and businesses can build to **Build local capacity:** ▪ Build strong relationships with utility providers ▪ Conduct education and outreach to the public about proper generator use ▪ Conduct regional catastrophic power outage exercises ▪ Create a power outage continuity plan
Nature-based opportunities ▪ The use of alternative power sources such as wind and solar could lessen the impacts of these types of events		

24.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address the PSPS hazard:

- Action 2018-001: Support Legislative Efforts that Formalize California's Comprehensive Mitigation Program.
- Action 2018-002: Strengthen Inter-agency Coordination Actions Including State, Regional, and Local Linkages.
- Action 2018-003: Broaden Public and Private Sector Mitigation Linkages.

TERRORISM

Climate Impacts:
While climate change may not be a direct root cause of terrorism, it is recognized as a predominant destabilizing force that fosters an enabling environment for violent extremist organizations (Romm 2022)

Equity Impacts:
30.4% of exposed population (all persons in the State are exposed) identified as living in equity priority communities

State Facilities Exposed:
All facilities exposed

Community Lifelines Exposed:
All community lifelines exposed

Impact Rating: High (30)

25. Terrorism

Terrorism has been identified as high-impact under the hazard impact rating protocol applied for this Plan. This hazard has occurred historically in California and all State-owned or -leased facilities and community lifelines are exposed as potential targets based on their importance for State operations. While the entire population is exposed to this hazard, terrorism tends to target certain types of populations. The impact rating for this hazard assumes that equity priority communities would be impacted more by these type events due to limited resources. The development of buildable lands is not considered to increase the risk to this hazard. The frequency and severity of these events is not anticipated to be directly increased due to the impacts of climate change but has noted above there could be an indirect increase in frequency due to destabilization of areas dur to impacts from climate change.

25.1. HAZARD OVERVIEW

The term "terrorism" refers to intentional, criminal malicious acts. There is no single, universally accepted definition of terrorism, and the term can be interpreted in many ways. This SHMP uses the following definition from federal law (28 CFR, Section 0.85):

> "…the unlawful use of force and violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives."

Terrorism as assessed for this SHMP includes the following:

- The use of weapons of mass destruction, including biological, chemical, nuclear, and radiological weapons
- Arson, incendiary, explosive, and armed attacks
- Industrial sabotage
- Intentional hazardous materials releases

25.2. HAZARD LOCATION

Terrorism can occur in any place and at any time. Most instances of terrorism occur in locations with concentrated populations or locations of high economic or social value, such as stadiums, schools, prominent offices, or government buildings.

25.3. PREVIOUS HAZARD OCCURRENCES

25.3.1. Disaster and Emergency Declarations

The following disaster declarations or emergency proclamations related to terrorism have been issued for California (see Appendix F for details):

- Federal DR or EM declaration, 1953 – 2022: None
- California Emergency Proclamations, 1950 – 2022: one event, classified as terrorism
- USDA agricultural disaster declarations, 2012 – 2022: None

25.3.2. Event History

The 2018 SHMP listed terrorism events in California through 2017. Table 25-1 summarizes terrorism events between 2018 and 2022. For events prior to 2018, refer to Appendix K.

Table 25-1. Terrorist Events in California, 2018 to 2022

Date	Location	Description
March 12, 2018	Travis Air Force Base	An attacker in a car loaded with propane tanks ran through the main gate at Travis AFB.
November 2018	Thousand Oaks	12 people were killed during a mass shooting at the Borderline Bar and Grill.
July 28, 2019	Gilroy	Three people were killed, and a dozen were wounded when a gunman opened fire at the Gilroy Garlic Festival.
May 29, 2020	Oakland	Two officers were shot, one killed, after a man shot them in front of a federal building in downtown Oakland.
June 6, 2020	Ben Lomond	Ambush attack on deputies.
September 12, 2020	Los Angeles	Ambush shooting of two police officers sitting in a vehicle.
May 3, 2022	Los Angeles	Police officer attacked and injured at a protest of projected Supreme Court decision on abortion.

According to data from the Department of Homeland Security (DHS) Office of Intelligence and Analysis, domestic terrorism incidents occurred in locations throughout the U.S. from 2010 through 2021. The greatest number of attacks occurred in states with major metropolitan areas, such as California (Los Angeles, San Diego, and San Francisco), New York (New York City), and Washington, D.C. California had the most incidents during this time period, while several states (Connecticut, Hawaii, Maine, Mississippi, New Hampshire, Rhode Island, South Dakota, and Vermont) had none.

Source: (U.S. Government Accountability Office 2023)

25.4. PROBABILITY OF FUTURE HAZARD EVENTS

25.4.1. Overall Probability

Based on history of occurrences between 2001 and 2022, the State of California can expect to see an average of two terrorist events each year.

25.4.2. Climate Change Impacts

While climate change may not be a direct root cause of terrorism, it is recognized as a predominant destabilizing force that fosters an enabling environment for violent extremist organizations. When regions are exposed to, or situated in, an environment susceptible to climate insecurities and are highly dependent on that environment for livelihoods, a positive correlational relationship between climate change and violence strengthens. This relationship may affect violent extremism as well (Romm 2022).

25.5. IMPACT ANALYSIS

25.5.1. Severity

Acts of terrorism can range from minor to severe, with fatalities and damage that can fall in the same categories.

25.5.2. Warning Time

The National Terrorism Advisory System is designed to communicate information about terrorist threats by providing timely, detailed information to the American public. The U.S. Department of Homeland Security (DHS) maintains the National Terrorism Advisory System. As of June 2022, the system rates the national threat as "heightened threat environment."

25.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with terrorist events:

- Widespread utility failure
- Health effects as a result of bioterrorism or weapons of mass destruction
- Structural fires
- Wildfires
- Contamination of drinking water
- Potential economic impacts (i.e., an attack at a stadium such as a sporting event may deter future attendance)

25.5.4. Environmental Impacts

Terrorism has a harmful effect not only on economic and social life, but also on the environment. The environmental damage caused by terrorism includes, but is not limited to, terrestrial conflicts, terrorist camps and bases, training activities, and carbon dioxide emissions related to energy consumption (Bildirici and Gokmenoglu 2020). Terrorist activities such as bomb blasts produce enormous toxic pollutants such as carbon dioxide (CO_2) and sulfur dioxide (SO_2), which contaminate the environment directly through the destruction of natural resources (Mannion 2003).

The effect of terrorism on the environment is not limited to carbon dioxide emissions; terrorists also use a large scale of chemicals and heavy metals (iron, copper, steel, and depleted uranium) related to mass destruction weapons. The heavy metals possess toxic elements such as lead, cadmium, zinc, and copper. The chemicals and heavy metals contaminate soil, air, and water, which cannot be easily purified.

25.5.5. Local Hazard Impacts

Ten of the hazard mitigation plans prepared for California's 58 counties list terrorism as a "hazard of interest." Hazards of interest are hazards that local communities consider to be important but for which a complete risk assessment is not performed due to the nature of the hazard. The following counties listed terrorism as a hazard of interest:

- Contra Costa
- Humboldt
- Imperial
- Lassen
- Monterey
- San Benito
- San Diego
- Sonoma
- Tulare
- Yolo

25.6. VULNERABILITY ANALYSIS

25.6.1. Exposure of State-Owned or -Leased Facilities, Critical Facilities, and Community Lifelines

All State-owned or -leased facilities, critical facilities, and community lifelines as listed in Table 4-1, Table 4-2, and Table 4-3, are vulnerable to the impacts of terrorism. This includes 23,961 State-owned facilities, 1,893 State-leased facilities, and 755 community lifeline facilities.

25.6.2. Estimates of Loss

The initial economic impact of a terrorist attack can be measured in immediate costs such as costs related to responding to the event and those associated with the immediate loss of productivity due to closed businesses. The fuller economic impact includes long-term costs such as terrorism mitigation activities and cost associated with long-term recovery and productivity.

State assets could be targets for terrorism events, but there are no standard generic formulas for estimating associated losses. Instead, loss estimates were developed representing 10 percent, 30 percent, and 50 percent of the replacement cost value of all State-owned facilities (see Table 25-2). This allows the State to select a range of potential economic impacts based on an estimate of percent of damage to these assets. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure.

Table 25-2. Loss Potential of State-Owned Assets for Terrorism

Type of Facility	Total Replacement Cost Value (contents only)	Estimated Loss Potential Based on % Damage		
		10% Damage	30% Damage	50% Damage
Facilities Housing Vulnerable Populations				
Correctional Facility	$5,673,743,477	$567,374,348	$1,702,123,043	$2,836,871,738
Development Center	$696,669,418	$69,666,942	$209,000,825	$348,334,709
Hospital	$837,461,197	$83,746,120	$251,238,359	$418,730,598
Migrant Center	$996,980,976	$99,698,098	$299,094,293	$498,490,488
Special School	$128,610,363	$12,861,036	$38,583,109	$64,305,182
All Other Facilities	**$28,392,185,985**	**$2,839,218,598**	**$8,517,655,796**	**$14,196,092,992**
Total	**$36,725,651,416**	**$3,672,565,142**	**$11,017,695,425**	**$18,362,825,708**

25.6.3. Buildable Land

An estimated 11.7 million acres of land is available for development in California. Because the entire State is vulnerable to terrorism, any type of development of any of this land will be susceptible to damage and impacts from this hazard.

25.6.4. Equity Priority Communities

Research finds that African Americans and Latinos perceive that they are at greater risk from terrorism than do non-Latin Whites. A 2002 survey reported that African Americans were most likely to limit their outside activities and change their mode of transportation in response to fears of terrorism. Another survey found that persons with disabilities were more anxious about their personal risk from terrorism than were persons without disabilities, even when equally prepared. Another study reported that persons who increased their disaster preparations in response to the possibility of terrorist attacks included African Americans, Latinos, persons with disabilities or household dependents, and non–U.S.-born populations (Eisenman, et al. 2009).

Because the entire population of the State of California is exposed and vulnerable to terrorism, the exposed population in equity priority communities is equal to the statewide percentage: 30.4 percent of the total population, or 12 million people.

25.7. MITIGATING THE HAZARD

25.7.1. Existing Measures to Mitigate the Hazard

The California Anti-Terrorism Program under the California Department of Justice (DOJ) works with federal, State, and local law enforcement agencies for the purpose of detecting, investigating, prosecuting, dismantling, preventing, and responding to domestic and international terrorist activities in a unified and coordinated manner.

25.7.2. Opportunities for Mitigating the Hazard

There are various mitigation options for the terrorism hazard. They include defensive measures that reduce the vulnerability of people and property to terrorist acts and offensive measures that prevent, deter, and respond to terrorism. A four-phase mitigation process should be used to deal with threats of terrorism:

1. Identify and organize resources
2. Conduct a risk assessment and estimate potential losses
3. Identify mitigation actions
4. Implement the actions, evaluate the results, and keep the plan up to date

Table 25-3 provides potential alternatives for mitigating terrorism. See Section 1.2.3 for a description of the different types of alternatives.

25.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address terrorism:

- Action 2018-003: Broaden Public and Private Sector Mitigation Linkages.
- Action 2018-102: Homeland Security Strategy: Reduce the impact of human-made disaster events through a coordinated effort of capacity-building for State and local agencies.
- Action 2018-103: Homeland Security Grant Programs: Prioritize and allocate federal funding resources to support California’s Homeland Security Strategy.

Table 25-3. Potential Opportunities to Mitigate the Terrorism Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ None **Reduce exposure and vulnerability** ▪ None **Build local capacity** ▪ Increase awareness of vulnerability to threats ▪ Neighborhood watch program ▪ Keep informed ▪ Develop an emergency response plan ▪ Report suspicious activities	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability** ▪ Incorporate anti-terrorism and security mitigation measures in site and layout design of facilities ▪ Consider site security in landscape design of facilities ▪ Restrict access by implementing controlled access zones ▪ Increase security measures ▪ Install physical barriers around critical facilities ▪ Implement parking restrictions to reduce vulnerability **Build local capacity** ▪ Become a partner (stakeholder) in mitigation and prevention ▪ Educate employees ▪ Develop an emergency response plan ▪ Develop a Continuity of Operations Plan ▪ Use liberal signage techniques to inform and increase capability of users of facilities	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability** ▪ Construct new critical facilities with Clear Zones ▪ Retrofit existing Critical Facilities ▪ Restrict access by implementing controlled access zones ▪ Reduce single-point vulnerabilities such as: redundancy for critical lifelines and infrastructure ▪ Install physical barriers around critical facilities **Build local capacity** ▪ Educate public on threats and vulnerability ▪ Enhance emergency response capability by contingency planning for specific events based on identified vulnerabilities ▪ Consider performance-based zoning as a land use alternative to mitigate impacts of human-caused hazards ▪ Employ Crime Prevention Through Environmental Design techniques in design of public facilities ▪ Consider providing incentives for mitigation ▪ Leverage the capabilities and capacities of the State Threat Assessment Center and other Fusion Centers
Nature-based opportunities ▪ There are no identified nature-based solutions to mitigate the impacts from terrorism		

AIR POLLUTION

Climate Impacts:
Changes in long-term weather patterns in the State will have direct consequences for air quality and public health

Equity Impacts:
30.4% of exposed population (all persons in the State are exposed) identified as living in equity priority communities

State Facilities Exposed:
All facilities exposed

Community Lifelines Exposed:
All lifelines exposed

Impact Rating: High (30)

26. Air Pollution

Air Pollution has been identified as high-impact under the hazard impact rating protocol applied for this Plan. This hazard occurs frequently in the State. While all State-owned or -leased facilities and community lifelines are exposed to air pollution, this hazard will not directly cause damage to these assets. There could be indirect impacts associated with the corrosive effects of acid rain. Air pollution can impact the entire population, including those identified as living in equity priority communities. The development of buildable lands could increase the risk to this hazard as it would increase the population and sources for air pollution. The frequency and severity of air pollution is anticipated to be increased due to impacts from climate change over the next 30 years.

26.1. HAZARD OVERVIEW

The World Health Organization defines "air pollution" as "the contamination of the indoor or outdoor environment by any chemical, physical or biological agent that modifies the natural characteristics of the atmosphere" (World Health Organization 2022). Air pollution has the potential over time to be highly hazardous to the health of a large number of Californians. Temporarily hazardous air conditions can occur as a result of natural and human-caused hazards, including wildfires, high winds and dust, volcanic activities, stratospheric ozone intrusion, hazardous material accidents, structural fires, and fireworks (National Park Service 2018).

26.1.1. Air Quality Standards

The U.S. Environmental Protection Agency (EPA) set National Ambient Air Quality Standards for six common air pollutants: ozone, particulate matter (PM), carbon monoxide, lead, sulfur dioxide, and nitrogen dioxide (EPA 2022i). These "criteria air pollutants" cause human and environmental health issues. The California Air Resources Board (CARB) has set California Ambient Air Quality Standards for the EPA's criteria pollutants and for hydrogen sulfide, vinyl chloride, sulfate, and visibility-reducing particles (State of California 2022e). PM and ozone have some of the greatest concern from a human health perspective (State of California 2022k). More information on ambient air quality standards can be found on CARB's California ambient air quality standards web page (State of California 2022b).

Air Pollution Sources

Sources of air pollution are generally grouped into four categories (National Park Service 2018):

- ***Stationary sources*** include fixed facilities such as power plants and landfills.
- ***Mobile sources*** are typically associated with operation of vehicles such as cars, trucks, ships, and airplanes, which are often the largest source of emission in a region.
- ***Area-wide sources*** are widely dispersed and may include agriculture, construction grading, or unpaved roads.
- ***Natural sources*** can include plant pollens, biological decay, and windblown dust.

26.1.2. Particulate Matter

PM is a mixture of suspended liquids and solids that can include organic substances, dust, soot, and metals. Two types are typically monitored (EPA 2022d):

- $PM_{2.5}$ is PM that consists of fine particles 2.5 micrometers or less in diameter (about 1 ten-thousandth of an inch). These particles are typically formed when gas-phase emissions from human activities (e.g., uncombusted gasoline and diesel, industrial processes, asphalt, household products) react in the atmosphere to form PM. A substantial fraction of $PM_{2.5}$ is also emitted from combustion of motor vehicles, power plants, industrial processes and factories, wildfires, residential wood burning, agricultural burning, and other activities.
- PM_{10} consists of coarse particles that are 10 micrometers or less in diameter. PM_{10} includes mostly dust, pollen, and bacteria fragments (State of California 2022f).

$PM_{2.5}$ is an extremely small pollutant, and human exposure to it is linked to adverse health outcomes. The smaller the particles, the deeper they can move into the lungs when people breathe. $PM_{2.5}$ is capable of reaching deep into the lungs and causing a host of complication including heart disease, respiratory disease, asthma, and premature mortality (OEHHA 2022a). $PM_{2.5}$ is also linked to hospital emergency department admissions for sensitive populations such as children or those who have reduced lung function (State of California 2022f).

PM_{10}, like $PM_{2.5}$, is a small pollutant, and human exposure to it is linked to adverse health outcomes. PM_{10} is linked to the worsening of respiratory diseases. It reduces lung function and contributes to respiratory mortality (State of California 2022f).

In 2012, CARB updated the 24-hour average standards for $PM_{2.5}$ and PM_{10} (State of California 2022f). In 2005, CARB updated the 1-hour and 8-hour time weighted average standard. In 2015, the EPA lowered the national 8-hour standard (State of California 2022i).

26.1.3. Ozone

Ozone, also referred to as O_3, is a highly reactive gas composed of three oxygen atoms. It is both a natural and a human-made product that occurs in the Earth's upper atmosphere (the stratosphere) and lower atmosphere (the troposphere). It is a secondary pollutant produced from nitrogen oxides and volatile organic compounds in the presence of sunlight (EPA 2022e).

According to the California Office of Environmental Health Hazard Assessment (OEHHA), the main sources of the components of ground-level ozone are trucks, cars, planes, trains, factories, farms, construction, and dry cleaners. Ozone levels are typically highest in the afternoon and on hot days (OEHHA 2022). Studies of historical ozone levels find that increased daytime temperatures increase ozone concentrations (Kleeman, Chen and Harley 2010).

Ozone is among the most widespread and significant air pollution health threats in California (OEHHA 2022). Studies have shown that exposure to ozone can damage respiratory tract tissues, causing decreased lung function and respiratory symptoms (State of California 2022f). At higher daily concentrations, ozone increases asthma attacks and deaths related to respiratory causes. Children are the most susceptible to harmful effects from ozone, and increased medication use, hospitalizations, and school absences have been noted (EPA 2022b). Ozone can also impact plant health by limiting the plants' ability to photosynthesize (National Park Service 2020).

26.2. HAZARD LOCATION

All of California is susceptible to air pollution, but the extent varies by location. Generally, pollutants that affect air quality are created by polluting industries, transportation emissions, wildfires, dust, and heat waves (Earth.org 2022). Therefore, populated and industrial areas such as Los Angeles and areas that are prone to wildfire are at a generally higher risk. The San Joaquin Valley has a reputation for poor air quality due to these contributors and the geography, which prevents clean air from reaching the valley (PBS 2022). While pollution levels are generally highest at the site of emissions, winds can transport pollutants to downwind regions, so air pollution can affect many communities in a region.

In October 2021, OEHHA finalized the CalEnviroScreen 4.0 Indicator Maps, which display pollution exposure data, including ozone, $PM_{2.5}$, diesel PM, toxic releases from facilities, and other pollutants. It also maps population characteristics such as asthma around the State. The CalEnviroScreen 4.0 tool generates a score for each area based on pollution exposure, population characteristics, and socioeconomic factors (OEHHA 2022b). On the OEHHA mapper, air quality pollutants are measured by percentage of the census tract in California (OEHHA 2022b).

Figure 26-1 shows average emission rate data from a range of pollutants from CalEnviroScreen 4.0, by county, in October 2021. Based on this data, Los Angeles County had the highest pollution burden, followed by Stanislas, Madera, and Kings County.

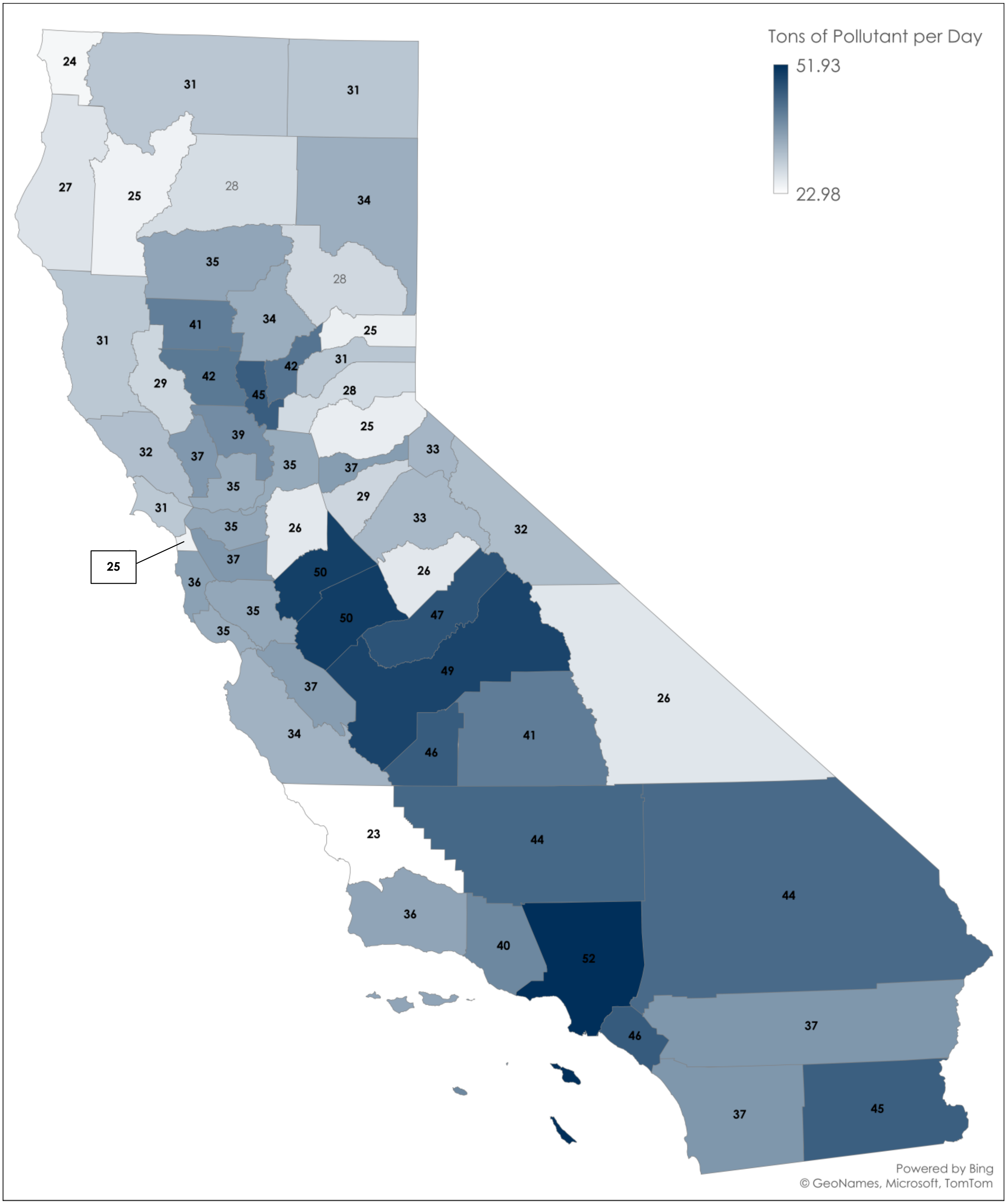
26.3. PREVIOUS HAZARD OCCURRENCES

26.3.1. Disaster and Emergency Declarations

No FEMA, USDA, or State disaster declarations or proclamations related to air pollution have been issued relevant to California or any of its counties.

However, the State has been included in numerous declarations related to wildfire. Smoke from wildfires can increase PM in the air, and the heat combines with the smoke and other pollutants to create more ground-level ozone.

Figure 26-1. Average Air Pollutant Burden by County in Tons per Day



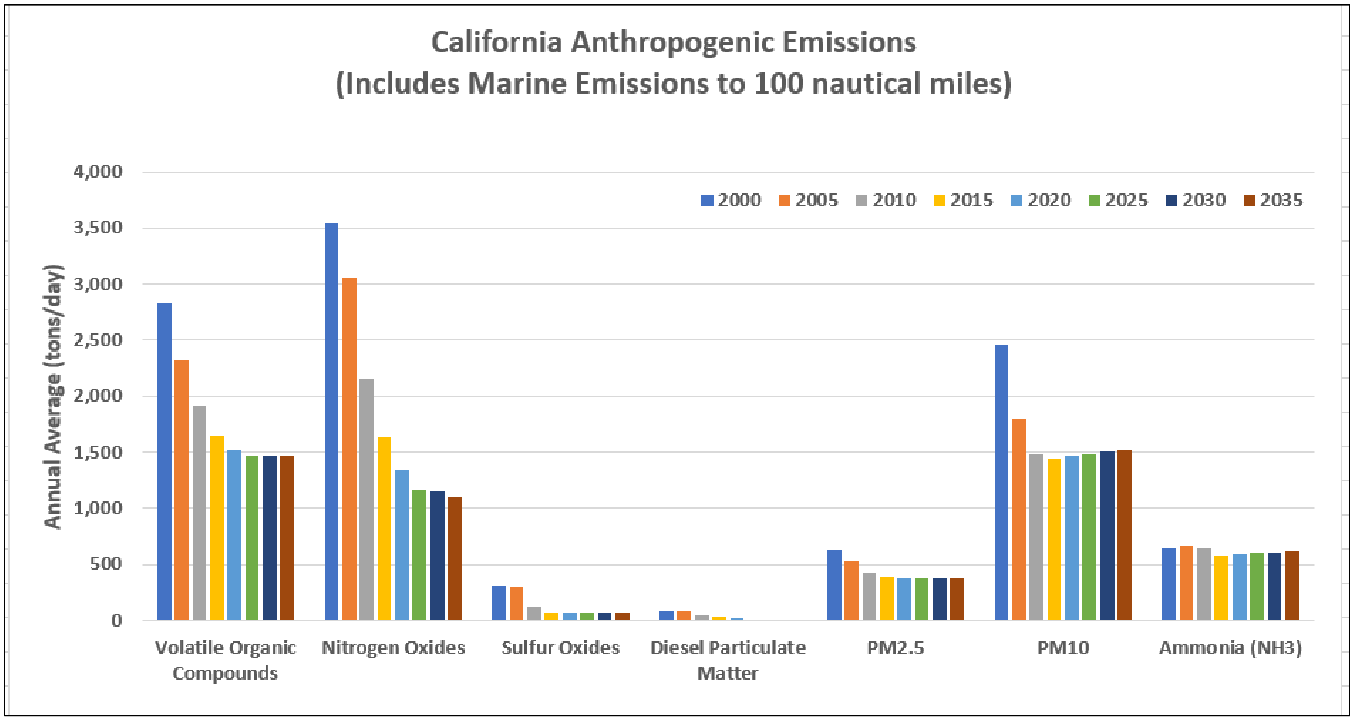
Source: (OEHHA 2022b)

26.3.2. Event History

Air pollution is a continuous threat to the State of California and its residents. According to 2017 estimated emissions data, the following CARB air basins had the highest emissions: The Northeast Plateau, San Joaquin Valley, South Coast, Sacramento Valley, and Mountain Counties. Pollutants include total organic gases, volatile organic gases, carbon monoxide, nitrogen oxides, sulfur oxides, PM, PM_{10}, $PM_{2.5}$, and ammonia (NH_3) (State of California 2021).

Figure 26-2 shows average quantities of emissions in tons per day from 2000 to 2015 and forecasts to 2035. Forecast emissions for future years take into account emissions data, projected growth rates, and future adopted control measures. In general, emission rates tend to level off in the future, with potential moderate increases.

Figure 26-2. Air Pollutant Emission Trends and Forecasts in California, 2000 – 2035



Source: (State of California 2013)

Most counties in California meet federal and State air quality standards for the criteria air pollutants; however, some counties are still working to attain the ozone, $PM_{2.5}$, and PM_{10} standards as of October 2022, as show in Figure 26-3 through Figure 26-5 (State of California 2020):

Figure 26-3. 2022 Area Designations for State Ambient Air Quality Standards $PM_{2.5}$

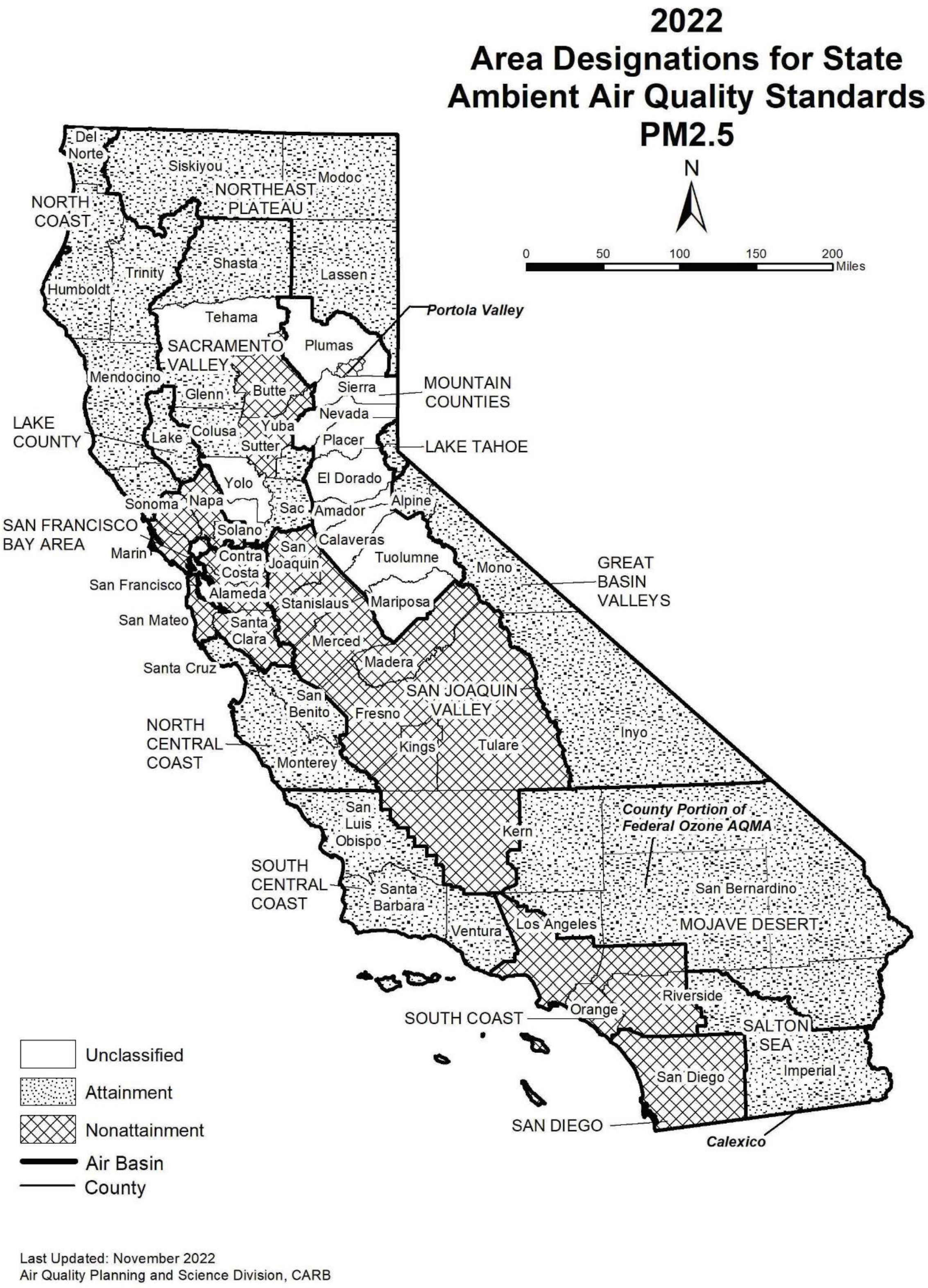


Figure 26-4. 2022 Area Designations for State Ambient Air Quality Standards PM_{10}

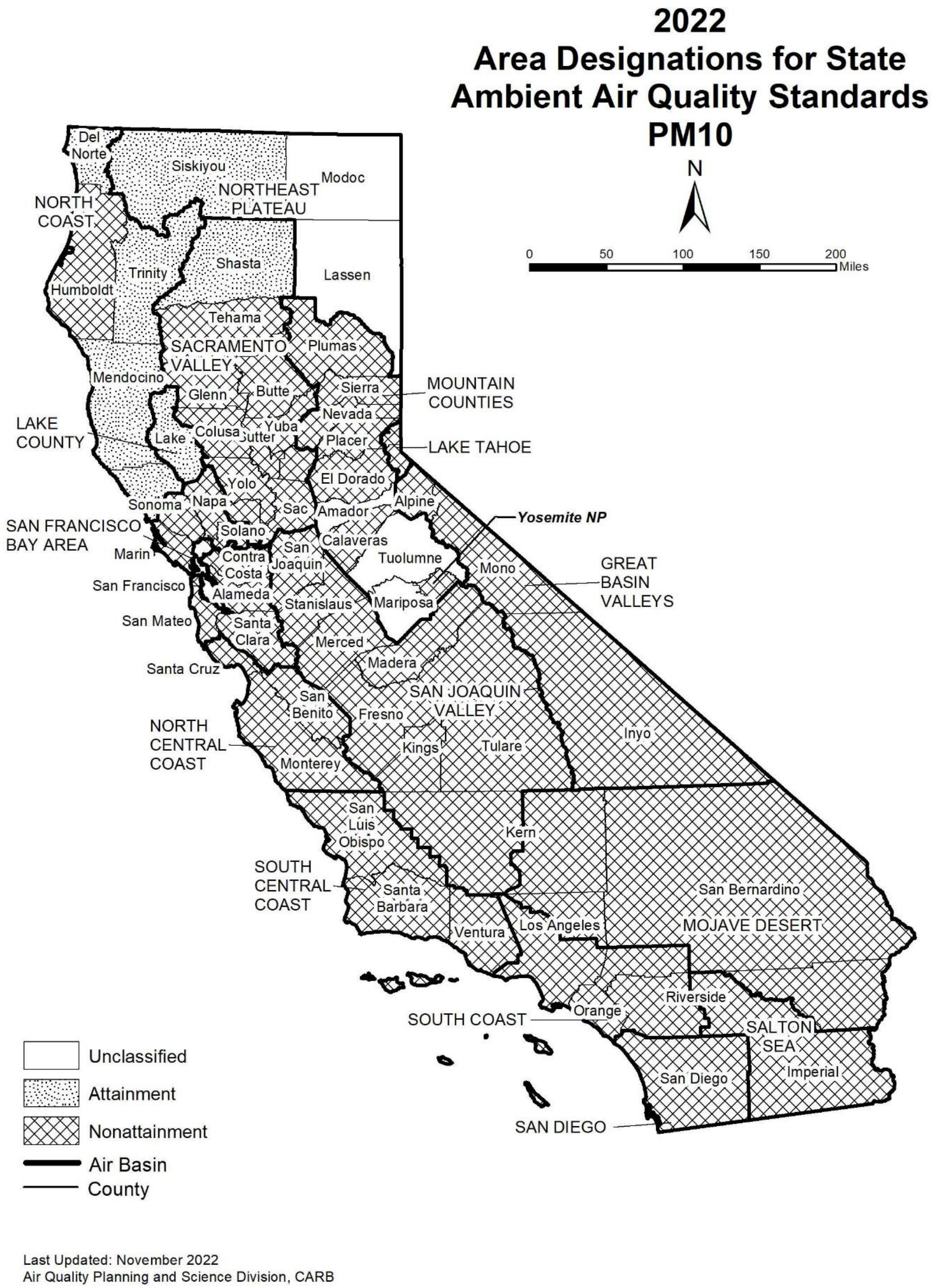
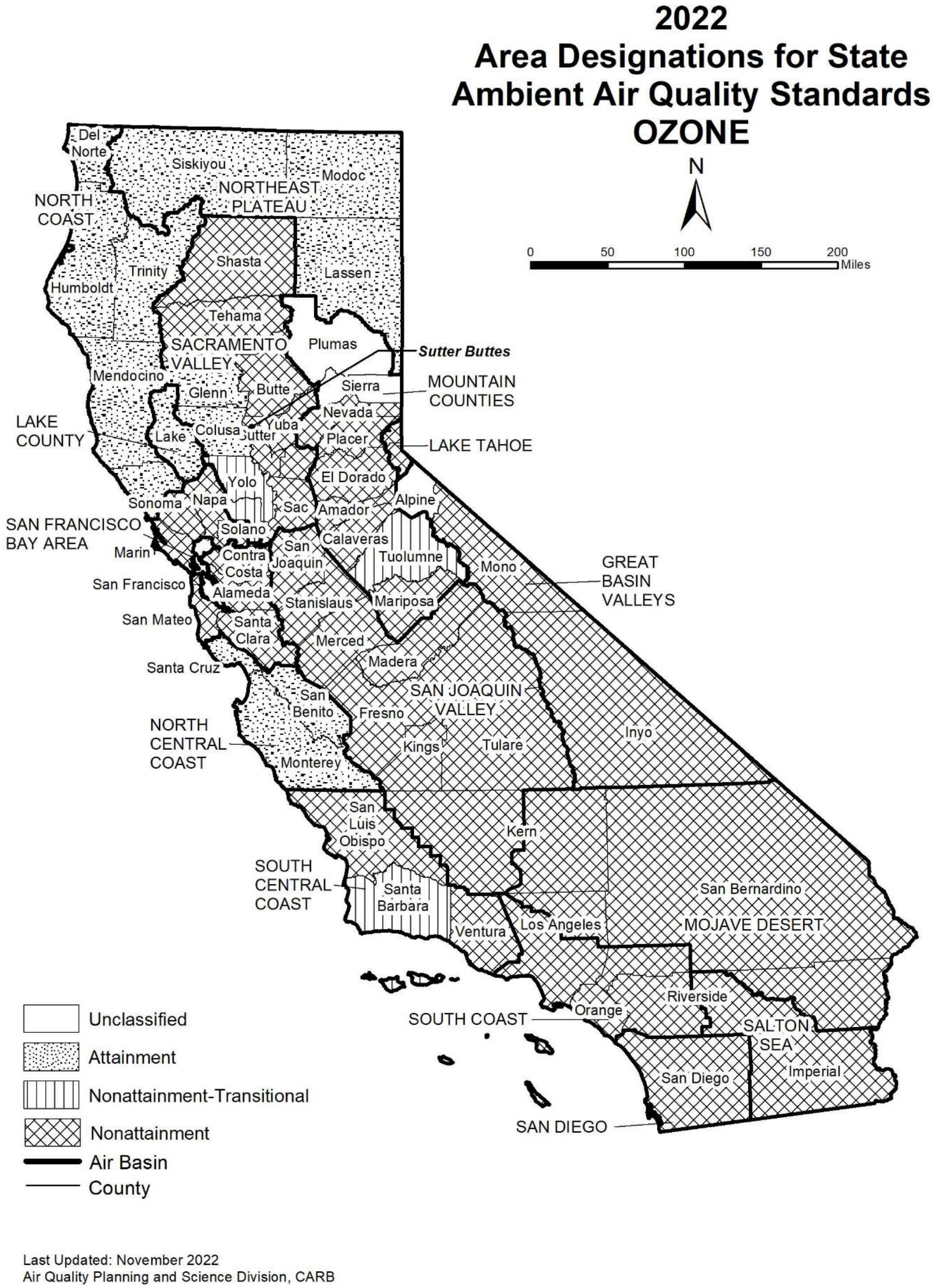


Figure 26-5. 2022 Area Designations for State Ambient Air Quality Standards Ozone



26.4. PROBABILITY OF FUTURE HAZARD EVENTS

26.4.1. Overall Probability

Air pollution will continue to impact the State on a continuous basis. Growing populations and higher demand for new development can lead to an increase in emissions and air pollution, with adverse effects on human and environmental health. This hazard has a high probability of occurring in the future.

26.4.2. Climate Change Impacts

Climate change is anticipated to have direct consequences for air quality (EPA 2016a). The air pollutants that cause climate change are a global focus for reduction (World Health Organization 2021). Many greenhouse gases (GHGs), such as methane, also have public health consequences (World Health Organization 2022). In addition, indirect impacts of climate change, such as changes in weather patterns and increases in wildfire, can exacerbate air quality challenges and introduce new ones:

- If ozone precursors (nitrogen oxides and volatile organic compounds) are present, ozone production increases with higher temperatures and greater solar radiation (CDPH 2007); (Earth.org 2022). Climate change increases the average temperature and influences more intense dry periods, which increases solar exposure (OEHHA 2022a).
- Climate change has the potential to worsen PM concentrations due to smoke and ash produced by increased incidence of wildfire.
- Dry, warm weather can result in greater amounts of dust being blown and suspended in air (State of California 2022f).
- With increasing temperatures, demand for electric power to run air conditioning will increase, and the resulting increased emission of pollutants may contribute further to poor air quality.
- Precipitation is the primary method for removing pollutants from the air; the increased risk of droughts and less rainfall caused by climate change will reduce the mitigation of air pollution.
- Solar radiation can be affected nonlinearly by PM. PM can absorb more solar radiation, thereby increasing temperature and speeding the process of ozone formation. Alternatively, PM can serve as a conduit for cloud formation, which

blocks solar radiation. These competing forces make it difficult to predict future air quality events.

A decline in air quality due to climate change threatens public health because of increased risk of asthma, other respiratory ailments, and cardiovascular disease (State of California 2022f). Climate change magnifies existing health inequities, including exacerbating health impacts on vulnerable populations due to poor air quality (State of California 2022f).

26.5. IMPACT ANALYSIS

26.5.1. Severity

CARB identifies about 200 toxic air contaminants that may cause serious, long-term effects, such as cancer, even at low levels. Most toxic air contaminants have no known safe levels, and some may accumulate in the body from repeated exposures. Table 26-1 summarizes the most common health and environmental effects of each air pollutant with a national or California ambient air quality standard, as well as those of toxic air contaminants. Air monitoring in California shows over 90 percent of residents breath unhealthy levels of one or more air pollutants during some part of the year (CARB 2022b).

Table 26-1. Common Health and Environmental Effects of Air Pollutants

Pollutant	Effects on Health and the Environment
Ozone	▪ Respiratory symptoms ▪ Worsening of lung disease leading to premature death ▪ Damage to lung tissue ▪ Crop, forest, and ecosystem damage ▪ Damage to a variety of materials, including rubber, plastics, fabrics, paint, and metals
$PM_{2.5}$	▪ Premature death ▪ Hospitalization for worsening of cardiovascular disease ▪ Hospitalization for respiratory disease ▪ Asthma-related emergency room visits ▪ Increased asthma symptoms, increased inhaler usage
PM_{10}	▪ Premature death and hospitalization, primarily for worsening of respiratory disease ▪ Reduced visibility and material soiling

Pollutant	Effects on Health and the Environment
Nitrogen Oxides	▪ Lung irritation ▪ Enhanced allergic responses
Carbon Monoxide	▪ Chest pain in patients with heart disease ▪ Headache ▪ Light-headedness ▪ Reduced mental alertness
Sulfur Oxides	▪ Worsening of asthma: increased symptoms, increased medication usage, and increased emergency room visits
Lead	▪ Impacted mental functioning in children ▪ Learning disabilities in children ▪ Brain and kidney damage
Hydrogen Sulfide	▪ Nuisance odor (rotten egg smell) ▪ At high concentrations, headache and breathing difficulties
Sulfate	▪ Same as $PM_{2.5}$, particularly worsening of asthma and other lung diseases ▪ Reduces visibility
Vinyl Chloride	▪ Central nervous system effects, such as dizziness, drowsiness, and headaches ▪ Long-term exposure: liver damage and liver cancer
▪ Visibility Reducing Particles	▪ Reduced airport safety, scenic enjoyment, road safety, and discourages tourism
Toxic Air Contaminants About 200 chemicals have been listed as toxic air contaminants	▪ Cancer ▪ Reproductive and developmental effects ▪ Neurological effects

Source: (CARB 2022a).

26.5.2. Warning Time

There are 35 local air districts in California that partner with CARB and are responsible for regional air quality planning, monitoring, and stationary source and facility permitting (CARB 2021). The districts administer air quality improvement grant programs and provide daily air quality forecasts for their regions to inform residents of air quality and any recommendations for the general population. Figure 26-6 shows an example of air quality rating used by one local air district.

Figure 26-6. Air Quality Conditions and Health Recommendations

Air Quality conditions

→Check current air quality first at www.AVAQMD.ca.gov or www.AirNow.gov then use this chart.

Length of activity	**GOOD for all groups** AQI 0-50 Visibility: 11+ miles	**MODERATE for Group 1** AQI 51-100 Visibility: 6-10 miles	**UNHEALTHY for Groups 1 & 2** AQI 101-150 Visibility: 3-5 miles	**UNHEALTHY for all groups** AQI 151-200 Visibility: 1 1/2 - 2 3/4 miles	**VERY UNHEALTHY/ HAZARDOUS for all groups** AQI 201+ Visibility: <1 1/4 miles
30 minutes	No restrictions	Group 1 should monitor or reduce physical activity.	Groups 1 & 2 should limit time spent outdoors or reduce physical activity.	Groups 1 & 2 should avoid the outdoors; Group 3 should reduce physical activity.	All groups should avoid the outdoors and physical activity.
1 hour	No restrictions	Group 1 should monitor or reduce physical activity.	Groups 1 & 2 should considerably limit time spent outdoors and reduce physical activity.	All groups should avoid the outdoors and physical activity.	All groups should avoid the outdoors and physical activity.
2+ hours	No restrictions	Group 1 should limit prolonged physical activity.	Groups 1 & 2 should avoid the outdoors and Group 3 should reduce physical activity.	All groups should avoid the outdoors and physical activity.	All groups should avoid the outdoors and physical activity.

How to *roughly* estimate air quality based on visibility without an air quality monitor or airport visibility estimate:
1) Face away from the sun. **2)** Determine the limit of your visible range by looking for targets at known distances (miles).
3) Visible range is that point at which even high contrast objects totally disappear. **4)** Use the values above to determine the local AQI.

Group 1: Individuals with respiratory or heart disease, angina, pulmonary disease, asthma, emphysema or any other disease that may be impacted by any level of smoke or particle pollution.

Group 2: Individuals with asthma or recent respiratory infections, those who experience seasonal allergies, work outside or in general are more sensitive to acute effects of smoke or particle pollution.

Group 3: Individuals who are normally resistant to short-term effects of smoke (healthy). Healthy people may also experience adverse effects of smoke dpeending on duration and exposure.

Sources: (Antelope Valley Air Quality Management District n.d.)

26.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with air pollution (National Geographic 2022):

- Short-term effects are temporary and often include irritation to the nose, eyes, throat, or skin. Air pollution can also cause headaches, dizziness, and nausea.
- Long-term effects can last for years or a lifetime. They include heart disease, lung cancer, and respiratory diseases such as emphysema. Air pollution can also cause long-term damage to nerves, brain, kidneys, liver, and other organs.
- Other tangible cascading impacts from air pollution include school closures, reduced visibility, impacts on HVAC systems, and short-term health impacts, including effects on cognitive abilities.

26.5.4. Environmental Impacts

Potential environmental impacts due to air pollution include the following:

- ***Acid rain*** is precipitation that contains harmful amounts of nitric and sulfuric acid. As it falls—in the form of rain or snow—it can damage trees and cause soils and water bodies to acidify. This makes water unsuitable for fish and wildlife (Massachuetts Department of Environmental Protection 2013).
- ***Eutrophication*** is a condition in a water body where high concentrations of nutrients (such as nitrogen) stimulate algae blooms, which can then lead to killing fish and losing plants and animals. Human activities, such as agricultural runoff containing pesticides and fertilizers, can accelerate naturally occurring eutrophication by increasing the rate at which nutrients enter water bodies (Massachuetts Department of Environmental Protection 2013). Recently, an algae bloom at Lake Merritt caused thousands of fish to die, leading to a cleanup process along the shoreline of the lake (Darrow 2022).
- ***Haze*** is caused when sunlight encounters tiny pollution particles in the air, reducing the clarity and color of what people see. Particulates from haze can contribute to acid rain and ozone. Exposure to these particulates is linked to health problems and environmental damage (EPA 2006).
- ***Wildfire*** smoke consists of a mixture of gaseous pollutants (e.g., carbon monoxide), hazardous air pollutants (e.g., polycyclic aromatic hydrocarbons), water vapor, and particle pollution. PM represents a main component of wildfire smoke and the principal public health threat. It is a general term for a mixture of solid and liquid droplets suspended in the air. There are many sources of particle pollution; the most common is combustion-related activities such as wildfires (EPA 2022c).
- ***Crops and forests*** can be damaged by air pollution in a number of ways:
  - Ozone can reduce a plant's ability to photosynthesize, can damage cells, and can make plants more susceptible to disease. This can lead to reduced crop or fruit yields (State of California 2022i). Ground-level ozone can lead to reduced growth and survivability of tree seedlings and increased plant susceptibility to disease, pests, and other environmental stresses (Massachuetts Department of Environmental Protection 2013).
  - PM deposition on plants and in soil can lead to uptake by plants, resulting in affected plant yield or growth (State of California 2022f).

26.5.5. Local Hazard Impacts

None of the hazard mitigation plans prepared for California's 58 counties list air pollution as a hazard of concern or hazard of interest.

26.6. VULNERABILITY ANALYSIS

Air pollution can affect buildings and infrastructure. Some air pollution, such as acid rain, can corrode building materials, requiring costly repairs to structures. When outdoor air is polluted, ventilation systems may not be able to filter the air coming inside, posing a health risk to people inside (World Green Building Council 2022).

26.6.1. Exposure of State-Owned or -Leased Facilities, Critical Facilities, and Community Lifelines

All State-owned or -leased assets, as listed in Table 4-1 and Table 4-2, are exposed to air pollution. This includes 23,961 State-owned facilities, and 1,893 State-leased facilities. All 755 State critical facilities and community lifelines, as listed in Table 4-3, are exposed to this hazard as well. The vulnerability of these assets to impacts from air pollution is considered to be very low.

26.6.2. Estimates of Loss

Air pollution is not likely to result in any losses associated with damage or impairment to State assets. All losses from this hazard would be associated with impacts on the economy, based on health effects or people modifying their normal behaviors because of poor air quality.

26.6.3. Buildable Land

An estimated 11.7 million acres of land is available for development in California. Because the entire State is vulnerable to air pollution, any type of development of any of this land will be susceptible to damage and impacts from this hazard.

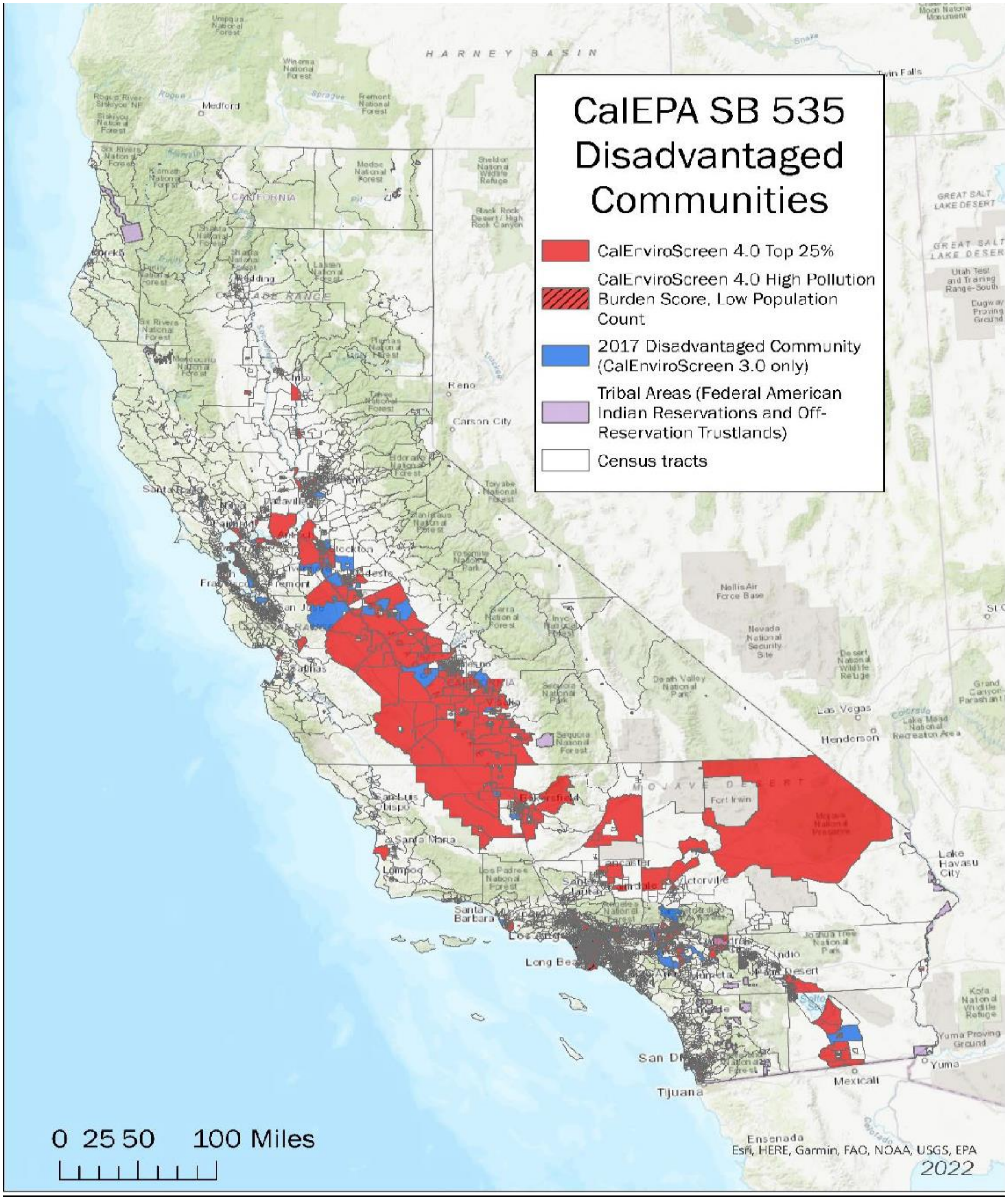
26.6.4. Equity Priority Communities

People who live near large transportation routes or large industrial sources are more vulnerable to poor air quality (Spaceshipone 2020). Children and those with reduced lung function are most vulnerable to the health effects of PM. Children are often more susceptible to harmful ozone because they spend more time outside, breathe faster, have smaller bodies, and may have less effective immune systems (State of California 2022f).

The CalEnviroScreen tool identifies "disadvantaged communities," which are those that are disproportionately burdened by multiple sources of pollution and have population characteristics that make them more sensitive to pollution. As shown in Figure 26-7, disadvantaged communities can be found in the following counties: Almeda, Butte, Contra Costa, Fresno, Glenn, Imperial, Kern, Kings, Los Angeles, Madera, Merced, Monterey, Orange, Riverside, Sacramento, San Bernadino, San Francisco, San Joaquin, San Matteo, San Diego, Santa Barbara, Santa Clara, Santa Cruz, Solano, Sonoma, Stanislaus, Sutter, Tulare, and Ventura (State of California 2022c).

Since the entire population of the State of California is exposed and vulnerable to air pollution, the exposed population in equity priority communities is equal to the statewide percentage: 30.4 percent of the total population (12 million people).

Figure 26-7. Disadvantaged Communities From CalEnviroScreen 4.0 Report



Source: (CalEPA 2022a)

26.7. MITIGATING THE HAZARD

26.7.1. Existing Measures for Mitigating the Hazard

Measures continue to be adopted in California to reduce emissions of air toxins. Criteria pollutants and toxic air contaminants are measured statewide to assess the adequacy of programs for cleaning the air. CARB works with local air pollution control districts to reduce air pollution from all sources (CARB 2022a).

California has taken steps to ensure that air quality mitigation and management is integrated into planning efforts. The California Department of Public Health (CDPH) provides recommendations and guidelines for counties to use in the case of a significant air quality event. State law requires counties to develop air quality plans prior to the update of their emergency plans.

26.7.2. Opportunities for Mitigating the Hazard

A range of potential opportunities for mitigating the hazard is provided in Table 26-2. See Section 1.2.3 for a description of the different types of alternatives.

26.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address the air pollution hazard:

- Action 2018-072: Air Quality/Pollution Monitoring: Maintain CalEnviroScreen mapping tool.
- Action 2018-073: Air Pollution Planning: Incorporate Environmental Justice into General Plans.
- Action 2023-006: Prohousing Designation Program: Promote the Program to encourage cities and counties to apply for this designation to receive points or preference in competitive housing, community development, and infrastructure programs.
- Action 2018-006: Enhance Collaboration on the Development and Sharing of Data Systems and geographic information systems (GIS) Modeling.

Table 26-2. Potential Opportunities to Mitigate the Air Pollution Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ Reduce the number of trips taken in car ▪ Reduce or eliminate fireplace and wood stove use ▪ Avoid burning leaves, trash, and other materials ▪ Avoid using diesel-powered lawn and garden equipment ▪ Install high efficiency appliances ▪ Incorporate solar power systems where appropriate **Reduce exposure and vulnerability:** ▪ None **Build local capacity:** ▪ Education and outreach in the impact from air pollution	**Manipulate the hazard:** ▪ Implement energy efficiency programs and procedures ▪ Energy conservation measures above and beyond requirements ▪ Convert fleet vehicles to alternative fuels ▪ Provide park-and-ride lots or satellite telecommuting centers ▪ Provide on-site shops and services for employees, such as cafeteria, bank/ATM, dry cleaners, convenience market, etc. ▪ Incorporate solar power systems where appropriate **Reduce exposure and vulnerability:** ▪ None **Build local capacity:** ▪ Education and outreach in the impact from air pollution	**Manipulate the hazard:** ▪ Adopt air quality element/general plan air quality policies/specific plan policies ▪ Implement regulations to reduce emissions ▪ Adopt air quality enhancing design guidelines or standards ▪ Provide transit enhancing infrastructure that includes transit shelters, benches, street lighting, route signs and displays, and bus turnouts ▪ Provide transit incentives ▪ Incorporate solar power systems where appropriate **Reduce exposure and vulnerability:** ▪ None **Build local capacity:** ▪ Education and outreach in the impact from air pollution
Nature-based opportunities ▪ Use urban greenspace to reduce the urban heat island and improve air quality		

Energy Shortage

Climate Impacts:
Expected to severely impact energy availability over time
Equity Impacts:
30.4% of exposed population (all persons in the State are exposed) identified as living in equity priority communities
State Facilities Exposed:
All facilities exposed
Community Lifelines Exposed:
All lifelines exposed

Impact Rating: Medium (26)

27. Energy Shortage

Energy Shortage has been identified as medium-impact under the hazard impact rating protocol applied for this Plan. This hazard happens frequently within California and all State-owned or -leased facilities and community lifelines could be impacted. Energy shortages would impact the entire population, including those identified as living in equity priority communities. The development of buildable lands would not increase the risk to this hazard. The frequency and severity of energy shortage events is anticipated to be increased due to the impacts from climate change.

27.1. HAZARD OVERVIEW

An energy shortage is any shortage or interruption in the supply of energy to end users. California's energy infrastructure is designed to cope with the State's highly variable conditions and frequent disruptions caused by wildfires, storms, and floods. Generally, power outages caused by these events are short-term and limited to regional impacts. Of more concern are system-wide outages or shortages caused by a major disruption in supply or transmission. The analysis of energy shortage for this SHMP focuses on disruptions to electrical power supply.

27.1.1. Types of Power Disruptions

Electric power disruptions can be generally grouped into two categories.

- Intentional disruptions:
  - **Planned—**Some intentional disruptions can be scheduled based maintenance or upgrading needs. PSPS events (see Chapter 24) are an example of planned outages.
  - **Unscheduled—**Some intentional disruptions must be done with little notice in response to an emergency.

    - **Demand-Side Management—**Some customers have entered into an agreement with their utility provider to curtail their demand for electricity during periods of peak system loads.
    - **Load Shedding—**When the power system is under extreme stress due to heavy demand or failure of critical components, it is sometimes necessary to intentionally interrupt the service to selected customers to prevent the entire system from collapsing. These intentional interruptions result in unplanned outages.

- Unplanned disruptions:
    - Accident by a utility, utility contractor, or others
    - Malfunction or equipment failure
    - Equipment overload (utility company or customer)
    - Reduced capability (equipment that cannot provide design capacity)
    - Tree contact
    - Vandalism or intentional damage
    - Weather taking down power lines
    - Wildfire that damages transmission lines

Unintentional or unplanned disruptions are outages that come with essentially no advance notice. This type of disruption is the most problematic.

27.1.2. Energy Sources

Electrical Generation

The following are the primary sources of electrical generation in California (CEC 2021):

- Most in-state electrical generation is derived from natural gas (50.2 percent).
- Hydro-generation provides 10.2 percent of California’s electric power.
- Coal, primarily from imports, makes up 3 percent of California’s electrical generation. About 97 percent comes from out-of-state power plants. Imports of coal-fired generation are expected to become zero by the end of 2025.
- Renewables comprise 34.8 percent of in-state electrical generation and the percentage is very similar (33.6 percent) when combined with imports. Renewable energy sources include:
    - Wind (7.8 percent)
    - Solar (17.1 percent)

- Geothermal (5.7 percent)
- Biomass (2.8 percent)
- Small hydroelectric (1.3 percent)

In-state electrical generation is 69.9 percent (194,128 gigawatt hours [GWh]) of the total (277,764GWh), with the remaining being provided through imports from the southwest and northwest.

Natural gas plays an important role in California. Nearly 45 percent of the natural gas burned in the State is used for electricity generation, and much of the remainder is consumed in the residential (21 percent), industrial (25 percent), and commercial (nine percent) sectors. California continues to depend on out-of-state imports for nearly 90 percent of its natural gas supply (CEC 2022b).

The California Energy Commission (CEC) provides full forecasts for electricity and natural gas demand every two years as part of the Integrated Energy Policy Report process. CEC uses detailed models for each economic sector (such as residential, commercial, industrial, and transportation) to project electricity consumption and demand for the full energy demand forecast (CEC 2022a).

Transportation Fuels

Transportation accounts for a major portion of California's energy budget. Gasoline is the most used transportation fuel in California, with 97 percent of all gasoline being consumed by light-duty cars, pickup trucks, and sport utility vehicles. In 2021, 13.8 billion gallons of gasoline were sold. Gasoline sold in California at retail is made up of 90 percent petroleum-based gasoline (as specified by CARB) and 10 percent ethanol (CEC 2022e).

Diesel fuel is the second largest transportation fuel used in California behind gasoline, representing 17 percent of total fuel sales. In 2015, 4.2 billion gallons of diesel, including off-road diesel, were sold (CEC 2022d).

27.1.3. California's Energy System

The energy system consists of three main parts (CEC n.d.-b):

- Energy extraction, transport, and conversion (such as combusting natural gas in power plants to generate electricity or producing gasoline and diesel from crude oil in refineries)

- Energy consumption for services (such as electricity for lighting, natural gas use in homes and buildings for space and water heating, and gasoline and diesel to fuel cars and trucks)
- Use of electricity from out-of-state plants serving California

Figure 27-1 shows the type and capacity of California power plants by county in operation as of 2021. Figure 27-2 shows the extent and complexity of California's electrical transmission system.

27.2. PREVIOUS HAZARD OCCURRENCES

27.2.1. Disaster and Emergency Declarations

Each year thousands of energy shortage events occur statewide. The following disaster declarations or emergency proclamations related to energy shortage have been issued for California (see Appendix F for details):

- Federal DR or EM declaration, 1953 – 2022: none
- California Emergency Proclamations, 1950 – 2022: one event, classified as energy emergency
- USDA agricultural disaster declarations, 2012 – 2022: none

27.2.2. Event History

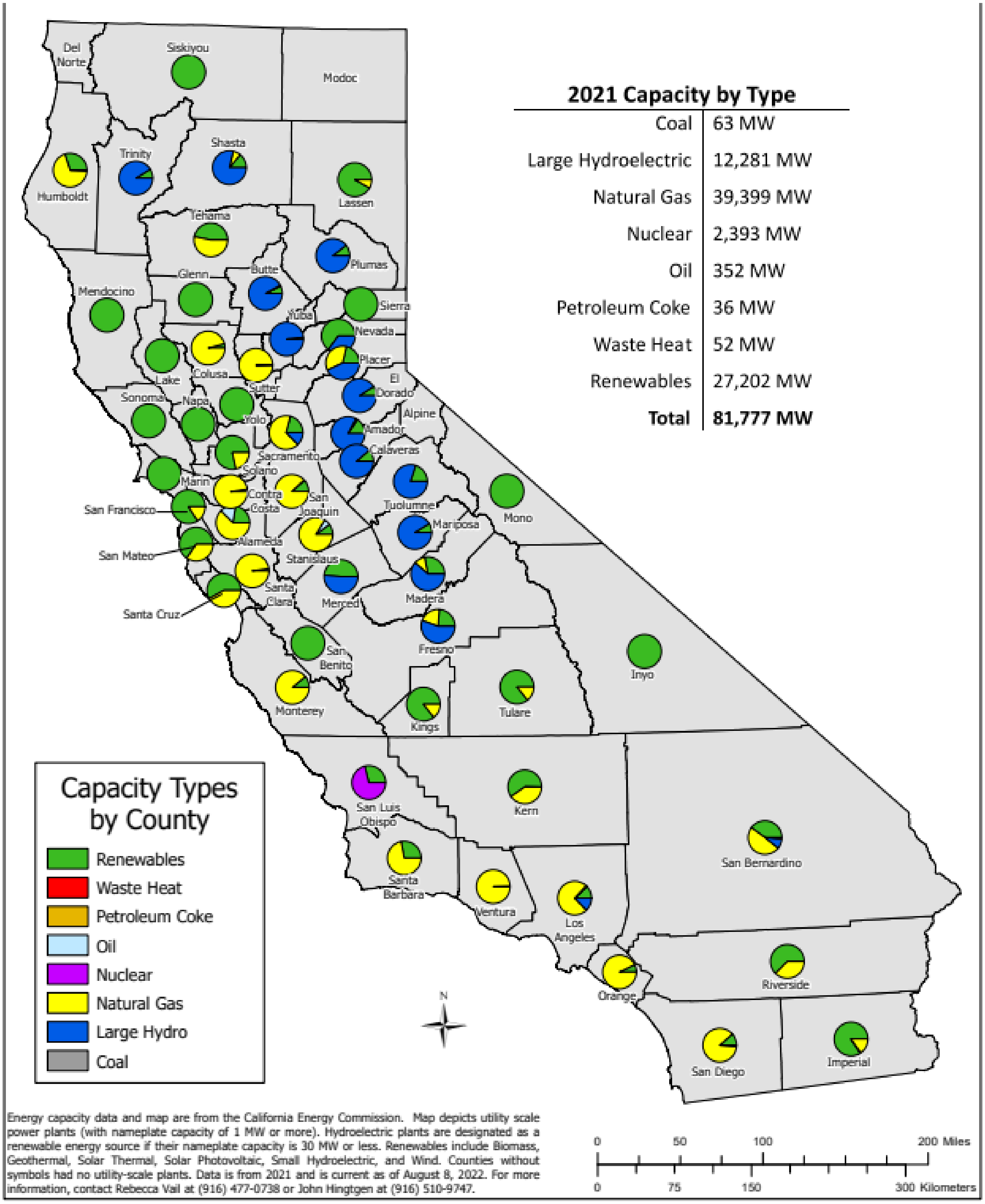
Table 27-1 summarizes energy shortage events statewide since 2018.

Table 27-1. Energy Shortage Events in the State of California (2018 to 2022)

Year of Event	Event Type	Number of Events
2018	Energy Shortage	20,598
2019	Energy Shortage	25,281
2020	Energy Shortage	22,940
2021	Energy Shortage	19,017
2022	Energy Shortage	7,246

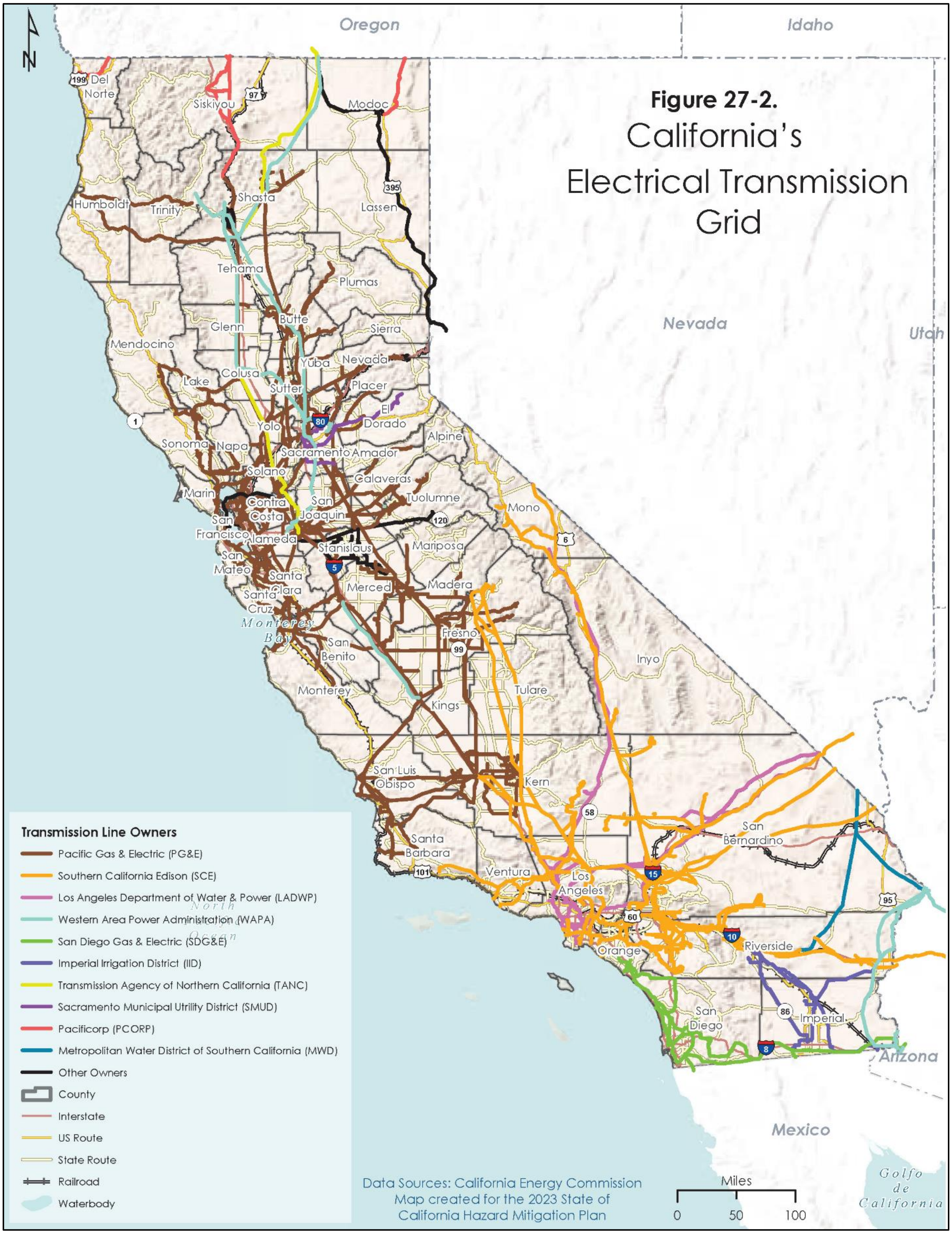
Source: (Bloom Energy 2022)

Figure 27-1. California's 2021 Operating Power Plant Capacity and Type, by County



Source: (CEC 2022f)

Figure 27-2. California's Electric Transmission Grid



27.3. PROBABILITY OF FUTURE HAZARD EVENTS

27.3.1. Overall Probability

According to power outage records from CPUC, the State experienced 95,082 energy shortage events between 2018 and 2022. Based on that history, California has a high probability of future energy shortages, with potential for over 19,000 events per year on average.

27.4. HAZARD LOCATION

The entire State is vulnerable to power disruptions and other energy shortages.

27.4.1. Climate Change Impacts

Climate change is expected to severely impact energy availability over time. Changes in temperatures, precipitation patterns, extreme events, and sea-level rise have the potential to decrease the efficiency of thermal power plants and substations, decrease the capacity of transmission lines, render hydropower less reliable, spur an increase in electricity demand, and put energy infrastructure at risk of flooding (CPUC 2022).

With rising temperatures, higher costs from increased demand for cooling in the summer are expected to outweigh the decreases in heating costs in the cooler seasons. Hotter temperatures in California will mean more energy is needed to cool homes and businesses during the daytime peak of the temperature cycle, during heat waves, and on a daily basis (Office of Governor 2022). The California Independent System Operator (CAISO) experienced record-breaking grid demand with forecasts exceeding 52,000 megawatts during the September 2022 heat wave. During future heat waves, historically cooler coastal cities are projected to experience greater relative increases in temperature, causing new demand for cooling mechanisms such as air conditioning.

27.5. IMPACT ANALYSIS

27.5.1. Severity

Unplanned outages during severe weather events can impact hundreds of thousands of Californians (Ronayne 2022).

27.5.2. Warning Time

Energy shortages can result in power outages at any time. Many utilities offer notification services through text or email, but the sign-up process for these notifications tends to be voluntary. CPUC requires electric utilities to report their specific plans for Community Resource Centers, critical facilities, PSPS exercises, education and outreach-related surveys and accessibility efforts, notifications, highest risk circuits, and identified lessons learned from the previous year.

CAISO is tasked with managing the power distribution grid that supplies most of California, except in areas served by municipal utilities. CAISO coordinates the statewide flow of electrical supply and issues alerts to the media based on system conditions (California ISO n.d.):

- **Flex Alerts**—A call to consumers to voluntarily conserve electricity when CAISO anticipates using nearly all available resources to meet demand. Reducing energy use during a Flex Alert can prevent more dire measures, such as moving into energy emergency alerts, emergency procedures, and even rotating power outages.
- **Restricted Maintenance Operations**—High loads are anticipated. CAISO participants are cautioned to avoid taking grid assets offline for routine maintenance to ensure that all generators and transmission lines are available.
- **Transmission Emergency**—Declared for any event threatening or limiting transmission grid capability, including line or transformer overloads or loss.
- **Energy Emergency Alert Watch**—Analysis shows all available resources are committed or forecasted to be in use, and energy deficiencies are expected. Market participants are encouraged to offer supplemental energy. This notice can be issued the day before a projected shortfall or if a sudden event occurs.
- **Energy Emergency Alert 1**—Real-time analysis shows all resources are in use or committed for use, and energy deficiencies are expected. Market participants

are encouraged to offer supplemental energy and ancillary service bids. Consumers are encouraged to conserve energy.

- **Energy Emergency Alert 2**— CAISO requests emergency energy from all resources and has activated its emergency demand response program. Consumers are urged to conserve energy to help preserve grid reliability.
- **Energy Emergency Alert 3**— CAISO is unable to meet minimum contingency reserve requirements and controlled power curtailments are imminent or in progress according to each utility's emergency plan. Maximum conservation by consumers requested.

27.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with energy shortages:

- Energy shortage events can have economic and health consequences for residents and businesses. Loss of power and access to air conditioning or heating can lead to health impacts. During periods of extreme temperature, vulnerable populations are susceptible to temperature-related illnesses such as hypothermia or heatstroke (EPA 2021).
- Food losses due to no refrigeration can lead to cascading effects on those who cannot afford to restock their food, food service/restaurant industry impacts (supply loss, spoilage, etc.), and disruption to lifelines and infrastructure. In 2019, an economist estimated that planned power outages by California power companies could cost the State up to $2.6 billion (CBS News 2019).

27.5.4. Environmental Impacts

As California seeks to strengthen its electrical infrastructure and pursue more sustainable energy avenues, this may have impacts on the natural environment. Higher demand for energy will result in more land being necessary for power facilities that could impact wildlife and open space. Solar developers require a minimum of 10 acres for a project, but at least 200 acres of land is necessary for a project of utility scale (YSG Solar 2021).

27.5.5. Local Hazard Impacts

One of the hazard mitigation plans prepared for California's 58 counties—the Lassen County hazard mitigation plan—lists energy shortage as a "hazard of interest". Hazards of interest are hazards that local communities consider to be important but for which a complete risk assessment is not performed due to the nature of the hazard.

27.6. VULNERABILITY ANALYSIS

27.6.1. Exposure of State-Owned or -Leased Facilities, Critical Facilities, and Community Lifelines

All State-owned or -leased assets, as listed in Table 4-1 and Table 4-2, are exposed to energy shortage. This includes 23,961 State-owned facilities, and 1,893 State-leased facilities. All 755 State critical facilities and community lifelines, as listed in Table 4-3, are exposed to this hazard as well.

27.6.2. Estimates of Loss

Energy shortage events are not likely to result in any losses associated with damage or impairment to State assets. All losses from this hazard would be associated with impacts on the economy, based on impaired operations due to power failure.

Nearly all State-owned or -leased facilities rely on electricity to operate and provide essential services. Energy shortages can disrupt communications, water and wastewater treatment facilities, transportation systems, and other government functions. They can cause a reduction in employment and wholesale and retail sales, a need for utility repairs, and increased medical risks. Local governments might lose tax revenues, and the finances of private utility companies and the businesses that rely on them would be disrupted.

27.6.3. Buildable Land

An estimated 11.7 million acres of land is available for development in California. Because the entire State is vulnerable to energy shortage, any type of development of any of this land will be susceptible to damage and impacts from this hazard.

27.6.4. Equity Priority Communities

Energy shortages are especially hard on vulnerable populations, specifically those who rely on medical equipment or drugs, older adults, and low-income communities. For example, those who rely on electric power for life-sustaining medical equipment, such as breathing machines, are adversely affected by power outages. Also, during periods of extreme temperature emergencies, people with chronic conditions, older adults, and the very young are more vulnerable to the loss of temperature-regulating systems requiring power sources (air conditioners, heaters, etc.).

A study was conducted among 440 Californians experiencing planned power shutoffs or receiving alert notifications on power shutoffs from September 2019 to October 2020. The survey asked participants to assess their ability to purchase emergency items, concerns about health, and social connections that can be used during planned power shutoffs (Ham and Lee 2022). Based on these criteria, the survey identified 90 participants (21 percent) as socially vulnerable (Ham and Lee 2022).

Results indicated that equity priority communities experience hardships such as food spoilage more often than others during power shutoffs. There are statistically significant differences in the attitudes of those living in equity priority communities toward utility companies, the need for backup generators, and losses due to power shutoffs, compared to other groups (Ham and Lee 2022). These findings suggest that additional targeted interventions are required for equity priority communities to enhance their ability to cope with planned power shutoffs (Ham and Lee 2022).

The entire population of the State is exposed and vulnerable to energy shortages. The population exposed to the hazard in equity priority communities is equal to the statewide percentage: 30.4 percent of the total population (12 million people).

27.7. MITIGATING THE HAZARD

27.7.1. Opportunities for Mitigating the Hazard

From maintaining a stable and efficient electric power system to installing and using alternative power sources (e.g., solar, wind), there are different mitigation measures that can reduce or eliminate the impacts from energy shortages. Table 27-2 provides a range of potential alternatives for mitigating the energy shortage hazard. See Section 1.2.3 for a description of the different types of alternatives.

Table 27-2. Potential Opportunities to Mitigate the Energy Shortage Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ None **Reduce exposure and vulnerability:** ▪ Have backup generators and fuel sources **Build local capacity:** ▪ None	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Install energy storage systems ▪ Retrofit electric power infrastructure with disaster-resilient techniques ▪ Reduce energy load to buildings **Build local capacity:** ▪ Develop a comprehensive plan that outlines what to do in the event of a shortage or outage	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** Identify specific at-risk populations that may be exceptionally vulnerable in the event of long-term power outages ▪ Install energy storage systems at critical facilities ▪ Retrofit electric power infrastructure with disaster-resilient techniques ▪ Microgrids ▪ Reduce energy load to State buildings/assets **Build local capacity:** ▪ Develop a comprehensive plan that outlines what to do in the event of a shortage or outage
Nature-based opportunities ▪ Expand the use of sustainable energy sources such as wind and solar		

27.7.2. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address energy shortage:

- Action 2018-082: Existing Buildings Energy Efficiency Action Plan: Double the energy efficiency savings of existing buildings by 2030.
- Action 2018-002: Strengthen Inter-agency Coordination Actions Including State, Regional, and Local Linkages.
- Action 2018-003: Broaden Public and Private Sector Mitigation Linkages.

CYBER THREATS

Climate Impacts:
Potential impacts on frequency and severity of hazard events
Equity Impacts:
30.4% of exposed population (all persons in the State are exposed) identified as living in equity priority communities
State Facilities Exposed:
All facilities exposed
Community Lifelines Exposed:
All lifelines exposed

Impact Rating: Medium (21)

28. Cyber Threats

Cyber threat has been identified as medium-impact under the hazard impact rating protocol applied for this Plan. This hazard happens frequently in the State. Only State-owned or -leased facilities and community lifelines that rely on computer systems for day-to-day operations are considered to be exposed. At least half of the State's population is exposed to cyber threats because they have access to devices (cell phones, automobiles, computers, or any other device that uses a Wi-Fi connection) that could be accessed by hackers. While equity priory communities may not have the same access to these devices as the general population, it is estimated that the impacts of cyber threats on these communities would be high based on their reliance on support services that use devices that could be targets. The development of buildable lands would not increase the risk to this hazard or the frequency. Severity of cyber threats may increase due to impacts from climate change.

28.1. HAZARD OVERVIEW

Cyber threats are attempts by cyber criminals to attack a government, organization, or private party by damaging or disrupting a computer or computer network, or by stealing data from a computer or computer network for malicious use. Such threats can lead to numerous impacts:

- Loss or theft of computer resources
- Inappropriate access to and disclosure of personal and secure information
- Delay of essential services
- Repair or rebuilding of complete systems
- Damage to networks
- High cost of remediation impacting operational technology for industrial control systems

- Disruption of essential operations supporting critical infrastructure needed for emergency management

As the use of digital integration into society and infrastructure expands, Californians will become more vulnerable to the potential technological hazard from cyber event impacts. Cyber threats to critical infrastructure can be posed by anyone with the capability, technology, opportunity, and intent to do harm. Potential threats can be foreign or domestic, internal or external, state-sponsored or a single rogue individual. Terrorists, insiders, disgruntled employees, and hackers are included in this profile.

The Greatest Threat

A recent survey by the United States Government Accountability Office found that "agencies having high-impact systems identified cyber-attacks from 'nation-states' as the most serious and most frequently occurring threat to the security of their systems." The Government Accountability Office continually publishes new reporting as part of its Cybersecurity Reports series.

Source: (GAO 2017)

28.2. HAZARD LOCATION

Many systems rely on computers for day-to-day operations, including heating, ventilation and air conditioning systems, traffic signals, power plants, and all the systems the State of California depends on to operate the government. Therefore, cyber threats can occur anywhere in the State.

28.3. PREVIOUS HAZARD OCCURRENCES

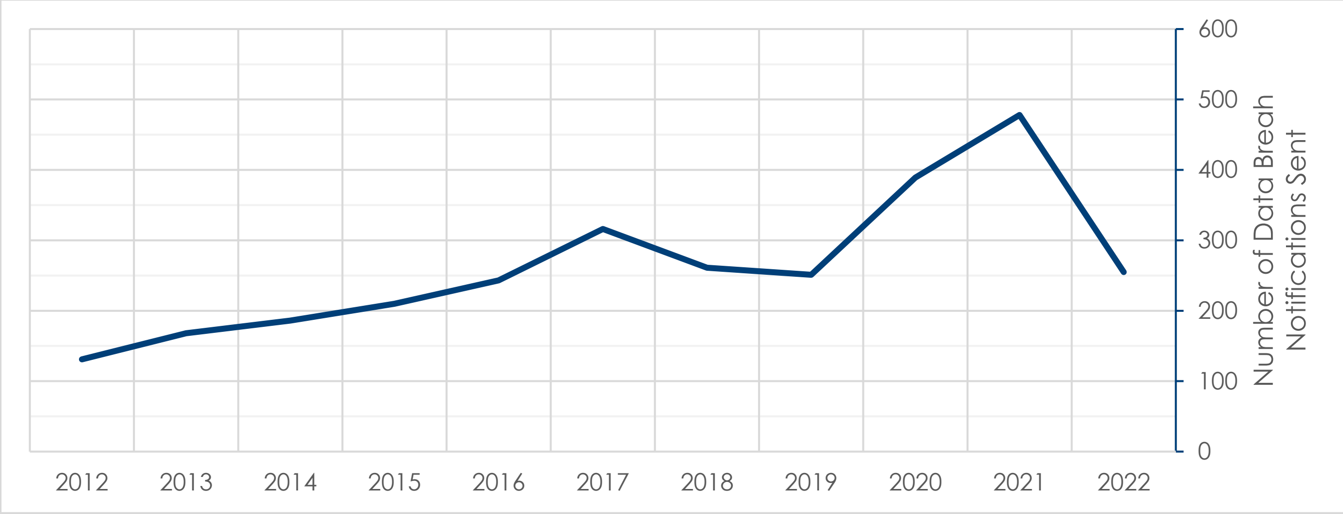
28.3.1. Disaster and Emergency Declarations

No FEMA, USDA, or State disaster declarations or proclamations related to cyber threats have been issued relevant to California or any of its counties.

28.3.2. Event History

California law requires a business or State agency to notify any California resident whose unencrypted personal information was acquired or is reasonably believed to have been acquired by an unauthorized person (California Civil Code Sections 1798.29(a) and1798.82(a)). The law also requires that a copy of any breach notice sent to more than 500 California residents be provided to the California Attorney General (Office of the California Attorney General 2022). As shown in Figure 28-1, the California Attorney General sent out notices notifying individuals of nearly 2,900 data breaches between 2012 and July 2022 (Office of the California Attorney General 2022).

Figure 28-1. Cyber Threat/Data Breach Events in the State of California (2012 to 2022)



Note: 2022 data is for first seven months only.

Source: (Office of the California Attorney General 2022)

28.4. PROBABILITY OF FUTURE HAZARD EVENTS

28.4.1. Overall Probability

Cyber threats are an emerging hazard that has the potential to impact the State's computer infrastructure and the systems and services provided to the general public. Concerns about cyber threats are growing throughout California and the United States, and their impacts could have crippling effects. Considering that California Attorney General sent out notices notifying individuals of nearly 2,900 data breaches between 2012 and July 2022, it is reasonable to expect a nearly 100 percent chance of ongoing occurrences in any given year.

28.4.2. Climate Change Impacts

Climate change may impact the frequency or severity of cyber-attacks as valuable resources become scarcer. The increased use of computing resources due to a surge in remote work, blockchain mining, and supercomputing also contributes to climate change. People who no longer trust financial institutions due to prominent hacks and leaks are shopping and trading online or putting their money in cryptocurrencies. (Brode 2022).

An indirect impact of climate change on cyber threats could be politically based. Eco-terrorist hackers might target companies or agencies with whose policies or practices they do not agree.

28.5. IMPACT ANALYSIS

28.5.1. Severity

Cyber threats can vary in their severity, based on the systems affected by an attack, the warning time, and the ability to preempt an attack (CISA 2020). In 2016, the White House released a schema describing the extent of cybersecurity threats. The schema defines six levels of cyber incidents—from zero through five—as shown in Figure 28-2. Each level describes the incident's potential to affect public health or safety, national security, economic security, foreign relations, civil liberties, or public confidence. An incident that ranks at a Level 3 or above is considered "significant" (The White House 2016).

Costs associated with cyber-attacks have varied widely across industries and year over year. Healthcare data breach costs increased from an average of $7.13 million in 2020 to $9.23 million in 2021, a 29.5 percent increase. Costs in the energy sector decreased from $6.39 million in 2020 to $4.65 million in 2021. Costs surged in the public sector, which saw a 78.7 percent increase in cost, from $1.08 million to $1.93 million (IBM 2021).

Figure 28-2. Cybersecurity Threat Levels

	General Definition
Level 5 *Emergency* (Black)	*Poses an imminent* threat to the provision of wide-scale critical infrastructure services, national gov't stability, or to the lives of U.S. persons.
Level 4 *Severe* (Red)	*Likely to result in a significant* impact to public health or safety, national security, economic security, foreign relations, or civil liberties.
Level 3 *High* (Orange)	*Likely to result in a demonstrable* impact to public health or safety, national security, economic security, foreign relations, civil liberties, or public confidence.
Level 2 *Medium* (Yellow)	*May impact* public health or safety, national security, economic security, foreign relations, civil liberties, or public confidence.
Level 1 *Low* (Green)	*Unlikely to impact* public health or safety, national security, economic security, foreign relations, civil liberties, or public confidence.
Level 0 *Baseline* (White)	Unsubstantiated or inconsequential event.

Source: (DHS 2016)

28.5.2. Warning Time

The severity and timing of cyber threats are impossible to predict. There may be no warning. Some cyber incidents take weeks, months, or even years to be discovered and identified (FEMA 2021a).

28.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. Computer system failures have the potential to result in cascading hazards such as energy outages, hazardous materials release, oil spills, transportation accidents, or dam failure.

Modern critical infrastructure such as a water treatment plant, water distribution system, or power grid is representative of cyber/physical systems in which the physical processes are monitored and controlled in real time. One source of complexity in such systems is the set of intra-system interactions and inter-dependencies. Consequently, these systems are a potential target for attackers. When one or more of these infrastructure facilities are attacked, the connected systems may also be affected due to potential cascading effects.

28.5.4. Environmental Impacts

Cyber threats generally do not have direct impacts on the environment; however, the environment can be affected if a hazardous materials release occurred due to infrastructure failure as a result of a cyber breach. Wastewater treatment facilities are vulnerable to cyber-attacks that could cause releases of raw sewage or inadequately treated effluent (AXAXL Insurance n.d.). Oil and gas pipelines are also vulnerable to cyber-attack based on their use of remotely operated systems to control operations and perform leak detections. Attacks on these systems could result in loss of functionality, resulting in catastrophic leaks and the subsequent destruction of surrounding ecosystems (AXAXL Insurance n.d.).

28.5.5. Local Hazard Impacts

Seven of the hazard mitigation plans prepared for California’s 58 counties list the cyber threat as a “hazard of interest.” Hazards of interest are hazards that local communities consider to be important but for which a complete risk assessment is not performed due to the nature of the hazard. The following counties listed cyber threats (using different wording) as a hazard of interest:

- Contra Costa—Cybersecurity Issues
- Lassen—Cyber Threat
- Merced—Cyber Attack
- Monterey—Cyber Attack
- Santa Barbara—Cyber Attack
- Sonoma—Cyber Attack
- Stanislaus— Cyber Attack

28.6. VULNERABILITY ANALYSIS

28.6.1. Exposure of State-Owned or -Leased Facilities, Critical Facilities, and Community Lifelines

All State-owned or -leased facilities are vulnerable to cyber threats. While the physical structures of the buildings are typically not at risk, information systems and data storage within those buildings are vulnerable. State computer networks may contain sensitive information and data, making them targets for cyber-attacks. Many assets are also essential to daily operations with computer networks to monitor and control functions throughout the State. A large-scale cyber incident could lead to significant economic losses to impacted State departments and agencies, businesses, and other industries.

All State-owned or -leased assets, as listed in Table 4-1 and Table 4-2, are exposed to cyber threat. This includes 23,961 State-owned facilities, and 1,893 State-leased facilities. All 755 State critical facilities and community lifelines, as listed in Table 4-3, are vulnerable; interruption of services may impact facilities that need to be in operation in response to a cyber-attack.

28.6.2. Estimates of Loss

Cyber-attacks are not likely to result in any losses associated with damage or impairment to State assets. All losses from this hazard would be associated with impacts on the economy, based on impaired operations due to affected information technology infrastructure.

28.6.3. Buildable Land

An estimated 11.7 million acres of land is available for development in California. Because the entire State is vulnerable to cyber threats, any type of development of any of this land will be susceptible to damage and impacts from this hazard.

28.6.4. Equity Priority Communities

Because the majority of the population of the State of California is considered to be exposed and vulnerable to cyber threats, the exposed population in equity priority communities is equal to the statewide percentage: 30.4 percent of the total population (12 million people). While equity priority communities may not have access to devices vulnerable to cyber threats, these communities likely rely heavily on agencies and programs that do, which could worsen the impacts of cyber events on these communities.

Cyber-attacks typically affect organizations but can also be aimed at individuals. Exposure of personal information can result in individuals facing economic hardship from fraud, putting people at risk of poverty. Smaller businesses face greater impacts from cyber-attacks, as they have fewer resources to recover from a loss of functionality. The population most vulnerable to cyber-attacks are adults over 75 and younger adults, who may be newer users to digital channels (Gaskell 2021).

28.7. MITIGATING THE HAZARD

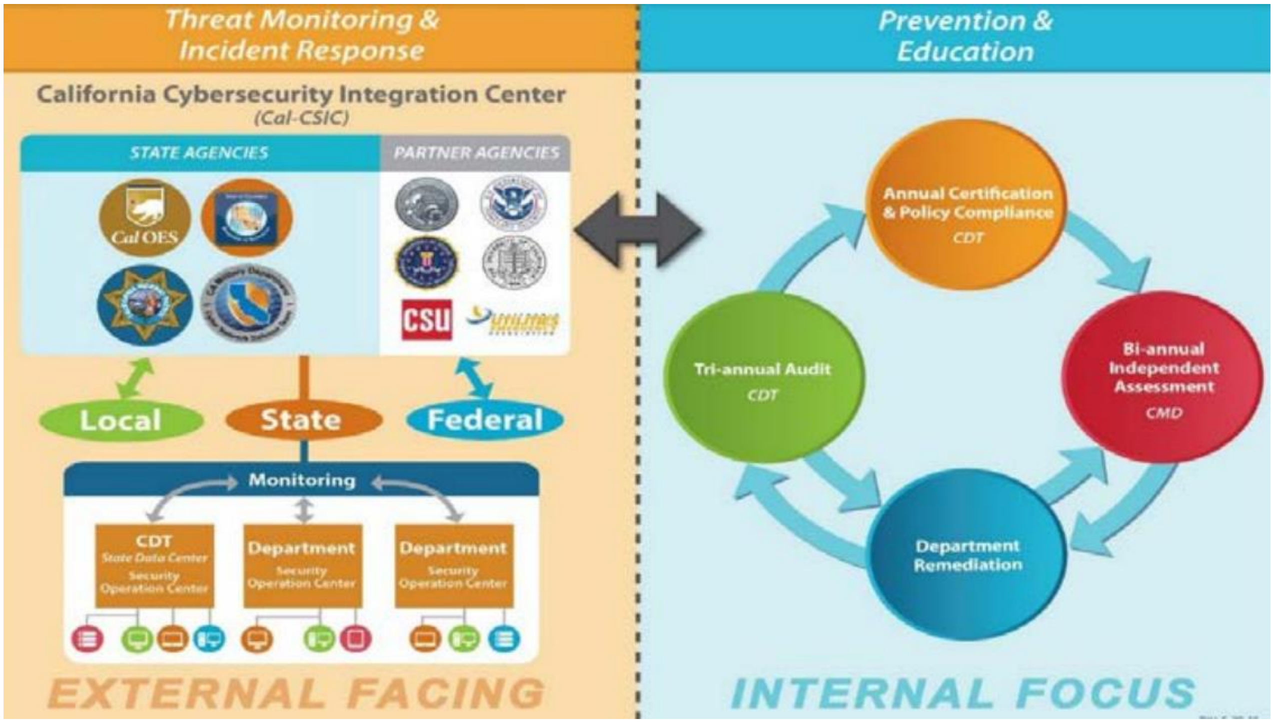
28.7.1. Existing Measures for Mitigating the Hazard

The fact that most of the nation's vital services are delivered by private companies creates a significant challenge in assigning responsibility for protecting critical assets from cyber-attacks. Still, the State can act to reduce the severity of cyber-attacks. The State of California pursues a unified multi-department and partnering effort in addressing cyber threats. Many departments participate in four areas of activities:

- Threat monitoring
- Incidence response
- Prevention
- Education

The major cyber security efforts are conducted by the California Department of Technology (CDT), the California Governor's Office of Emergency Services (Cal OES), the California Military Department (CMD), and the California Highway Patrol (CHP). Efforts are grouped into external facing or internal focus, as shown in Figure 28-3. The external-facing actions are coordinated through the work of the California Cybersecurity Integration Center, which is housed within Cal OES.

Figure 28-3. California Cybersecurity Defense



Source: (CDT 2017)

California Cybersecurity Integration Center

The mission of the California Cybersecurity Integration Center (Cal-CSIC) is to reduce the number of cyber threats and attacks in California. The focus is to respond to cyber threats and attacks that could damage the economy, its critical infrastructure, or computer networks in the State. The Cal-CSIC is the hub of State government's cybersecurity events. The Cal-CSIC coordinates information sharing at all levels of government agencies, utilities and other service providers, academic institutions, and non-governmental organizations (NGOs).

CAL-SECURE

Cal-Secure is a multi-year cybersecurity roadmap for California. Designed to be flexible and innovative, Cal-Secure enables the State to manage existing and future threats more effectively. Cal-Secure defines a path for State entities to strengthen their cybersecurity measures so that they may continue to provide critical services without interruption. The roadmap was created through a collaborative process among Cal-CSIC, its critical partners (Cal OES, CHP, CDT, and CMD), and the State government security community. The roadmap outlines capabilities the State must adopt and achieve in a prioritized fashion. The end goal is to ensure that California's Executive branch has a world-class cybersecurity workforce, an empowered and right-sized federated cybersecurity oversight governance structure, and effective cybersecurity defenses for all technology, including critical infrastructure.

28.7.2. Opportunities for Mitigating the Hazard

In addition to the mitigation measures conducted by the State, there are additional potential opportunities for mitigating the cyber threat hazard, as shown in Table 28-1. See Section 1.2.3 for a description of the different types of alternatives.

28.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address the cyber threat hazard:

- Action 2018-105: Annual Vulnerability Assessments.
- Action 2018-106: Security Audit Program: Measure the effectiveness of security policies and guidelines.
- Action 2018-108: Cal-CSIC & Task Force: Reduce the likelihood and severity of cyber incidents that could damage the economy, critical infrastructure, or public and private sector computer networks, through State agency coordination.
- Action 2018-109: Protecting Critical Power Grid Infrastructure: Protect power grid integration from cyber threats.

Table 28-1. Potential Opportunities to Mitigate the Cyber Threat Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ None **Reduce exposure and vulnerability:** ▪ Apply all available software updates and upgrade accordingly **Build local capacity:** ▪ None	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Apply all available software updates and upgrade accordingly ▪ Assign privileges based on risk exposure and as required to maintain operations. ▪ Develop system recovery plans ▪ Enforce signed software execution policies ▪ Detect, contain, and remove any malicious presence within the network ▪ Segregate critical networks and services ▪ Prioritize protection for accounts with elevated privileges or remote access and those used on high value assets **Build local capacity:** ▪ Actively manage systems and configurations ▪ Use hardware security features such as unified extensible firmware interface secure boot, trusted platform module, and hardware virtualization ▪ Leverage multi-sourced threat reputation services for files, DNS, URLs, IPs, and email addresses	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Apply all available software updates and upgrade accordingly ▪ Assign privileges based on risk exposure and as required to maintain operations. ▪ Develop system recover plans ▪ Enforce signed software execution policies ▪ Detect, contain, and remove any malicious presence within the network ▪ Segregate critical networks and services ▪ Prioritize protection for accounts with elevated privileges or remote access and those used on high value assets **Build local capacity:** ▪ Actively manage systems and configurations ▪ Use hardware security features such as unified extensible firmware interface secure boot, trusted platform module, and hardware virtualization ▪ Leverage multi-sourced threat reputation services for files, DNS, URLs, IPs, and email addresses ▪ Leverage the capabilities of the State Threat Assessment Center and other Fusion Centers
Nature-based opportunities ▪ There are no identified nature-based solutions to mitigate the impacts from cyber threats.		

Tree Mortality

Climate Impacts:
Potential to increase the rate of tree mortality by increasing number of droughts and insect populations

Equity Impacts:
30.4% of exposed population (all persons in the State are exposed, especially those living in and near forested areas) identified as living in equity priority communities

State Facilities Exposed:
Approximately 14% of State-owned or -leased facilities potentially exposed; especially those located in and near forested areas

Community Lifelines Exposed:
All community lifelines exposed; especially those located in and near forested areas

Impact Rating: Medium (18)

29. TREE MORTALITY

Tree mortality has been identified as medium-impact under the hazard impact rating protocol applied for this plan. This hazard occurs frequently in California. It has been estimated that less than 14 percent of State-owned or -leased facilities and community lifelines are exposed to the tree mortality hazard. It has also been estimated that more than 30 percent of the total population could be considered exposed to this hazard and that same range would apply to equity priority communities. The development of buildable lands is not anticipated to increase the risk to this hazard. The frequency and severity of tree mortality is anticipated to be increased due to the impacts from climate change over the next 30 years.

29.1. HAZARD OVERVIEW

Tree mortality refers to the death of forest trees and provides a measure of forest health. Forest health is important because trees remove CO_2 from the atmosphere and store a significant amount of the Earth's carbon. High levels of tree mortality can indicate widespread insect or disease impacts or stress from regional weather events such as drought (USFS 2021a). The U.S. Forest Service conducts annual aerial surveys of California's forests to identity tree mortality.

Drought impacts tree health by limiting the water supply. Trees require water to enter their system through vast root networks. The amount of water entering the tree must equal the tree's need for water for respiration and evapotranspiration (the sum of evaporation and transpiration). When droughts limit the water supply, there is more water leaving the tree than entering the tree, and the tree is at risk of dying (Choat, et al. 2018).

Insects and diseases can travel rapidly in forests and pose a serious risk of tree mortality. Drought weakens trees, making them more susceptible to these threats. The most destructive cause of tree death is bark beetle infestation, which has killed over

102 million trees in California (CAL FIRE 2019). Other common causes of tree mortality are western, mountain, and Jeffrey pine beetles; flatheaded fir and goldspotted oak borers; and sudden oak death. These insects and disease killed over 32 million trees in California in 2022 (USFS 2023). Invasive insect species are discussed further in Chapter 30.

29.2. HAZARD LOCATION

California has 33 million acres of forested land, accounting for nearly one-third of the State's total land area (see Figure 29-1) (USDA n.d.-c). The State's pattern of tree mortality corresponds with changing climate trends that are linked to dry and hot conditions (OEHHA 2019a).

Tree mortality is particularly dramatic on the west side of the southern Sierra Nevada range and in parts of the Transverse range. Central and northern areas showed an increase in mortality as well (USFS 2021). A majority of the mortality is attributed to the effects of drought and impacts of the bark and engraver beetles.

29.3. PREVIOUS HAZARD OCCURRENCES

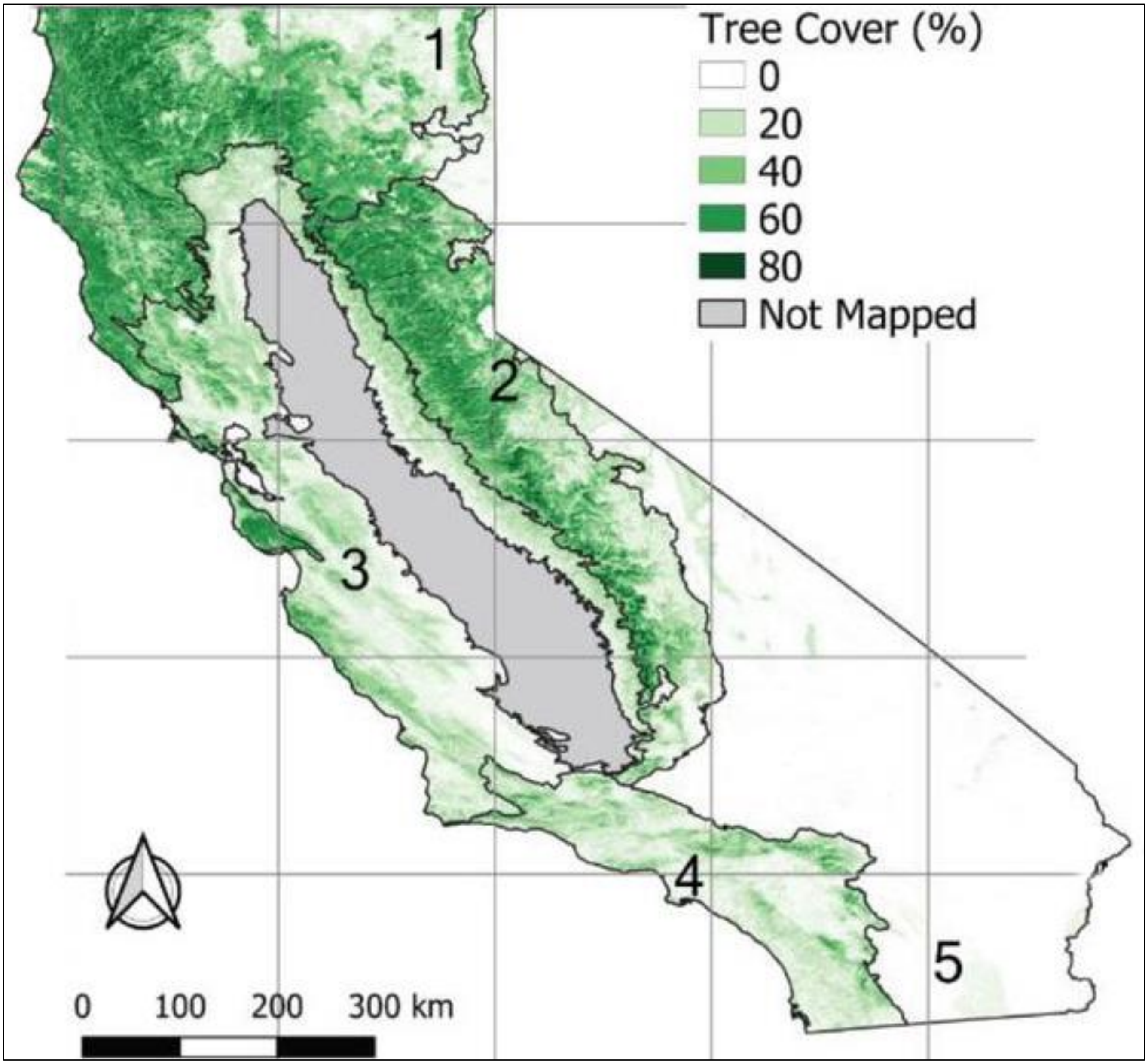
29.3.1. Disaster and Emergency Declarations

No FEMA, USDA, or State disaster declarations or proclamations related to tree mortality have been issued relevant to California or any of its counties.

29.3.2. Event History

Between 2012 and 2017, 129 million trees died in California. Between 2018 and 2021, an estimated 42.6 million trees died in an area of 5.46 million acres (see Table 29-1).

Figure 29-1. Forest Cover in California



Source: (Wang, et al. 2022)

Table 29-1. Tree Mortality in the State of California, 2018 to 2021

Year	Acres Surveyed	Acres of Morality	Number of Dead Trees (estimated)
2018	37 million	2 million	18 million
2019	41 million	2.2 million	15.1 million
2020	No survey conducted due to the Coronavirus Disease 2019 (COVID-19) pandemic		
2021	38 million	1.26 million	9.5 million

Source: (USFS 2022)

29.4. PROBABILITY OF FUTURE HAZARD EVENTS

29.4.1. Overall Probability

Tree mortality will continue to occur and impact the State on a continuous basis. Drought, insects, wildfires, and other stressors have increased and will continue to increase the rate of tree mortality across the State.

29.4.2. Climate Change Impacts

Climate change is projected to result in increased frequency and severity of drought and wildfire events. In addition, changes in seasonal patterns for temperature and precipitation can allow pest populations, such as bark beetles, to increase with limited population reductions in the winter (Cal OES 2018a).

29.5. IMPACT ANALYSIS

29.5.1. Severity

California has been experiencing its worst epidemic of tree mortality in recent history. Years of drought, combined with increased infestation of bark beetles, have contributed to the death of millions of trees across the State (CAL FIRE 2018). In 2020, elevated levels of tree mortality were recorded on 1.3 million acres. This totaled an estimated 9.5 million acres of dead trees.

29.5.2. Warning Time

The U.S. Forest Service conducts aerial surveys to provide annual estimates of tree mortality and damage in California. The purpose of the survey is to create maps of areas containing current year conifer and hardwood mortality, defoliation, and other damage. The number of trees and acres with damage are calculated for areas surveyed and reported each year. This monitoring helps the State understand how many trees are dying and where they are dying (USFS 2022).

29.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with tree mortality:

- Tree mortality contributes to increased wildfire risk as it creates fuel.
- It also causes an increase threat to power outages from dead trees falling onto power lines (OEHHA 2019a).
- Differences in tree mortality between species result in changes in forest composition.

29.5.4. Environmental Impacts

An increase in the number of trees dying will increase impacts on air and water quality, increase the risk of flooding, fire, and erosion, and destroy natural habitats.

29.5.5. Local Hazard Impacts

In reviewing the 58 county hazard mitigation plans, none identified tree mortality as a hazard of interest.

29.6. VULNERABILITY ANALYSIS

29.6.1. Exposure of State-Owned or -Leased Facilities, Critical Facilities, and Community Lifelines

Tree mortality generally affects heavily forested areas, where it is likely that few State-owned or -leased facilities are directly exposed (estimated to be less than 14 percent of all State-owned or -leased facilities, critical facilities, and community lifelines). Critical facilities such as roads are more likely to be exposed. Any facilities in and near forested areas may have an increased risk to structural damage due to downed trees. They can also experience power outages as dead trees fall on power lines.

29.6.2. Estimates of Loss

Tree mortality is not likely to result in any losses associated with damage to State assets. All losses from this hazard would be associated with impacts on the economy, based on lost timber revenue, firefighting costs, and limitations on activities in forest areas.

29.6.3. Buildable Land

An estimated 11.7 million acres of land is available for development in California. Any development of areas experiencing higher rates of tree mortality will be susceptible to damage and impacts from such events.

29.6.4. Equity Priority Communities

The entire population of the State of California is equally exposed to tree mortality, so the exposed population in equity priority communities is equal to the statewide percentage: 30.4 percent of the total population (12 million people).

29.7. MITIGATING THE HAZARD

29.7.1. Existing Measures to Mitigate the Hazard

The U.S. Forest Service has prioritized treatments for tree mortality in the hardest hit forests in the southern and central Sierra Nevada—the Sequoia, Sierra, Stanislaus, Tahoe and Eldorado national forests and the Lake Tahoe Basin Management Unit. Each forest is working with its communities and with other federal, State, and local agencies to plan and implement hazard tree mitigation projects. As of October 2018, treatment had been applied to 638,000 hazard trees and nearly 66,000 acres along 1,136 miles of roads and 126 miles of power lines, in 363 recreation sites, and around 163 communities.

29.7.2. Opportunities for Mitigating the Hazard

Table 29-2 provides a range of potential opportunities for mitigating the tree mortality hazard. See Section 1.2.3 for a description of the different types of alternatives.

Table 29-2. Potential Opportunities to Mitigate the Tree Mortality Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ None **Reduce exposure and vulnerability:** ▪ Creating defensible space to improve a home's chance of surviving a wildfire ▪ Plan evacuation routes in the event of an evacuation ▪ Individual treatments such as preventive spraying with insecticides, the use of synthetic products that repel bark beetles, supplemental watering, and prompt removal/disposal of infested trees ▪ Plan evacuation routes in the event of an evacuation **Build local capacity:** ▪ None	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Create defensible space around buildings to improve chance of surviving a wildfire ▪ Determine evacuation routes and inform staff of procedures if an evacuation is needed ▪ Individual treatments such as preventive spraying with insecticides, the use of synthetic products that repel bark beetles, supplemental watering, and prompt removal/disposal of infested trees ▪ Determine evacuation routes and inform staff of procedures if an evacuation is needed **Build local capacity:** ▪ None	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Identify areas that represent high-hazard zones for wildfire and falling trees ▪ Re-assess areas for new hazards as tree mortality continues ▪ Reduce tree density and restore resilience against forest pests and wildfires ▪ Remove dead or dying trees in high-hazard areas that threaten power lines, roads, evacuation routes, and critical infrastructure ▪ Clear hazard trees that threaten State, county, and local highways, and roads ▪ Purchase equipment – large volume masticators, chippers, and portable sawmills to help with tree removal **Build local capacity:** ▪ Compile a toolbox of tools and resources for State and county landowners and managers to assist in managing affected areas and support decision-making on the best course forward
Nature-based opportunities ▪ There are no identified nature-based solutions to mitigate the impacts of tree mortality.		

29.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address tree mortality:

- Action 2018-001: Support Legislative Efforts that Formalize California's Comprehensive Mitigation Program.
- Action 2018-003: Broaden Public and Private Sector Mitigation Linkages.
- Action 2018-006: Enhance Collaboration on the Development and Sharing of Data Systems and GIS Modeling.
- Action 2018-008: Develop a database containing a description of the specific natural hazard event for which each project was designed to mitigate.

Invasive and Nuisance Species

Climate Impacts:
Likely to alter the number and types of species
Equity Impacts:
30.4% of exposed population (all persons in the State are exposed) identified as living in equity priority communities
State Facilities Exposed:
All facilities exposed but not directly affected
Community Lifelines Exposed:
All lifelines exposed but not directly affected

Impact Rating: Medium (18)

30. Invasive and Nuisance Species

The invasive and nuisance species hazard has been identified as medium-impact under the hazard impact rating protocol applied for this Plan. These events happen frequently, impacting ecosystems within the State. They typically do not impact or cause damage to State-owned or -leased facilities and community lifelines. The impacts of this hazard on the general population and equity priority communities are considered to be low, even though the entire population could be considered to be exposed to this hazard. The development of buildable land could remediate the risk to this hazard, so there would be no expansion of risk by new development. The frequency and severity of invasive and nuisance species events is anticipated to increase over the next 30 years due to the impacts from climate change.

30.1. HAZARD OVERVIEW

Invasive and nuisance species are organisms that cause economic or environmental harm. A non-indigenous species is considered an invasive species when it becomes established in a new location, causing impacts. Invasive species may be introduced intentionally or unintentionally as a result of human activity. Once introduced, they can become a permanent part of an ecosystem, creating environmental imbalances, presenting risks to human health, and causing significant economic problems.

Under certain conditions, species that are native to an area or that are found worldwide may become a nuisance. Native species and cosmopolitan species (those found worldwide) may be classified as nuisance species when they become out of balance. Invasive and nuisance species vary widely, and their impacts can range from clogging water pipes to killing wildlife, from harming crops and forests to posing a human health hazard (Invasive Species Council of California 2022).

30.1.1. Agricultural and Silvicultural Pests

California agriculture (crop cultivation) and silviculture (tree cultivation) are at risk from invasive pests and diseases that can cause economic, environmental, or physical harm. Infestation generally involves the artificial introduction of an insect, disease, vertebrate, or weed pest. These pests are particularly destructive because they have no natural enemies to keep them under control. The type and severity of an infestation will vary based on many factors, including weather, crop diversity, tree health, and proximity to urban areas (USFS n.d.). Table 30-1 lists many of the most notable invasive and nuisance pests and diseases in the State.

Agriculture pests and diseases can result in economic and human health disasters. For example, insect pest hazards can have a major economic impact on farmers, farm workers, packers, and shippers of agricultural products (Warnert 2019). In addition, insect pests and diseases such as bark beetles, sudden oak death, and pitch canker in trees can destroy large expanses of forest and woodland, increasing the fuel load and contributing to greater fire risk (CAL FIRE 2019).

Notable invasive and nuisance species are discussed in further detail in the following sections.

Asian Citrus Psyllid

The Asian citrus psyllid is a pest that acts as a carrier or vector spreading Huanglongbing, a devastating disease of citrus trees. This bacterial disease is transmitted to healthy trees by the psyllid after it feeds on infected plant tissue.

The Asian citrus psyllid damages citrus by withdrawing large amounts of sap from the plant and producing large amounts of honeydew. The honeydew coats the leaves of the tree, causing sooty mold to grow. However, the most serious damage caused by the Asian citrus psyllid is the introduction of a harmful bacterium that causes Huanglongbing. This disease renders the fruit of the infected tree unusable. It was identified in California in 2012 (CDFA 2022a).

Shot Hole Borer Beetles

The polyphagous shot hole borer was introduced to Southern California from Vietnam and the Kuroshio shot hole borer from Taiwan. The known host range includes nearly 60 California trees and plants.

Table 30-1. Invasive and Nuisance Pests and Diseases of Concern in California

Dangerous to	Pests and Diseases	
Crops and other plants	▪ Argentine Ant ▪ Asian Citrus Psyllid (carrier of Huanglongbing disease) ▪ Asian Longhorned Beetle ▪ Avocado Lace Bugs ▪ Avocado Thrips ▪ Bark Beetle ▪ Caribbean Fruit Fly ▪ Diaprepes Root Weevil ▪ European Grapevine Moth ▪ False Coddling Moth ▪ Glassy-Winged Sharpshooter ▪ Guava Fruit Fly	▪ Gypsy Moth ▪ Japanese Beetle ▪ Light Brown Apple Moth ▪ Malaysian Fruit Fly ▪ Mediterranean Fruit Fly ▪ Melon Fruit Fly ▪ Mexican Fruit Fly ▪ Olive Fruit Fly ▪ Oriental Fruit Fly ▪ Peach Fruit Fly ▪ RIFA Profile ▪ Spongy Moth ▪ Spotted Lanternfly ▪ White Striped Fruit Fly
Trees	▪ Ash Whitefly ▪ Asian Longhorned Beetle ▪ Asian Wooly Hackberry Aphid ▪ Australian Gum Tree Weevil ▪ Avocado Lace Bugs ▪ Avocado Thrips	▪ Bark Beetle ▪ Emerald Ash Borer ▪ Gold Spotted Oak Borer ▪ Pitch Canker ▪ Polyphagous Shot Hole Borers ▪ Sudden Oak Death (*Phythothora ramorum*)
Terrestrial Plant Species	▪ Arundo ▪ Tree of Heaven ▪ Salt Cedar	▪ Brazilian Pepper Tree ▪ Alder Buckthorn ▪ Tall Whitetop
Livestock or poultry	▪ Foot-and-mouth Disease ▪ Highly Pathogenic Avian Influenzas (H5/H7)	▪ Exotic Newcastle Disease
Humans	▪ Africanized honeybee	▪ Mosquito
All	▪ Red Imported Fire Ant ▪ Bovine Spongiform Encephalopathy (Mad Cow Disease)	▪ Zoonotic Animal Viruses

Sources: (CDFA 2022a) (CDFA 2022b) (UC Riverside 2022) (Cal OES 2018a)

Native California host species that can be infected by the shot hole borer include coast live oak and riparian species such as California sycamore, Fremont cottonwood, red willow, box elder, maples, and white alder. The effects of these pests on oak woodland and riparian ecosystems have decreased rangeland and recreational value, and increased fire risk in Southern California. Urban shade trees, including English oak, silk tree, coral tree, Titoki tree, and sweetgum also host the shot hole borer. Loss of shade trees can have serious aesthetic and health effects. Commercial agricultural hosts include avocado, persimmon, olive, macadamia, eastern mulberry, hazelnut, loquat, peach, grapevine, citrus, cassava, and crabapple. Damage to these important commercial crops can cause severe economic losses.

Most pests prefer distressed or dying trees but shot hole borers typically attack healthy trees. Some trees are reproductive hosts, while some are attacked but do not support the full development of the insect and the associated fungi (UC 2022a).

Bark Beetles

Native California conifer trees in the central and southern Sierra Nevada Mountain range weakened by years of drought have experienced elevated levels of mortality from bark beetles (Oleniacz 2021). Bark beetles are host-specific, generally only attacking a preferred size class of a specific tree species. Bark beetles of specific concern include the western pine beetle, which primarily attacks ponderosa pine; mountain pine beetle, which primarily attacks sugar pine; fir engraver beetle, which primarily attacks true firs (white and red fir); and Jeffrey pine beetle, which primarily attacks Jeffery pine (USDA 2015).

Bark beetles are not dangerous under normal circumstances, but when trees are weakened due to lack of water from prolonged drought, they are more susceptible to attacks from bark beetles. Once attacked by bark beetles, the tree will die. More than 102 million trees, mostly conifers, have died from drought and bark beetles in California. In some communities, up to 85 percent of the forest trees have been killed (CAL FIRE 2019).

Foot and Mouth Disease

Foot and mouth disease is a debilitating disease affecting all cloven–hoofed animals, including cattle, pigs, and sheep. It is one of the most highly contagious, infectious, viral diseases of animals. It can be spread by the wind and on clothing (County of Los Angeles Department of Health Services 2001). Clinical signs commonly seen in cattle are drooling, lip smacking, and lameness, caused by blisters on the tongue, dental pad, and feet. Sheep and pigs have similar, but often less pronounced, clinical signs.

Bovine Spongiform Encephalopathy

Bovine spongiform encephalopathy (BSE), widely known as "Mad Cow Disease," is a fatal disease of cattle first recognized in the United Kingdom in 1986. Most research suggests that an abnormal protein, known as a prion, causes BSE. Scientific evidence shows the same disease agent that causes BSE in cattle also causes variant Creutzfeldt–Jakob disease in humans. BSE spreads in cattle primarily through animal feed containing processed ruminant products. Cattle infected with BSE take two to eight years before showing signs of disease, which include changes in temperament such as nervousness or aggressiveness, and progressive incoordination (CDFA 2022c).

Other Animal Pests and Diseases

Diseases such as Exotic Newcastle Disease in poultry and tuberculosis in dairy cattle are credible threats to the State food supply and economy. Other diseases such as anthrax, and Deforming Wing Virus in honeybees, also pose a serious threat to the food supply (CDFA 2022d).

30.1.2. Aquatic Species

The introduction of non-indigenous species into California's marine, estuarine, and freshwater environments can cause significant economic, human health, and ecological impacts. Aquatic pests can result in economic and human health disasters. For example, mussels and snails can clog water distribution pipes and algae blooms may contain toxins that can harm humans and other living organisms.

Nonindigenous species are introduced into aquatic habitats through multiple pathways, including aquaculture, aquarium trade, commercial shipping, live bait, live seafood trade/commercial fishing, marine debris, and recreational vessels. Maritime transportation is the primary vector moving species around the globe. Vessels transport organisms through two primary mechanisms: ballast water and biofouling. Ballast water is taken on and later discharged by a vessel during cargo loading and unloading operations to maintain the vessel's trim and stability. Biofouling refers to the organisms or community of organisms that are directly attached to, or associated with, wetted hard surfaces of the vessel, such as the hull (SLC 2022).

The following are aquatic species in California that have harmful impacts on people property or the environment:

- Species with impacts on other aquatic species

  - Cyanobacteria
  - Egeria
  - Hydrilla
  - New Zealand mudsnail
  - Nutria
  - Quagga Mussel
  - Zebra Mussel
- Species with impacts on infrastructure
  - Nutria
  - Quagga Mussel
  - Zebra Mussel
- Species with impacts on human health
  - Cyanobacteria
- Invasive plant species
  - Primrose
  - Hyacinth

Cyanobacteria

Cyanobacteria, commonly known as blue-green algae, can reproduce quickly under certain conditions and result in algae blooms. Some cyanobacteria produce toxins that can be harmful to humans and animals. Studies suggest that significant exposure to high levels of cyanobacteria-producing toxins can cause amyotrophic lateral sclerosis in humans (Caller, et al. 2009).

Quagga and Zebra Mussels

Invasive mussels are prolific breeders and settle on or within water facility infrastructure such as water intakes, gates, diversion screens, hydropower equipment, pumps, pipelines, and boats. Infested water and hydropower infrastructure can fail, or the mussels can choke off water transmissions. Invasive mussels negatively impact the natural ecology, which can be detrimental to native and endangered species, including native fisheries (USBR n.d.).

New Zealand Mudsnail

New Zealand mudsnails can reproduce quickly, with one snail and its offspring resulting in over 2.7 billion snails within four years. Dense populations of these snails displace native species. They may consume up to half of the food resources in a stream and have been linked to reduced populations of aquatic insects important to trout and salmon. High density populations are likely to cause substantial negative impacts on fisheries by replacing preferred, nutritious foods (CDFW 2022).

Nutria

Nutria are large, semi-aquatic rodents that reach up to 2.5 feet in body length. Through their burrowing and eating habits, nutria have devastating impacts on wetland habitats, agriculture, and water conveyance/flood protection infrastructure. Nutria consumes up to 25 percent of their body weight in above- and below-ground plant material each day. Due to their feeding habits, up to 10 times the amount of plant material consumed is destroyed, causing extensive damage to the native plant community, soil structure, and nearby agricultural crops. The loss of plant cover and soil organic matter results in severe erosion of soils. Nutria burrow into banks and levees, and often cause severe streambank erosion, increased sedimentation, levee failures, and roadbed collapses (CDFW 2022a).

30.2. HAZARD LOCATION

Invasive and nuisance species are many and varied and can be found statewide, both on land and in waterways. The location of notable agricultural and silvicultural pests and diseases is described below.

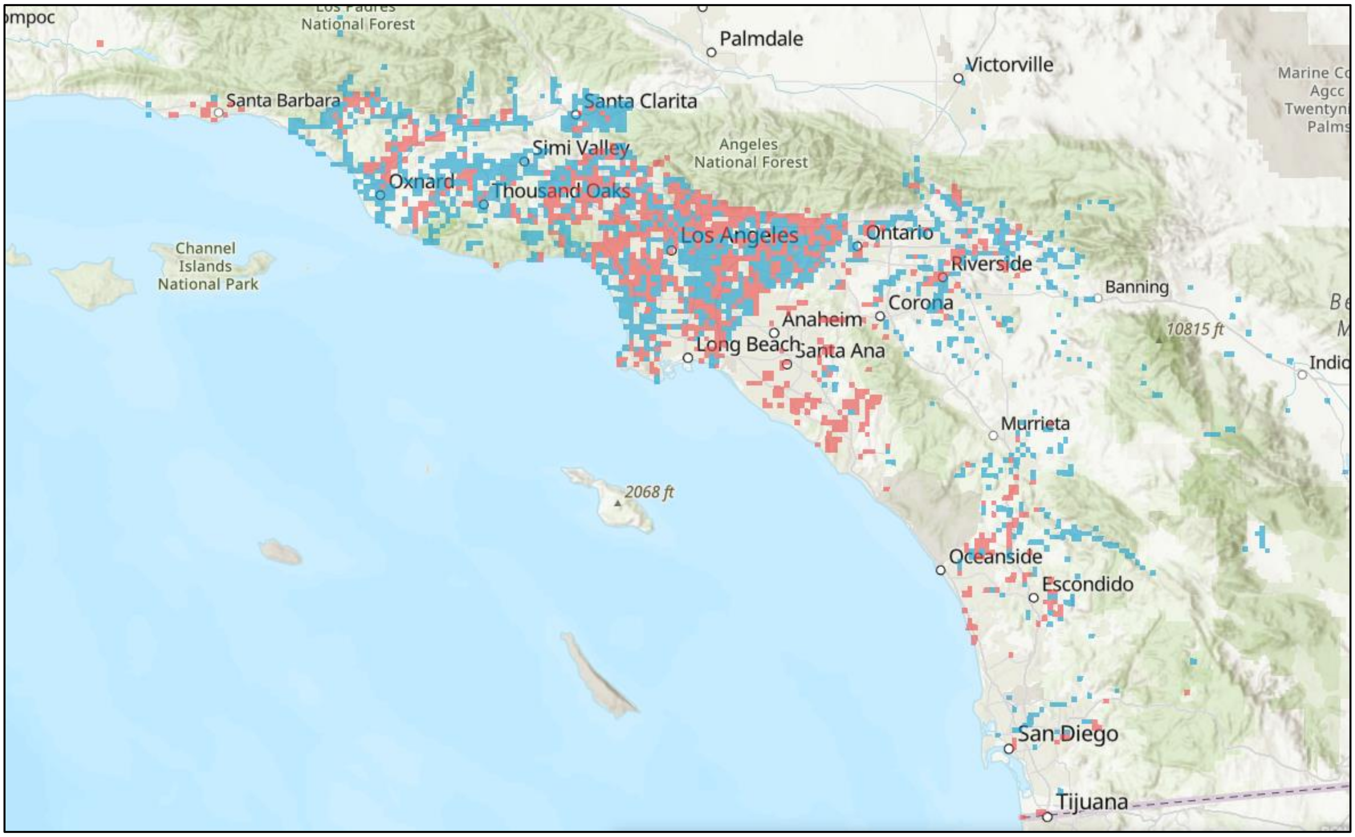
30.2.1. Shot Hole Borers

Figure 30-1 shows the spread of shot hole borers in Southern California. Red indicates areas where trees tested positive for the pest; areas in blue tested negative (UC 2022a). Shot hole borers are moving toward northern areas already affected by tree mortality from bark beetle, which further threatens forests in Central California.

30.2.2. Bark Beetles

Bark Beetles are most often found in the Sierra Nevada conifer forests.

Figure 30-1. Invasive Shot Hole Borer Spread in Southern California



Source: (UC 2022a)

30.2.3. Bovine Spongiform Encephalopathy

In 2012, a routine surveillance sample from a Holstein cow carcass at a rendering plant in the Central Valley of California was positive for the atypical strain of BSE. No part of this carcass entered the human or animal food chain (CDFA 2022c).

30.3. PREVIOUS HAZARD OCCURRENCES

The following disaster declarations or emergency proclamations related to invasive and nuisance species have been issued for California (see Appendix F for details):

- Federal DR or EM declaration, 1953 – 2022: none
- California Emergency Proclamations, 1950 – 2022: 18 events, classified as invasive/nuisance
- USDA agricultural disaster declarations, 2012 – 2016: 604 events (see Table 30-2)

Table 30-2. Invasive and Nuisance Species Events in the State of California, 2012 to 2016

Date*	Event Type	Total Number of USDA Declarations	Counties Impacted
2012	Insects	68	Alpine, Amador, Butte, Calaveras, Colusa, Del Norte, El Dorado, Fresno, Glenn, Humboldt, Imperial, Inyo, Kern, Kings, Lassen, Los Angeles, Madera, Mariposa, Mendocino, Merced, Modoc, Mono, Monterey, Nevada, Orange, Placer, Plumas, Riverside, San Benito, San Bernardino, San Diego, San Joaquin, San Luis Obispo, Santa Barbara, Shasta, Sierra, Siskiyou, Stanislaus, Sutter, Tehama, Trinity, Tulare, Tuolumne, Ventura, Yuba
2013	Insects	164	All counties
2014	Insects	206	All counties
2015	Insects	80	All counties
2016	Insects	86	All counties

* The USDA only designated insect disaster declarations between 2012 and 2016

30.4. PROBABILITY OF FUTURE HAZARD EVENTS

30.4.1. Overall Probability

California's 604 USDA-declared invasive/nuisance species events between 2012 and 2016 represent an average of about 120 events per year. The State is expected to continue to experience multiple such events each year.

30.4.2. Climate Change Impacts

Agricultural and Silvicultural Species

California farmers contend with a wide range of crop-damaging pests and pathogens. Continued climate change is likely to alter the abundance and types of many pests, lengthen pests' breeding season, and increase pathogen growth rates (Skendzic, et al. 2021).

According to the CEC report "Vulnerability and Adaptation to Climate Change in California Agriculture," change in climate can directly impact crop growth through new temperature patterns and northward shifts of pests and disease. Additionally, longer growing seasons may enable pest species to complete more reproductive cycles, which can increase severity of infestations (CEC 2012).

Temperature is not the only climatic influence on pests. For example, some insects are unable to cope in extreme drought, while others cannot survive in extremely wet conditions. Furthermore, while warming speeds up the life cycles of many insects, suggesting that pest problems could increase, some insects may grow more slowly as elevated carbon dioxide levels decrease the protein content of the leaves on which they feed (Skendzic, et al. 2021).

Possible future strategies to address climate change influences on insect pests and diseases might include the following (Food and Agriculture Organization of the United Nations 2008):

- Inventorying and monitoring invasive species that threaten crops
- Downscaling climate change data to allow informed decisions on biodiversity planning by farmers and rural communities
- Strengthening the dissemination of knowledge, appropriate technologies, and tools to improve management practices related to agricultural biodiversity and ecosystem services

Aquatic Species

Climate change, which is warming marine waters, freshwater, and estuarine environments and altering the water chemistry (such as changes to water salinity and pH), can also bolster invasive species populations and range. The changes in marine environment can weaken native species not accustomed to warmer temperatures or altered water chemistry. Non-indigenous species tend to be more tolerant and resilient to changes in their environment; therefore, shifts in species composition due to climate change events can favor invasive non-indigenous species over native species (Finch, et al. 2021).

30.5. IMPACT ANALYSIS

30.5.1. Severity

If left unchecked, invasive species can threaten native species, biodiversity, ecosystem services, recreation, water resources, agricultural and forest production, cultural resources, economies and property values, public safety, and infrastructure (USFS n.d.-c).

The extent of a devastating event would depend on many factors, including the specific pest introduced, climatic conditions at the time of introduction, fluctuations in funding for pest detection and eradication, and public pressure regarding aerial and ground applications of pesticides proximate to urban areas.

Levels of threat from invasive and nuisance species range from minimal to widespread. The threat typically intensifies when the ecosystem or host species is already stressed, such as during periods of drought.

30.5.2. Warning Time

Early warnings about invasive species can come from environmental DNA samples in water and soil, and citizen science tools. New technologies have emerged in the past decade to find some of the best ways that exotic species could be detected early in their invasions (The Wildlife Society 2020).

30.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with invasive and nuisance species:

- Tree mortality is a clear cascading hazard related to invasive and nuisance species.
- As vegetation dies or becomes stressed and weakened by pests such as bark beetles, available fuel and high-intensity wildfires increase (CAL FIRE 2019).
- Potable water supply can be degraded due to the proliferation of algae blooms.

- Wildfire risk increases with the proliferation of invasive species such as the lodge pole pine.
- The proliferation of burrowing animals like the nutria could impact areas protected by levees.

30.5.4. Environmental Impacts

Invasive and nuisance species are as harmful to native species and ecosystems in the environment as they are to the agricultural and built environments associated with human activities.

30.5.5. Local Hazard Impacts

Of the 58 counties in California, six assessed invasive species as a hazard of interest:

- Butte
- Humboldt
- Monterey
- Santa Barbara
- Stanislaus
- Sutter

Fifteen counties assessed the broader "agricultural hazards" as a hazard of concern in their hazard mitigation plans. Seven ranked agricultural hazards as high risk; six ranked it as medium risk, and two ranked it as low risk. The following counties listed agricultural hazards as a high-risk hazard:

- Colusa
- Lake
- Madera
- Merced
- Modoc
- Nevada
- Placer

30.6. VULNERABILITY ANALYSIS

30.6.1. Exposure of State-Owned or -Leased Facilities

All State-owned or -leased facilities, as listed in Table 4-1 and Table 4-2, are vulnerable to the impacts from invasive and nuisance species. This includes 23,961 State-owned facilities and 1,893 State-leased facilities.

Some species can impact vegetation and can result in stream bank instability, erosion, and increased sedimentation, impacting ground stabilization and possibly causing foundation issues for nearby structures. If species cause trees and other vegetation to die, there is an increased risk of damage to roadways, powerlines, and buildings, and increased risk to wildfire.

Some invasive plants have been shown to destabilize soil due to high densities and shallow root systems, negatively impacting nearby buildings and septic systems. Other invasive plant species have been known to clog culverts and streams, increasing flooding risk.

30.6.2. Exposure of Critical Facilities and Community Lifelines

All 755 critical facilities and community lifelines listed in Table 4-3, are vulnerable to the impacts from invasive and nuisance species. Water treatment plants could be impacted by invasive and nuisance species because of issues similar to those that State-owned or -leased facilities can experience. Water that becomes polluted due to increased sedimentation and erosion will require additional treatment. If the system becomes clogged with these pollutants or with invasive aquatic species, the ability of water treatment plants to operate may become impaired. Additionally, soil that becomes unstable due to decaying vegetation can impact critical facilities that are built on or around these soils.

30.6.3. Estimates of Loss

Invasive and nuisance species are not likely to result in any significant losses associated with damage or impairment to State assets. All losses from this hazard would be associated with impacts on the economy, based on impacts on agricultural production.

30.6.4. Buildable Lands

The development of buildable land in the State may help to remediate the risk for invasive and nuisance species. An estimated 11.7 million acres of land is available for development in California. If this vacant land has been invaded by non-native species, the development of that land would likely replace those non-native species with other species associated with the development. Therefore, the development of buildable land is not anticipated to increase the risk from this hazard.

30.6.5. Equity Priority Communities

Damage to crops from invasive and nuisance species can cause significant increases in food prices and food insecurity among low-income communities (Paini, Dean R.; Sheppard, Andy W.; Cook, David C. 2016).

Because the entire population of the State of California is exposed and vulnerable to invasive and nuisance species, the exposed population in equity priority communities is equal to the statewide percentage: 30.4 percent of the total population (12 million people).

30.7. MITIGATING THE HAZARD

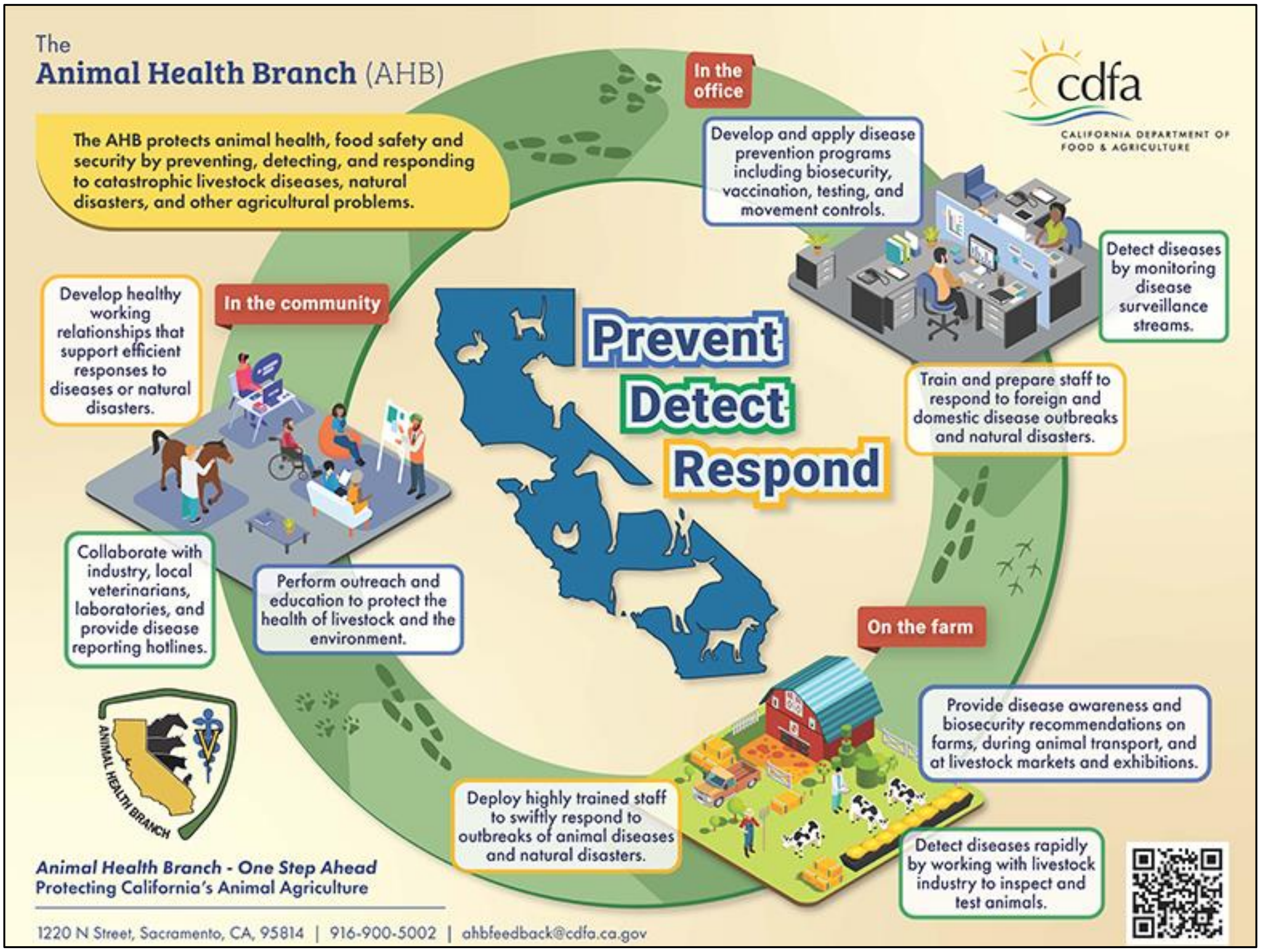
30.7.1. Existing Measures to Mitigate the Hazard

The Animal Health Branch of the California Department of Food and Agriculture (CDFA) provides public information animal disease prevention, protection, and response, such the informational graphic shown in Figure 30-2.

CDFA and USDA work cooperatively to monitor and regulate the movement of livestock and animal products. Despite these efforts, the risk of disease introduction is always present. Viruses, bacteria, and pests are not controlled by borders and are capable of entering on imported animals, meat and meat products, travelers' clothing and shoes, equipment, and other contaminated objects. CDFA maintains a biosecurity web site providing information on biosecurity measures and provides specific training and exercises to prevent the introduction of this disease into the State and nation.

The State's *California Aquatic Invasive Species Management Plan* provides management actions for addressing aquatic invasive species in the state (California Department of Fish and Game 2008). The plan focuses on non-native algae, crabs, clams, fish, plants, and other species that continue to invade California's creeks, wetlands, rivers, bays, and coastal waters. The plan provides ways the State can reduce the impacts of invasive species.

Figure 30-2. Animal Disease Prevention, Protection, and Response



Source: (CDFA 2022d)

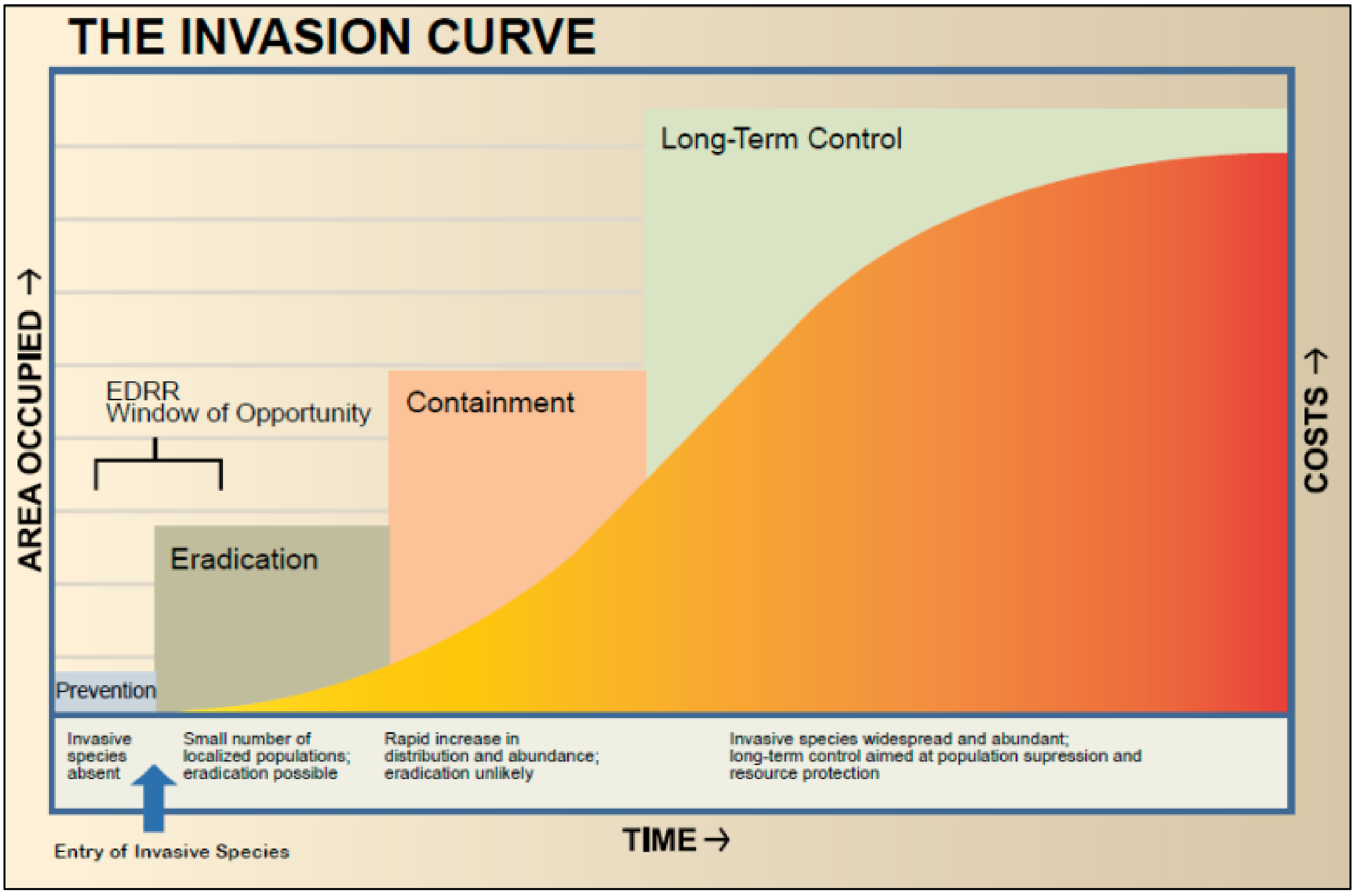
30.7.2. Opportunities for Mitigating the Hazard

Invasive and nuisance species can threaten biodiversity, food supply, overall health, and economic development. In order to reduce the impacts of invasive and nuisance species, there are several ways the State can act (The Regional Activity Centre for the Protocol Concerning Specially Protected Areas and Wildlife for the Wider Caribbean Region 2020):

- Prevent introductions of species that are known to be invasive or a nuisance
- Eradicate by destroying or removing the species, when possible, before they spread
- Contain by stopping new species from further spreading
- Manage the established impacted areas and restore habitats, where possible

Table 30-3 provides a range of potential alternatives for mitigating the invasive and nuisance species hazard. Figure 30-3 depicts management strategies for pests based on the level of infestation.

Figure 30-3. Invasive Species Management Strategies



Source: (U.S. Fish and Wildlife Service 2021)

Table 30-3. Potential Opportunities to Mitigate the Invasive and Nuisance Species Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ Participate in quarantine, control, or eradication programs **Reduce exposure and vulnerability:** ▪ Form citizen action groups to promote awareness and best practices on local levels **Build local capacity:** ▪ Regularly check the California Department of Fish and Wildlife (CDFW) invasive species page for updated information ▪ Comply with Invasive Species rules and regulations to minimize the chance for invasive species to spread ▪ Broaden collaborations focused on ecosystem restoration and ecosystem-based management	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ None **Build local capacity:** ▪ Build and maintain partnerships with government agencies, academia, and stakeholders to coordinate information sharing, and response for invasive and nuisance species throughout the State	**Manipulate the hazard:** ▪ Work with Federal/State agencies on quarantine, control, or eradication programs for invasive species **Reduce exposure and vulnerability:** ▪ Create/disseminate planting guides which explain which types of plants and vegetation are safe to plant within the State ▪ Pass municipal ordinances to enforce best practices for invasive species at the local level **Build local capacity:** ▪ Build and maintain partnerships with other stakeholders to coordinate information sharing, and response for Invasive Species throughout the county/region ▪ Work with federal/State agencies to disseminate information to local municipalities regarding Invasive Species from the CDFW and EPA ▪ Disseminate information to the general public to educate them on invasive species ▪ Work with stakeholders to identify and expand resources for prevention and early detection of invasive species ▪ Broaden collaborations focused on ecosystem restoration and ecosystem-based management." ▪ Build ecological restoration planning into IS management projects
Nature-based opportunities ▪ Verify that plants purchased for a yard or garden are not invasive. Replace invasive plants in gardens with non-invasive alternatives. Ask local nursery staff for help in identifying invasive plants ▪ When boating, clean the boat thoroughly before transporting it to a different body of water ▪ Clean boots before hiking in a new area to get rid of hitchhiking weed seeds and pathogens		

Community-Scale	Organizational Scale	Government-Scale
▪ Do not "pack a pest" when traveling. Fruits and vegetables, plants, insects, and animals can carry pests or become invasive themselves. Do not move firewood (it can harbor forest pests). Clean bags and boots after each hike. Throw out food before traveling from place to place ▪ Do not release aquarium fish and plants, live bait, or other exotic animals into the wild. Before acquiring an exotic pet, do research and plan ahead to understand the commitment involved in caring for it		

30.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address invasive and nuisance species:

- Action 2018-006: Enhance Collaboration on the Development and Sharing of Data Systems and GIS Modeling.
- Action 2018-008: Develop a database containing a description of the specific natural hazard event for which each project was designed to mitigate.
- Action 2018-071: Initiatives and Technology: Mitigating the spread of invasive pests.
- Action 2018-074: Marine Invasive Species Act: Reduce the introduction of invasive species transported through vessel ballast water.

Epidemic, Pandemic, and Vector-Borne Disease

Climate Impacts:
Likely to affect distribution and frequency
Equity Impacts:
30.4% of exposed population (all persons in the State are exposed) identified as living in equity priority communities
State Facilities Exposed:
All facilities indirectly exposed
Community Lifelines Exposed:
All lifelines exposed
Impact Rating: Medium (16)

31. Epidemic, Pandemic, and Vector-Borne Disease

The epidemic, pandemic, and vector-borne disease hazard has been identified as medium-impact under the hazard impact rating protocol applied for this Plan. These types of events have happened frequently in the State. They do not directly impact State-owned or -leased facilities or community lifelines, although they impact the people that work in them. These events would impact the entire population and would likely have higher impacts on equity priority communities. The development of buildable lands would not increase the risk to the built environment from this hazard. The frequency and severity of these health-related events is anticipated to be increased due to the impacts from climate change over the next 30 years, in addition to increases in population. These phenomena can result in increased frequency of health-related events.

31.1. HAZARD OVERVIEW

The COVID-19 pandemic alerted the world to how rapidly a disease outbreak or epidemic can become a large-scale pandemic. Many possible communicable disease threats exist—some known and some unknown. This chapter discusses diseases and conditions of concern in California, with a focus on COVID-19, pandemic influenza, vector-borne diseases, and valley fever.

31.1.1. The Spreading of Disease

Diseases that are usually present in a community have an established baseline, or endemic level. This expected level may continue to occur indefinitely. An outbreak refers to when the amount of a disease in a community rises above the endemic level in a limited geographic area. An epidemic refers to an unexpected rise in the amount of disease over a wider area. The greatest spread of a disease, or a pandemic, can affect large numbers of people in several countries, continents, or the entire globe (CDC n.d.).

A pandemic can lead to social disruption, economic loss, and general hardship on a wide scale (Felman 2020). Many biological pathogens can cause widespread disease. Pathogens can evolve over time. A virus that was previously unable to spread between animals and people might mutate so that it can. Pandemics may occur when humans have little or no immunity against new strains or subtypes of known viruses, such as influenza, or against entirely new viruses, such as SARS-CoV-2, which causes Coronavirus Disease 2019 (COVID-19). Bacteria and fungi that become resistant to antibiotic treatment may spread rapidly, whether through human behaviors, as with gonorrhea, or through healthcare settings, as with *Candida auris*.

Diseases that were once unheard of in California may be introduced, as in the case of Zika from invasive mosquitoes. Changes in climate, land use, occupations, and behavior can bring humans and pathogens such as fungi into closer contact, as with coccidioidomycosis (Valley fever).

31.1.2. Levels of Disease

The U.S. Centers for Disease Control and Prevention (CDC) have defined levels of disease as follows (CDC n.d.):

- *Sporadic* refers to a disease that occurs infrequently and irregularly.
- *Endemic* refers to the amount of a particular disease that is usually present in a community. This level is not necessarily the desired level, but rather is the observed level.
- *Hyperendemic* refers to persistent, high levels of disease occurrence.
- *Cluster* refers to an aggregation of cases grouped in place and time that are suspected to be greater than the number expected, even though the expected number may not be known.
- *Outbreak* refers to an increase, often sudden, in the number of cases of a disease above what is normally expected in that population in a limited geographic area.
- *Epidemic* refers to an increase, often sudden, in the number of cases of a disease above what is normally expected in that population in a wider area.

- *Pandemic* refers to an epidemic that has spread over several countries or continents, usually affecting a large population.

31.1.3. Coronavirus Disease 2019

COVID-19 is an infectious disease caused by the SARS-CoV-2 virus. The virus can spread in small liquid particles from the mouth or nose of infected persons when they cough, sneeze, speak, sing, or breathe. Most people infected with the virus experience mild to moderate respiratory illness and recover without requiring special treatment. However, some become seriously ill and require medical attention. Older adults and those with underlying medical conditions such as cardiovascular disease, diabetes, weakened immune system, chronic respiratory disease, or cancer are more likely to develop serious illness. Anyone at any age can get sick with COVID-19 and become seriously ill or die (World Health Organization 2022a).

31.1.4. Influenza (Flu)

Seasonal Flu

Seasonal flu is a viral infection that occurs every year, attacking the respiratory system (nose, throat, and lungs) in humans. In the United States, the influenza season typically extends from October through May, peaking in January or February, with yearly epidemics of varying severity. Although mild cases may be similar to a viral "cold," influenza is typically much more severe. Influenza usually comes on suddenly and may include fever, headache, tiredness, weakness, dry cough, sore throat, runny or stuffy nose, and body aches. Persons 65 and older, those with chronic illnesses, people who are obese, residents of nursing homes, pregnant women, and young children are at the highest risk for serious complications, including death (Mayo Clinic 2022).

Pandemic Flu

Pandemic flu happens when a new variant of flu virus spreads around the world, passing easily from person to person. Because people have not developed immunity, it can cause large numbers of people to become sick or die. A pandemic flu would likely affect businesses, travel, and some basic services for a period of time (CDPH 2020a).

Avian influenza, commonly referred to as "bird flu," primarily spreads only from birds to other birds (CDFA 2022). However, an avian flu virus may mutate or change so that it can be passed from birds to humans, potentially causing a pandemic (CDC 2022a).

Some strains of avian influenza could arise from continents where people have very close contact with infected birds, such as among poultry farmers or visitors to live poultry markets (Mayo Clinic 2022).

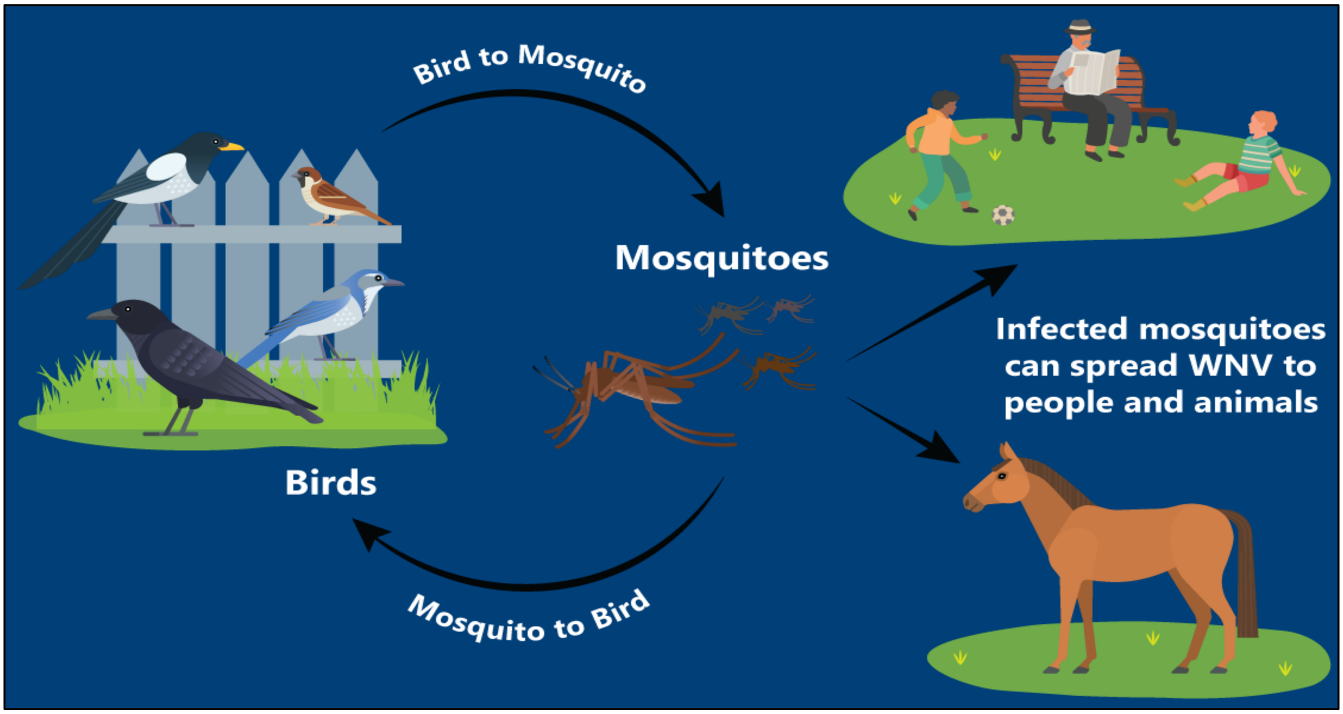
So far, avian influenza viruses have not mutated and demonstrated easy transmission from person to person. If avian influenza viruses were to mutate into a highly virulent form and become easily transmissible from person to person, the public health community would be very concerned about the potential for a pandemic (CDC 2022a). Such a pandemic could disrupt all aspects of society and severely affect the economy.

31.1.5. Vector-Borne Diseases

Mosquito-Borne Viruses

Fifteen mosquito-borne viruses are known to occur in California, but only three—West Nile Virus (WNV), St. Louis encephalitis virus, and western equine encephalitis virus—have caused significant human disease. These viruses are maintained in wild bird-mosquito cycles that do not depend on infections of humans or domestic animals to persist (see Figure 31-1). Surveillance and control activities focus on this maintenance cycle (CDPH 2022c).

Figure 31-1. Wild Bird-Mosquito Maintenance Cycle for Viruses



Source: (CDPH 2022f)

Since 2011, two invasive mosquito species with the potential to transmit viruses have been found in over 300 cities and 22 counties in Central and Southern California: *Aedes aegypti* (the yellow fever mosquito) and *Aedes albopictus* (the Asian tiger mosquito) (CDPH 2021). These mosquitoes have the potential to transmit Zika, dengue, chikungunya, and yellow fever. None of these viruses is known to be transmitted within California, but thousands of people are infected with them in other parts of the world, and the presence of these species in California poses a threat that the mosquitoes could acquire and spread the virus from returning infected travelers (CDPH 2022d).

The prevalence of standing water can provide breeding grounds for mosquito-borne diseases (see Figure 31-2) (CDPH 2022b). Natural disasters such as flooding, fires, and earthquakes may create mosquito-breeding habitat (CDC 2022f). For example, wildfires in recent years resulted in exposed structures—particularly septic systems and unmaintained pools—that became mosquito-breeding sources (Arthur 2019). Damaged structures from earthquakes may also hold water that becomes mosquito-breeding habitat, as was reported after the 1994 Northridge Earthquake (Martin 1994).

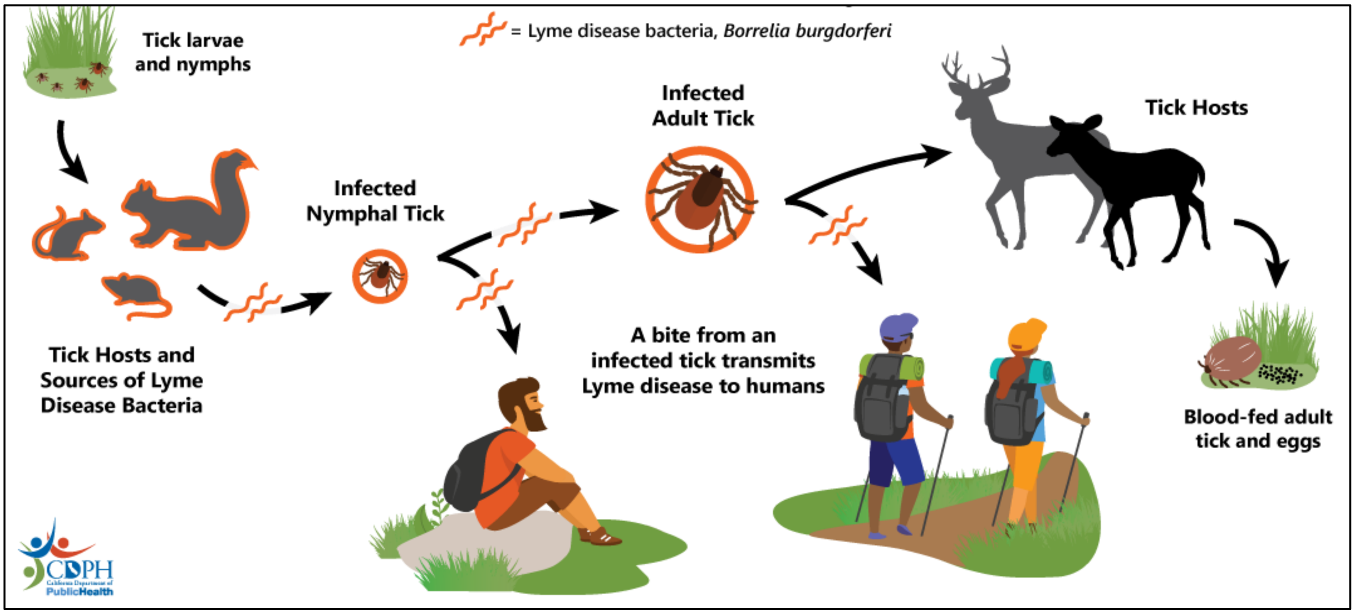
Figure 31-2. Residential Mosquito Breeding Sites

Source: (CDPH 2022d)

Lyme Disease

According to the CDC, Lyme disease is the most common vector-borne disease in the United States, with about 476,000 Americans diagnosed and treated each year (CDC 2021). Moreover, areas where Lyme disease is common are expanding. In California, Lyme disease is transmitted by the Western black-legged tick (see Figure 31-3). The ticks prefer cool, moist areas and can be found in wild grasses and low vegetation in both urban and rural areas.

Figure 31-3. Lyme Disease Transmission

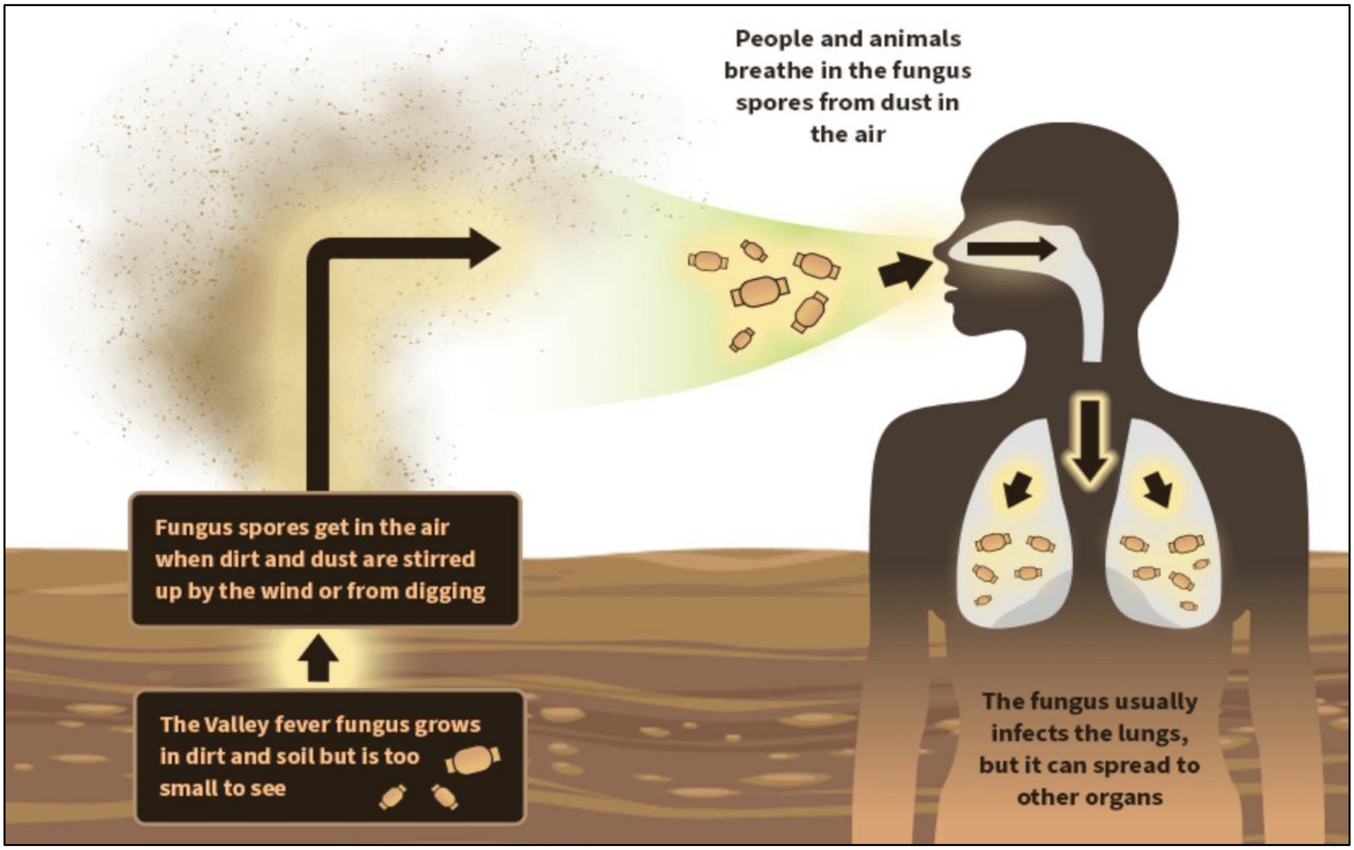


Source: (CDPH 2022e)

31.1.6. Valley Fever

Valley fever (also called coccidioidomycosis) is a disease caused by the *Coccidioides* fungus that grows in some areas of California and other southwestern states (see Figure 31-4). The spores of this fungus can infect the lungs and cause symptoms including cough, difficulty breathing, fever, and fatigue. In rare cases, the fungus can spread to other parts of the body and cause severe disease. Each year in California, there are around 80 deaths from Valley fever and more than 1,000 people are hospitalized with Valley fever (CDPH 2021b). Those most at-risk for severe disease include people who are African American or Filipino, adults 60 years or older, pregnant women, and people with diabetes or conditions that weaken the immune system (CDPH 2020).

Figure 31-4. Valley Fever Transmission



Source: (CDPH 2021b)

The annual number of cases of Valley fever has been increasing in recent years. Research has linked the increase to increased dust storms due to climate change (Tong, et al. 2018). There is no commercial test available to see if the valley fever fungus is in the dirt or dust in certain areas, but valley fever has been diagnosed in people living throughout California (CDPH 2021b).

31.2. HAZARD LOCATION

Some infectious diseases have shown geographic patterns in California:

- Lyme disease has been reported in 56 of the 58 counties in California, with the highest incidence of disease occurring in the northwest coastal and northern Sierra Nevada counties with western-facing slopes (UC 2016).
- Over 65 percent of valley fever cases in California are reported from the Central Valley and Central Coast regions (CDPH 2021b).

In general, epidemics, pandemics, and vector-borne diseases can occur without regard for location; therefore, all of California is at risk. Location-based factors such as population density, travel, and the length of time spent in a location all contribute to the spread of infectious diseases. For example, influenza and COVID-19 are more likely spread by persons in close contact. Indoor areas where people are in close contact with each other appear to be significant vectors for diseases that are spread through respiratory droplets (CDPH 2022i).

31.3. PREVIOUS HAZARD OCCURRENCES

31.3.1. Disaster and Emergency Declarations

The following disaster declarations or emergency proclamations related to public health have been issued for California (see Appendix F for details):

- Federal DR or EM declaration, 1953 – 2022: one event, classified as "biological (COVID)"
- California Emergency Proclamations, 1950 – 2022: one event, classified as "biological (COVID)"
- USDA agricultural disaster declarations, 2012 – 2022: none

31.3.2. Event History

California is susceptible to various diseases that have escalated to epidemic or pandemic proportions. In recent years, this has been seen most notably in the cases of COVID-19, Lyme disease, Valley fever, and WNV. Table 31-1 summarizes major reported outbreaks of these diseases since 2018. The most notable pandemic of the 20th century was the 1918 Spanish influenza pandemic, which was responsible for 20 million to 40 million deaths worldwide (Billings 2005).

Table 31-1. Reported Outbreak Events of Selected Diseases in California (2018 to 2022)

Date	FEMA Declaration Number	USDA Declaration Number	Impact
COVID-19			
2020-August 2022	DR-4482	N/A	10,329,995 cases 94,558 deaths
Counties Impacted: All			
Lyme Disease			
2018	N/A	N/A	119 cases
Counties Impacted: Alameda, Contra Costa, Fresno, Glenn, Humboldt, Lake, Los Angeles, Marin, Mendocino, Napa, Nevada, Riverside, Sacramento, San Bernardino, San Diego, San Francisco, San Joaquin, San Luis Obispo, Santa Barbara, Santa Clara, Santa Cruz, Sierra, Siskiyou, Solano, Sonoma, Stanislaus, Sutter, Tulare, Ventura, Yolo			
2019	N/A	N/A	139 cases
Counties Impacted: Alameda, Butte, Calaveras, Contra Costa, Fresno, Humboldt, Kings, Lake, Los Angeles, Marin, Mendocino, Monterey, Nevada, Riverside, Sacramento, San Bernardino, San Francisco, San Joaquin, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Siskiyou, Solano, Sonoma, Stanislaus, Tulare, Tuolumne, Ventura, Yolo, Yuba			
2020	N/A	N/A	53 cases
Counties Impacted: Alameda, Amador, Contra Costa, Kings, Lake, Los Angeles, Madera, Marin, Mendocino, Napa, Riverside, San Bernardino, San Diego, San Francisco, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Shasta, Solano, Stanislaus, Yuba			
Valley Fever			
2018	N/A	N/A	7,632 cases
Counties Impacted: All except Alpine, Del Norte, Glenn, Humboldt, Inyo, Mendocino, Modoc, Shasta, Sierra, Siskiyou, Sutter			
2019	N/A	N/A	9,292 cases
Counties Impacted: All except Alpine, Del Norte, Inyo, Modoc, Mono, Plumas, Sierra, Trinity			
2020	N/A	N/A	7,379 cases
Counties Impacted: All except Alpine, Modoc, Mono, Plumas, Sierra, Trinity			
2021	N/A	N/A	8,221 cases
Counties Impacted: All except Alpine, Colusa, Lassen, Modoc, Plumas, Sierra, Siskiyou, Trinity			
2022 (January-July)	N/A	N/A	4,095 cases
Counties Impacted: All except Alpine, Del Norte, Modoc, Mono, Napa, Plumas, Shasta, Sierra, Siskiyou, Sutter, Tehama, Trinity, Tuolumne			
WNV			
2018	N/A	N/A	243 cases 11 deaths
Counties Impacted: Amador, Butte, Contra Costa, Fresno, Glenn, Humboldt, Kern, Lake, Los Angeles, Madera, Merced, Monterey, Napa, Nevada, Orange, Placer, Riverside, Sacramento, San Bernardino, San Diego, San Joaquin, Santa Clara, Shasta, Stanislaus, Sutter, Tehama, Tulare, Tuolumne, Ventura, Yolo, Yuba			

Date	FEMA Declaration Number	USDA Declaration Number	Impact
2019	N/A	N/A	243 cases 6 deaths
Counties Impacted: Alameda, Amador, Butte, Colusa, Contra Costa, El Dorado, Fresno, Imperial, Kern, Kings, Long Beach, Los Angeles, Madera, Merced, Orange, Placer, Riverside, Sacramento, San Bernardino, San Diego, San Joaquin, San Luis Obispo, Santa Clara, Solano, Stanislaus, Sutter, Tulare, Ventura, Yolo			
2020	N/A	N/A	263 cases 11 deaths
Counties Impacted: Butte, Contra Costa, El Dorado, Fresno, Glenn, Imperial, Kern, Kings, Lake, Long Beach, Los Angeles, Madera, Merced, Orange, Placer, Riverside, Sacramento, San Bernardino, San Diego, San Joaquin, Santa Clara, Shasta, Solano, Stanislaus, Sutter, Tehama, Tulare, Yolo, Yuba			
2021	N/A	N/A	148 cases 12 deaths
Counties Impacted: Butte, Contra Costa, El Dorado, Fresno, Glenn, Kern, Kings, Long Beach, Los Angeles, Madera, Merced, Orange, Placer, Riverside, Sacramento, San Bernardino, San Diego, San Joaquin, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Shasta, Solano, Stanislaus, Tulare, Yolo			
2022 (January-August)	N/A	N/A	46 cases 4 deaths
Counties Impacted: Butte, Fresno, Kern, Kings, Los Angeles, Merced, Orange, Pasadena, Solano, Stanislaus, Tehama, Tulare, Yolo			

Source: (CDPH 2022g) (CDPH 2022h) (CDPH 2022i)

The first cases of COVID-19 in California were confirmed in January 2020 among residents who had returned from China. By February, the first COVID-related death in the State occurred in Santa Clara and the first community-transmission (no known exposure to the virus) case was documented in Solano County. Following numerous Emergency Declarations at the local level and positive cases increasing by the day, California's Governor declared a State of Emergency on March 4, 2020 (CalMatters 2022). On March 22, 2020, the State of California was included in the FEMA Major Disaster Declaration for the COVID-19 pandemic (FEMA 2020f).

Other major disease events in recent California history include the following:

- In 2009 a pandemic of H1N1 influenza, popularly referred to as the swine flu, was first identified in the United States in southern California (Jhung, et al. 2011). It resulted in many hospitalizations and deaths (CDPH 2010).
- From 2003 to 2021, there were 7,388 WNV human cases of WNV reported in California, with 332 deaths, and 1,347 horse cases.

- Since the reemergence of St. Louis encephalitis virus in California in 2015, 28 human cases of St. Louis encephalitis virus disease have been identified.

31.4. PROBABILITY OF FUTURE HAZARD EVENTS

31.4.1. Overall Probability

Based on the historical epidemic, pandemic, and vector-borne disease events in California, the State has a high probability of future events occurring within the next 25 years. According to FEMA and CDPH, California experienced more than three epidemic, pandemic, or vector-borne disease events every year between 2013 and 2022. It is reasonable to expect similar averages in the future.

31.4.2. Climate Change Impacts

Changes in temperature and precipitation can influence seasonality, distribution, and prevalence of vector-borne diseases, which are influenced significantly by high and low temperature extremes and precipitation patterns (Rocklöv and Dubrow 2020). A changing climate may also create conditions favorable for invasive mosquitoes in California (OEHHA 2019b).

High temperatures are among the factors associated with WNV outbreaks. Warmer temperatures associated with climate change can accelerate mosquito development, biting rates, and the incubation of the disease within a mosquito (EPA 2022f). Mild winters are associated with increased WNV transmission due, in part, to less mosquito and resident bird mortality. Warmer winter and spring seasons may allow for transmission to start earlier. Such conditions also allow more time for virus amplification in bird-mosquito cycles, increasing the potential for mosquitoes to transmit WNV to people (Hoover and Barker 2016).

Drought is an important predictor of WNV. Record hot temperatures and extended drought may have contributed to the elevated WNV activity in 2014 and 2015. Mosquito populations increase under drought conditions, especially in urban areas, due to stagnation of water in stormwater systems that would otherwise be flushed by rainfall. Drought conditions may also force infected birds to move to suburban areas where water is more available, bringing residents of these areas into contact with the disease (OEHHA 2019b).

Vector-borne disease transmission can be influenced by many factors other than climate, which makes it difficult to predict how climate change alone will influence future outbreaks of vector-borne diseases (OEHHA 2019b). These factors include how viruses adapt and change, the availability of hosts, changing ecosystems and land use, human behavior such as time spent indoors, and vector control programs.

Cases of valley fever in California have increased more than fivefold since 2001. A 2018 study noted that incidents of dust storms rose 240 percent between 1990 and 2011. According to data from the National Oceanic and Atmospheric Administration (NOAA), dust storms have likely intensified because of the warmer temperatures and increasing drier climate in the Southwest (Tong, et al. 2018)

31.5. IMPACT ANALYSIS

31.5.1. Severity

Widespread sickness and loss of life can result from epidemics, pandemics, and vector-borne diseases. The COVID-19 pandemic infected over 614 million people and caused more than 6.5 million deaths worldwide in less than three years and is still ongoing (Worldometer 2022).

31.5.2. Warning Time

Epidemics, pandemics, and vector-borne diseases can occur with very little warning. Air travel can hasten the spread of a new organism and decrease the time available for early implementation of interventions (Grépin, et al. 2021). Warning time will depend on the origin of the virus or disease, rate of spread, and the amount of time needed to identify it.

31.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with the epidemic, pandemic, and vector-borne disease hazard:

- As was seen with the COVID-19 pandemic, these events can cause significant economic impacts that may take decades to correct.

- Disease outbreaks reaching pandemic proportions can cause social impacts on a global scale (Shang, Li and Zhang 2021). Civil disorder, protests, depression, and anxiety are a few of the social impacts of the COVID-19 pandemic.

31.5.4. Environmental Impacts

Epidemic, pandemic, and vector-borne diseases can be directly or indirectly tied to environmental impacts. Air pollution dropped suddenly during the COVID-19 lockdown between March 19, 2020, and May 7, 2020. Ground-based observations around California showed a 38 percent drop in concentrations of nitrogen dioxide, a 49 percent drop in concentrations of carbon monoxide, and a 31 percent drop in PM during that time (Liu, et al. 2020). Overall improvement of air and water quality, reduction of noise, and restoration of ecology were all noted during the pandemic (Rume and Didar-Ul Islam 2020).

An increased demand for single-use plastic products during the pandemic led to more than 8 million tons of pandemic-associated plastic waste generated globally, with more than 25,000 tons entering the global ocean. Most of the plastic is from medical waste generated by hospitals (Peng, et al. 2021). Powerful disinfectants end up in water supplies. Microplastics from degrading personal protective equipment (e.g., masks, gloves) can contribute to high concentrations found in fish, water, sediments, soils, and the air (Hartman 2021).

31.5.5. Local Hazard Impacts

Eleven of California's 58 counties identified public-health-related events as a hazard of interest in their local hazard mitigation plans (LHMPs):

- Fresno
- Mono
- Monterey
- Napa
- Riverside
- San Benito
- San Mateo
- Santa Barbara
- Sonoma
- Stanislaus
- Ventura

31.6. VULNERABILITY ANALYSIS

31.6.1. Exposure of State-Owned or -Leased Facilities, Critical Facilities, and Community Lifelines

Epidemic, pandemic, and vector-borne disease events will not directly impact State-owned or -leased facilities by causing damage to these assets. However, the functionality of the assets could be impacted if the people who operate the facilities are sick and unable to do so.

31.6.2. Estimates of Loss

Health hazard events are not likely to result in any losses associated with damage or impairment to State assets. All losses from this hazard would be associated with impacts on operations and the economy.

The people who staff and maintain State facilities, as well as those served by the facilities, are vulnerable to the hazard. Large rates of infection may result in an increase in the rate of hospitalization, which may overwhelm hospitals and medical facilities and lead to decreased service for those seeking medical care (Gilligan 2021).

Potential statewide economic impacts include unemployment, price increases, and supply chain interruptions (Center on Budget and Policy Priorities 2022). Burnout and workforce shortages may be seen among first responders and public health and healthcare workers. Depending on the industry, worker morbidity and mortality increases, as do workplace disruptions (CDC 2022c); (National Library of Medicine 2021); (Peters, et al. 2022). Significant economic disruption can occur due to death, loss of work time, food insecurity, and costs of treating or preventing the spread of the virus or disease.

31.6.3. Buildable Land

An estimated 11.7 million acres of land is available for development in California. The development of buildable land in the State is not anticipated to have any direct impact on the risk to the built environment from epidemic, pandemic, and vector-borne disease. There could be an indirect impact from the development of buildable lands in that the population that could be exposed to this hazard would be increased. However, no direct impact is expected.

31.6.4. Equity Priority Communities

Because of concerns about COVID-19, an estimated 41 percent of U.S. adults delayed or avoided medical care, including urgent or emergency care (12 percent) and routine care (32 percent). Avoidance of urgent or emergency care was more prevalent among unpaid caregivers for adults, persons with underlying medical conditions, Black adults, Hispanic adults, young adults, and persons with disabilities (Czeisler, et al. 2020).

Food insecurity can impact those who lose employment during a pandemic, who are not eligible for Supplemental Nutrition Assistance Program, or SNAP, benefits due to immigration status, or who may not be able to access food at stores because of supply chain issues or lack of stock. Food banks may be the only option for these families. A survey conducted at the beginning of the COVID-19 pandemic in 2020 indicated that 33 percent of households with children were food insecure. In the months following the outbreak of COVID-19, food bank demand in California increased 73 percent (UC 2020).

Groups that are at higher risk of severe valley fever or getting very sick if they are infected include, older adults, people who are Black or Filipino, pregnant women, and people with diabetes or weakened immune systems (CDPH 2022j).

31.7. MITIGATING THE HAZARD

31.7.1. Existing Measures to Mitigate the Hazard

The Vector-Borne Disease Section of the CDPH protects the health and well-being of Californians from diseases transmitted to people from insects and other animals. This section conducts prevention, surveillance, and control of vector-borne diseases, including Hantavirus pulmonary syndrome, plague, Lyme disease, WNV, and other tick-borne and mosquito-borne diseases. It also performs surveillance and advises on control for introduction of exotic vector species that may harbor human pathogens (CDPH 2022a).

California’s comprehensive mosquito-borne disease surveillance and control program includes the Mosquito-borne Virus Surveillance & Response Plan, which is updated annually in consultation with local vector control agencies (CDPH 2022c). The California Arbovirus Surveillance Program emphasizes monitoring and providing early detection of temporal and spatial activity of WNV, St. Louis encephalitis virus, and western equine encephalitis virus.

The CDPH Division of Communicable Disease Control has developed a document titled "Guidance for Surveillance of and Response to Invasive *Aedes* Mosquitoes and Dengue, Chikungunya, and Zika in California" to address local issues that may arise with the introduction of the *Aedes aegypti* and *Aedes albopictus* exotic mosquitoes (CDPH 2021).

CDPH closely monitors communicable diseases in the State. Table 31-2 identifies the diseases and conditions that must be reported immediately or within one working day of identification to the local health officer for the jurisdiction where the patient resides (CDPH 2022).

Table 31-2 California Reportable Communicable Diseases and Conditions

DESCRIPTION	EXAMPLES	
Animal Associated		
These are diseases that are transmitted to humans by, or have pathogen reservoirs in, domestic or non-domestic animals.	▪ Brucellosis ▪ Campylobacteriosis ▪ Escherichia coli (E. coli) ▪ Hantavirus infections ▪ Middle Eastern Respiratory Syndrome ▪ Mpox (formerly called Monkeypox)	▪ Plague ▪ Psittacosis (ornithosis, parrot fever) ▪ Q Fever ▪ Rabies ▪ Salmonellosis ▪ Tularemia ▪ Viral Hemorrhagic Fever
Bloodborne		
Viruses, bacteria, and parasites that can be carried in blood and cause disease are known as bloodborne pathogens. Transmission of these diseases may be from direct blood contact, needle sticks, intravenous drug use, sexual behavior, insects, or other vectors.	▪ Babesiosis ▪ Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome (HIV/AIDS)	▪ Encephalitis ▪ Malaria

DESCRIPTION	EXAMPLES	
Community-Acquired Infections		
Community-acquired infections are infections that are contracted outside of a hospital (or are diagnosed within 48 hours of admission) without any previous health care encounter.	▪ Campylobacteriosis ▪ Candida auris infection ▪ Chickenpox (outbreaks) ▪ Diphtheria ▪ Influenza due to novel strains ▪ Meningitis	▪ Meningococcal Infections ▪ Monkeypox ▪ Poliovirus ▪ Smallpox ▪ Tuberculosis ▪ Tularemia
Foodborne		
Foodborne diseases can be spread when food becomes contaminated with fecal matter containing bacteria, viruses, or parasites. This contamination can happen at a farm, manufacturing plant, restaurant, or home. Foodborne diseases usually result in gastrointestinal illness, with symptoms such as diarrhea, vomiting, nausea, stomachache, and fever. People who are ill with a foodborne disease can give the infection to others, so hygiene and hand washing practices are essential to limit spread of the disease.	▪ Anthrax ▪ Botulism ▪ Brucellosis ▪ Campylobacteriosis ▪ Cholera ▪ Ciguatera fish poisoning ▪ Cryptosporidiosis ▪ Domoic acid poisoning ▪ Escherichia coli (E. coli) ▪ Hemolytic Uremic Syndrome ▪ Listeriosis	▪ Paralytic shellfish poisoning ▪ Paratyphoid fever ▪ Salmonellosis ▪ Scombroid fish poisoning ▪ Shiga toxin ▪ Shigellosis ▪ Trichinosis ▪ Tularemia ▪ Typhoid fever ▪ Vibriosis ▪ Yersiniosis
Mosquito-Transmitted		
Mosquitoes found in California are capable of spreading many diseases to humans.	▪ Chikungunya ▪ Dengue ▪ Encephalitis ▪ Flavivirus infection ▪ Malaria	▪ Viral Hemorrhagic Fever ▪ West Nile ▪ Yellow Fever ▪ Zika
Respiratory Viruses		
Respiratory viruses are responsible for influenza-like illness as well as the common cold. The virus that caused the COVID-19 pandemic is a respiratory virus. People with certain underlying conditions, older adults, the very young, and pregnant women are at a high risk for developing severe illness that results in hospitalization or death.	▪ Coronaviruses ▪ Haemophiles influenzae ▪ Influenza due to novel strains	▪ Measles ▪ Pertussis (whooping cough) ▪ Tuberculosis

DESCRIPTION	EXAMPLES	
Waterborne Diseases		
▪ Diseases caused by micro-organisms transmitted in water can be spread while bathing, washing, drinking water, or eating food exposed to contaminated water.	▪ Hemolytic Uremic Syndrome ▪ Typhoid Fever	▪ Vibriosis
Sexually Transmitted Disease		
Diseases representing a variety of clinical syndromes and infections caused by pathogens that can be acquired and transmitted through sexual activity.	▪ HIV/AIDS	▪ Syphilis ▪ Zika

Source: (CDPH 2022)

31.7.2. Opportunities for Mitigating the Hazard

Long-term prevention of the epidemic, pandemic, vector-borne disease hazard takes the actions of State and local partners, along with residents. Without proper control, diseases can lead to widespread outbreaks and be harmful to public health. Mitigation measures to help reduce the severity of the epidemic, pandemic, and vector-borne disease hazard vary widely depending on the pathogen and transmission pathway, including, but not limited to, nonpharmaceutical interventions, implementation of a quarantine system, isolating sick individuals, closing public spaces, and recalling food (in the event of a foodborne disease) (National Geographic 2022b).

A range of potential opportunities for mitigating the epidemic, pandemic, and vector-borne disease hazard is provided in Table 31-3. See Section 1.2.3 for a description of the different types of alternatives.

Table 31-3. Potential Opportunities to Mitigate the Epidemic, Pandemic, and Vector-Borne Disease Hazard

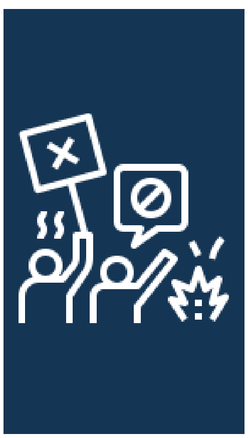
Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ Insect and other animal abatement **Reduce exposure and vulnerability:** ▪ Proper hygiene ▪ PPE ▪ Social distancing ▪ Focus on personal health ▪ Immunization ▪ Eliminate or reduce environments on private property that favor mosquito infestation (or other insects and animals) **Build local capacity:** ▪ Storage of PPE ▪ Storage of supplies and food to reduce need to enter public spaces ▪ Education	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ PPE ▪ Social distancing, including revising in-person work schedules as possible ▪ Distanced work environment ▪ Regular cleaning of work environment ▪ Immunize employees **Build local capacity:** ▪ Storage of PPE ▪ Equipment for monitoring ▪ Trainings for staff ▪ Inform employees on human health hazards	**Manipulate the hazard:** ▪ Insect and other animal abatement **Reduce exposure and vulnerability:** ▪ PPE ▪ Social distancing ▪ Eliminate or reduce environments on private property that favor mosquito infestation (or other insects and animals) ▪ Distanced work environment ▪ Regular cleaning of work environment ▪ Immunize employees **Build local capacity:** ▪ Storage of PPE ▪ Equipment for monitoring/treatment ▪ Trainings for staff ▪ Public outreach ▪ Collaborate with county health departments to ensure the health and welfare for the State ▪ Public education and outreach
Nature-based opportunities ▪ There are no identified nature-based solutions to mitigate the impacts from this hazard		

31.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address the epidemic, pandemic, and vector-borne disease hazard:

- Action 2018-006: Enhance Collaboration on the Development and Sharing of Data Systems and GIS Modeling.
- Action 2018-007: Support and Coordinate Monitoring of Progress on State Goals and Objectives: Set systematic near- and long-term mitigation targets and priorities.
- Action 2018-110: Planning and Technical Assistance: Identify and communicate with local governments to promote local hazard evaluation and mitigation planning and to assist in developing LHMPs.

CIVIL DISORDER



Climate Impacts:
Could likely increase as the effects of climate change become worse
Equity Impacts:
30.4% of exposed population (all persons in the State are exposed) identified as living in equity priority communities
State Facilities Exposed:
All facilities exposed
Community Lifelines Exposed:
All lifelines exposed

Impact Rating: Medium (16)

32. CIVIL DISORDER

Civil disorder has been identified as medium-impact under the hazard impact rating protocol applied for this plan. This hazard has occurred more than once in the past 25 years within the State. While all State-owned or -leased facilities and community lifelines could be considered exposed to civil disorder, only a small percentage are likely targets for such events. While the entire population could be exposed at any given time, the actual percentage of the population on a case-by-case basis is small. Equity priority communities could experience greater impacts when these events impact their communities. The development of buildable lands is anticipated to have a low impact on this hazard, with the emphasis on the increase in population that new development would create. The frequency and severity of civil disorder events could likely be increased due to impacts from climate change.

32.1. HAZARD OVERVIEW

Civil disorder (also referred to as civil unrest) is any social disruption—a demonstration, riot, strike, or disturbance at mass gatherings such as sporting events, concerts, and political events—that disrupts a community (FEMA 2002); (U.S. Fire Administration 2022).

Common Causes of Civil Disorder Worldwide

- **Famine**—Widespread scarcity of food
- **Economic collapse/recession**—Very slow or negative growth
- **Misinformation**—Erroneous information spread intentionally or unintentionally
- **Civil disturbance/public unrest/riot**—Group acts of violence against property and individuals
- **Strike/labor dispute**—Related to the terms and conditions of employment

Source: (York County Planning Commission 2018)

32.2. HAZARD LOCATION

Civil disorder can occur anywhere in the State of California. Government facilities, landmarks, prisons, and universities are common places for these events to happen. Peaceful protests, concerts, sporting events, and political events can all become sites of civil unrest (Donohue 2019). Government structures and prominent economic districts may be more vulnerable to damage due to their significance and their proximity to prominent areas where people gather (Griffin 2021).

32.3. PREVIOUS HAZARD OCCURRENCES

32.3.1. Disaster and Emergency Declarations

The following disaster declarations or emergency proclamations related to civil disorder have been issued for California (see Appendix F for details):

- Federal DR or EM declarations, 1953 – 2022: one event, classified as “fire as a result of civil unrest” (Rodney King Riots, April 29, 1992)
- California Emergency Proclamations, 1950 – 2022: one event, classified as civil unrest (Rodney King Riots, April 29, 1992)
- USDA agricultural disaster declarations, 2012 – 2022: None

32.3.2. Event History

Table 32-1 lists significant past civil disorder events in California—from the Los Angeles Riots in 1992 to protests in May 2020 following the murder of George Floyd. The majority of these events have taken place in metropolitan areas across the State. Refer to Appendix K for the history of civil disorder events since 1965.

Table 32-1. Summary of Significant Civil Disorders in California (2018 – 2022)

Date	Event	Location	Deaths	Injuries	Damage
1965	Watts Riots	South Central Los Angeles	34	1,032	$40 million
Riots that took place in the Watts neighborhood of Los Angeles.					
1992	Los Angeles Riots	South Los Angeles	50	Over 2,000	More than $1.0 billion
Looting, rioting, and fires lasted six days in response to the acquittal of police officers for the beating of Rodney King (Britannica n.d.).					
2011	Occupy California Protests	Various	0	1	$2.4 million
Protests in 50 large and small cities and college campuses, including 50,000 people participating in Occupy Oakland.					
2012	Anaheim Police Shootings and Protests	Anaheim	0	6	N/A
Two fatal shootings by police officers and subsequent public protests.					
2013	Oakland Riots	Oakland	0	2	N/A
Riots that occurred on July 13, 2013, following the acquittal of George Zimmerman in the shooting death of Trayvon Martin.					
2014	Oakland Riots	Oakland			N/A
A series of riots and civil disturbances following the decision of a grand jury in St. Louis not to charge Darren Wilson in the shooting death of African American teenager Michael Brown in Ferguson, Missouri.					
2016	Civil Disorder	Sacramento	0	10	N/A
A rally of left-wing protesters and white nationalist groups outside the California State Capitol on June 26, 2016. Ten people were hospitalized for stabbing and laceration wounds.					
2016	Election Protests	Oakland	0	3	N/A
Protests against the election of Donald Trump. Thirty protesters were arrested, and three officers were injured.					
2020	George Floyd Protests	Various	19	unknown	$1-2 billion
Protests broke out statewide in May 2020 following the murder of George Floyd at the hands of Minneapolis police officers. Looters smashing windows and setting fire to stores and property prompted the Los Angeles mayor to call in the National Guard and to set a curfew. California's Governor declared a State of Emergency in Los Angeles. In the Bay Area, similar looting and vandalism targeting the city's high-end retail in Union Square prompted the mayor to impose an 8 p.m. curfew. In the suburbs of Emeryville and Walnut Creek, a woman was shot in the arm. At least nine cities in California set a curfew (Ho 2020).					

32.4. PROBABILITY OF FUTURE HAZARD EVENTS

32.4.1. Overall Probability

Given past occurrences and the significance of California and its larger cities, civil unrest incidents are possible. Areas that are important to the State, region, and greater United States may be targets of civil unrest. These areas include universities, landmarks, correctional facilities, major industrial facilities, and other locations similar in nature. Based on the data in Table 32-1, there have been nine significant events in the past 57 years, or an average of one event about every six years.

32.4.2. Climate Change Impacts

Civil disorder will likely increase as the effects of climate change worsen. Large-scale protests in other nations have occurred due to crop and water loss.

One study found that unprecedented drought in Syria added to societal stressors that led to uprisings in 2011. The drought destroyed agriculture, drove up food prices, and led farm families to migrate to cities. The influx of people added to the existing stress of refugees pouring into Syria from the war in Iraq. The ensuing conflicts developed into a major, protracted civil war with ongoing international involvement (Columbia University n.d.).

Given California's history of climate-related events, communities may see protests as prolonged drought and climate change decrease the availability of critical resources.

32.5. IMPACT ANALYSIS

32.5.1. Severity

The severity of a civil disorder event depends on the nature of the disturbance. They can occur as small gatherings or large disturbances blocking access to buildings or disrupting normal activities. These events can range from peaceful sit-ins to full-scale riots. They can start spontaneously or be planned events.

Civil disorder incidents can lead to injury or death for involved persons as well as innocent bystanders. If a civil disorder event turns violent, it can lead to injury or death for personnel responding to the incident. The number of people exposed to a civil disorder depends on the population density and the location of the civil disorder. Increases in population or the hosting of major political, economic, or social events could increase the likelihood and severity of a civil disorder incident (Monroe County 2017).

32.5.2. Warning Time

Events of civil disorder typically have very little warning time prior to beginning. Although events like protests and sporting events may be scheduled in advance, there is little information that can determine beforehand if those events will result in unrest. Societal trends and emerging social issues should be watched closely, as these types of issues have led to instances of civil disorder in the past.

32.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with civil disorder:

- Civil disorder can result in economic and physical impacts on communities.
- Fires set by protesters can spread through communities, resulting in damage to homes and businesses.
- Critical facilities and community lifelines can become targets during civil unrest, resulting in utility failure and transportation interruption (Monroe County 2017).

32.5.4. Environmental Impacts

Civil unrest can result in environmental impacts, but they are likely to be limited (Juniata County 2001). Fires that are started during civil unrest events can spread throughout cities, burning through areas that may include natural resources or hazardous materials and facilities (Monroe County 2017).

32.5.5. Local Hazard Impacts

Four of the hazard mitigation plans prepared for California’s 58 counties list civil disorder as a “hazard of interest.” Hazards of interest are hazards that local communities consider to be important but for which a complete risk assessment is not performed due to the nature of the hazard. The following counties listed civil disorder (using different wording) as a hazard of interest:

- Orange—Civil Unrest
- Santa Barbara—Civil Disturbance
- Tulare—Civil Disturbance
- Yolo—Civil Disturbance

32.6. VULNERABILITY ANALYSIS

32.6.1. Exposure of State-Owned or -Leased Facilities, Critical Facilities, and Community Lifelines

State-owned or -leased facilities are often targets of civil disorders, making them more vulnerable to the effects of these events. They often become the focus of these types of events.

All State-owned or -leased assets, as listed in Table 4-1 and Table 4-2, are exposed to this hazard. This includes 23,961 State-owned facilities, and 1,893 State-leased facilities. All 755 State critical facilities and community lifelines, as listed in Table 4-3, are vulnerable; interruption of services may impact facilities that need to be in operation during a civil disorder incident.

32.6.2. Estimates of Loss

State assets could be targets for civil disorder events, but there are no standard generic formulas for estimating associated losses. Instead, loss estimates were developed representing 10 percent, 30 percent, and 50 percent of the replacement cost value of all State-owned facilities (see Table 32-2). This allows the State to select a range of potential economic impacts based on an estimate of percent of damage to these assets. Damage in excess of 50 percent is considered substantial by most building codes and typically requires total reconstruction of the structure.

Table 32-2. Loss Potential of State-Owned Assets for Civil Disorder

Type of Facility	Total Replacement Cost Value (contents only)	Estimated Loss Potential Based on % Damage		
		10% Damage	30% Damage	50% Damage
Facilities Housing Vulnerable Populations				
Correctional Facility	$5,673,743,477	$567,374,348	$1,702,123,043	$2,836,871,738
Development Center	$696,669,418	$69,666,942	$209,000,825	$348,334,709
Hospital	$837,461,197	$83,746,120	$251,238,359	$418,730,598
Migrant Center	$996,980,976	$99,698,098	$299,094,293	$498,490,488
Special School	$128,610,363	$12,861,036	$38,583,109	$64,305,182
All Other Facilities	**$28,392,185,985**	**$2,839,218,598**	**$8,517,655,796**	**$14,196,092,992**
Total	**$36,725,651,416**	**$3,672,565,142**	**$11,017,695,425**	**$18,362,825,708**

32.6.3. Buildable Land

An estimated 11.7 million acres of land is available for development in California. Developing this buildable land is anticipated to have a nominal impact on increasing the severity of this hazard, based solely on the fact that new development will lead to an increase in population.

32.6.4. Equity Priority Communities

Because the entire population of the State of California is exposed and vulnerable to civil disorder, the exposed population in equity priority communities is equal to the statewide percentage: 30.4 percent of the total population (12 million people). Civil disorder most immediately impacts populations living or working near the event.

32.7. MITIGATING THE HAZARD

32.7.1. Opportunities for Mitigating the Hazard

There are numerous ways to mitigate the civil disorder hazard in the State of California. Developing plans, conducting training and exercises, and identifying mitigation actions will help improve resilience and prevention of civil disorder incidents. A range of potential opportunities for mitigating the hazard is provided in Table 32-3. See Section 1.2.3 for a description of the different types of alternatives.

Table 32-3. Potential Opportunities to Mitigate the Civil Disorder Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ None **Reduce exposure and vulnerability:** ▪ None **Build local capacity:** ▪ None	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Evaluate existing emergency plans and update accordingly ▪ Implement security measures and enhance security levels ▪ Electronic illegal entry system – Confirm systems are in service and activate all features to the extent that operations permit ▪ Video surveillance system – Confirm the system is in full service and recording conditions. Enhance video surveillance of key areas such as the lobby, entrances, and docks. If possible, record video files to an off-site server or cloud computing platform. Ensure cameras can provide sufficient quality to identify persons ▪ Verify fire protection systems are ready, and ignitable materials are secured. Verify all fixed fire protection systems are in service ▪ Develop and implement evacuation procedures **Build local capacity:** ▪ Connect and coordinate with local fusion centers and InfraGard Chapters	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Evaluate existing emergency plans and update accordingly ▪ Implement security measures and enhance security levels ▪ Electronic illegal entry system – Confirm systems are in service and activate all features to the extent that operations permit ▪ Video surveillance system – Confirm the system is in full service and recording conditions. Enhance video surveillance of key areas such as the lobby, entrances, and docks. If possible, record video files to an off-site server or cloud computing platform. Ensure cameras can provide sufficient quality to identify persons. ▪ Verify fire protection systems are ready, and ignitable materials are secured. Verify all fixed fire protection systems are in service ▪ Develop and implement evacuation procedures **Build local capacity:** ▪ Leverage the capabilities and capacities of the State Threat Assessment Center and other Fusion Centers
Nature-based opportunities ▪ There are no identified nature-based solutions to mitigate the impacts from civil disorder.		

32.7.2. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address the civil disorder hazard:

- Action 2018-001: Support Legislative Efforts that Formalize California's Comprehensive Mitigation Program: Mitigation Legislation and Implementation.
- Action 2018-002: Strengthen Inter-agency Coordination Actions Including State, Regional, and Local Linkages.
- Action 2018-003: Broaden Public and Private Sector Mitigation Linkages.
- Action 2018-007: Support and Coordinate Monitoring of Progress on State Goals and Objectives.

NATURAL GAS PIPELINE HAZARDS

Climate Impacts:
Unknown

Equity Impacts:
30.4% of exposed population (all persons in the State are exposed) identified as living in equity priority communities

State Facilities Exposed:
All facilities exposed

Community Lifelines Exposed:
All lifelines exposed

Impact Rating: Medium (15)

33. Natural Gas Pipeline Hazards

The natural gas pipeline hazard has been identified as medium-impact under the hazard impact rating protocol applied for this plan. This hazard occurred more than once over the past 25 years within the State. It is estimated that less than 14 percent of State-owned or -leased facilities and community lifelines are exposed to this hazard. Only populations that reside near pipelines are considered to be exposed, which is estimated to be less than 25 percent of the total population. An estimated 34 percent of that population has been identified as equity priority communities. The development of buildable lands is anticipated to have a low impact on this hazard with an emphasis on the increase in population that new development would create. The frequency and severity of this hazard is not anticipated to increase due to the impacts from climate change.

33.1. HAZARD OVERVIEW

The United States is heavily dependent on transmission pipelines to distribute energy and fuel sources. Virtually all natural gas, which accounts for about 32 percent of energy consumed annually, is transported by transmission pipelines (U.S. Energy Information Administration 2022). Energy demand in the United States continues to increase. Although California is a leader in exploring and implementing alternative energy sources such as wind and solar, the expansion of traditional energy sources, such as natural gas, continues.

Natural gas is used throughout the United States, but five states accounted for about 39 percent of total U.S. consumption in 2021:

- Texas—15.2 percent
- California—6.8 percent
- Louisiana—5.9 percent
- Pennsylvania—5.7 percent
- Florida—5.0 percent

Virtually all natural gas is transported by transmission pipelines, either buried or above ground. In California, urbanization is resulting in more people living and working closer to gas transmission pipelines that were placed prior to land use and other pipeline safety regulations. Risk related to natural gas pipelines also comes from the deterioration of pipelines due to natural causes.

Compounding the potential risk is the age and gradual deterioration of the gas transmission system due to natural causes. Significant failure, including pipe breaks and explosions, can result in loss of life, injury, property damage, and environmental impacts. Causes of and contributors to pipeline failures include construction errors, material defects, internal and external corrosion, operational errors, control system malfunctions, outside force damage, subsidence, and seismicity. Growth in population, urbanization, and land development near transmission pipelines, together with addition of new facilities to meet new demands, may increase the likelihood of pipeline damage due to human activity and the exposure of people and property to pipeline failures.

33.2. HAZARD LOCATION

Forty-two natural gas pipelines service the State of California. Many of these pipelines are used to transport gas from out-of-state natural gas basins. Many of the pipelines are located in areas with high seismic activity, crossing the San Andreas and other active faults (CEC 2017a).

Natural gas transported via interstate pipelines and California-produced natural gas are delivered into the PG&E and Southern California Gas (SoCalGas) intrastate natural gas transmission pipeline systems. Natural gas in the utilities' pipeline systems is delivered to local transmission and distribution pipeline systems, or to natural gas storage fields. PG&E and SoCalGas own and operate several natural gas storage fields in California (CEC 2022).

33.3. PREVIOUS HAZARD OCCURRENCES

33.3.1. Disaster and Emergency Declarations

No FEMA, USDA, or State disaster declarations or proclamations related to natural gas pipelines have been issued relevant to California or any of its counties.

Aliso Canyon Leak

On October 23, 2015, SoCalGas discovered a leak at a natural gas storage well at Aliso Canyon Gas Storage Facilities, located in the Santa Susana Mountains of Los Angeles County (CPUC 2021). Attempts to plug the leak failed in November and December 2015. During that time actions were taken to reduce the amount of gas leaking from the facility, including withdrawing gas to reduce the gas pressure and curtailing injections of gas into the storage facility.

On February 18, 2016, State officials announced that the leak was permanently plugged after 119 days (CPUC 2021). The California Geologic Energy Management Division (CalGEM) maintained a moratorium prohibiting SoCalGas from injecting natural gas for storage at the facility until completion of a comprehensive safety review. This safety review required all 114 wells at the Aliso Canyon to be either thoroughly tested for safe operation or removed from operation and isolated from the underground reservoir.

On February 9, 2017, CPUC opened a proceeding to determine the feasibility of minimizing or eliminating the use of SoCal Gas' Aliso Canyon while still maintaining energy and electric reliability for the Los Angeles Basin. This proceeding was known as Order Instituting Investigation: I.17-02-002.

On July 19, 2017, State regulators confirmed the safety of the Aliso Canyon site and cleared SoCalGas to resume limited injections at the field to help prevent energy shortages once certain conditions were met. The CEC issued a letter to CPUC urging it to plan for the permanent closure of the facility within 10 years (CPUC 2021).

On September 23, 2022, CPUC issued a potential plan to reduce or eliminate the need for Aliso Canyon based on a report by independent consultants. CPUC proposed an approach to reduce gas demand and enable the closure of Aliso Canyon by 2027 or 2035.

33.3.2. Event History

According to the U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration, there have been 25 significant pipeline incidents in California since 2010. Significant Incidents are those including any of the following conditions (fire-first incidents are excluded):

- Fatality or injury requiring in-patient hospitalization
- $50,000 or more in total costs, measured in 1984 dollars

- Highly volatile liquid releases of 5 barrels or more or other liquid releases of 50 barrels or more
- Liquid releases resulting in an unintentional fire or explosion

Table 33-1 lists hazardous liquid pipeline events of note since 2010.

Table 33-1. Hazardous Liquid Pipeline Events in the State of California (2018 to 2022)

Date	Facility	Location	Commodity Released	Fatalities	Injuries
4/8/2010	Chevron Products Company	San Ramon	Refined and/or petroleum product (non-HVL) which is a liquid at ambient conditions	No	No
4/20/2010	Pacific Pipeline System LLC	Long Beach	Crude Oil	No	No
3/10/2011	Pacific Pipeline System LLC	Long Beach	Crude Oil	No	No
8/31/2011	Pacific Pipeline System LLC	Long Beach	Crude Oil	No	No
7/17/2013	Chevron U.S.A. Inc.	San Ramon	Crude Oil	No	No
9/14/2013	Crimson Pipeline L.P.	Long Beach	Crude Oil	No	No
11/25/2013	Crimson Pipeline L.P.	Long Beach	Crude Oil	No	No
3/20/2014	Pacific Coast Energy Company, L.P.	Orcutt	Crude Oil	No	No
6/20/2014	Chemoil Terminals Corp.	Long Beach	Refined and/or petroleum product (non-HVL) which is a liquid at ambient conditions	No	No
7/16/2014	Freeport-McMoRan Oil & Gas	Los Angeles	Crude Oil	No	No
1/28/2015	Crimson Pipeline L.P.	Long Beach	Crude Oil	No	No
8/20/2015	Ultramar Inc	Wilmington	Crude Oil	No	No
10/30/2015	Crimson Pipeline L.P.	Long Beach	Crude Oil	No	No
12/29/2015	Crimson Pipeline L.P.	Long Beach	Crude Oil	No	No
7/20/2016	Crimson Pipeline L.P.	Long Beach	Crude Oil	No	No

Date	Facility	Location	Commodity Released	Fatalities	Injuries
9/12/2016	Torrance Valley Pipeline Company LLC	Cerritos	Crude Oil	No	No
12/29/2017	Crimson Pipeline L.P.	Long Beach	Crude Oil	No	No
4/12/2019	Crimson Pipeline L.P.	Long Beach	Crude Oil	No	No
11/14/2019	Paramount Pipeline LLC	Paramount	Crude Oil	No	No
10/6/2020	Crimson Pipeline L.P.	Long Beach	Crude Oil	No	No
4/16/2021	Kern Oil & Refining Co.	Long Beach	Crude Oil	No	No
7/2/2021	Crimson Pipeline L.P.	Oxnard	Crude Oil	No	No
12/3/2021	Beta Offshore	Long Beach	Crude Oil	No	No

Source: (U.S. Department of Transportation 2023)

33.4. PROBABILITY OF FUTURE HAZARD EVENTS

33.4.1. Overall Probability

Given the significant number of residents living near a natural gas pipeline in the State of California, there is a high probability of pipeline-related events occurring with regularity in the future. This probability may decrease as the State's energy supply is derived more from renewable energy and the demand for natural gas diminishes.

33.4.2. Climate Change Impacts

No direct climate change impacts with specific association with natural gas pipeline accidents have been identified for this SHMP. Climate change impacts on other hazards such as extreme heat and severe weather could exacerbate conditions that make pipelines susceptible to failures.

33.5. IMPACT ANALYSIS

33.5.1. Severity

Pipeline releases can range from relatively minor leaks to catastrophic ruptures. Natural gas is highly flammable and toxic to inhale, so exposure to any population can have costly and deadly impacts. Natural gas can migrate underground from the source of a release to other areas via the path of least resistance, including through sewers, water lines, and geologic formations. However, given that natural gas is lighter than air, it often dissipates quickly in open areas.

The 2020 Emergency Response Guidebook, a hazardous materials resource produced by the U.S. Department of Transportation, identifies the extent of hazard for several types of natural gas pipeline.

- **Natural Gas Transmission Pipelines**—Large-diameter, steel pipelines transport flammable natural gas at very high pressures, ranging from 200 to 1,500 pounds per square inch (psi). Leaks may not be recognizable by people because natural gas in transmission pipelines is generally not odorized.
- **Natural Gas Distribution Pipelines**—Natural gas is delivered directly to customers via distribution pipelines. These pipelines are typically smaller-diameter, lower-pressure pipelines constructed of steel, plastic, or cast iron. Natural gas in distribution pipelines is odorized with mercaptan to be readily detectable by people.
- **Natural Gas-Gathering and Natural Gas Well Production Pipelines**—Natural gas-gathering and well production pipelines collect raw natural gas from wellheads and transport it to gas-processing plants. These gathering pipelines carry natural gas mixed with some quantity of natural gas liquids, water, and, in some areas, contaminants such as toxic hydrogen sulfide. Natural gas in these pipelines is not odorized with mercaptan, but it will have an odor if it contains hydrogen sulfide.

33.5.2. Warning Time

Explosions or fires associated with natural gas pipeline incidents can occur instantly and escalate quickly. Generally, the following could be indications warning of a pipeline leak or rupture:

- Hissing, roaring, or explosive sound
- Flames appearing from the ground or water (perhaps very large flames)
- Vapor cloud/fog/mist
- Dirt/debris/water blowing out of the ground
- Liquids bubbling up from the ground or bubbling in water
- Distinctive, unusually strong odor of rotten eggs, mercaptan (an odorant in some natural gas pipelines), skunk, or petroleum
- Discolored/dead vegetation or discolored snow above a pipeline right-of-way
- An area of frozen ground in the summer
- An unusual area of melted snow in the winter

33.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with the natural gas pipeline hazard:

- A severe natural gas pipeline event could lead to urban structure fires.
- There could be public health consequences for pipeline failures.
- There could be significant environmental impacts both long and short term.

33.5.4. Environmental Impacts

The burning of any fossil fuel, including natural gas, emits greenhouses gases into the atmosphere and contributes to climate change. Burning natural gas produces nitrogen oxides, which contribute to smog and acid rain.

33.5.5. Local Hazard Impacts

One of the hazard mitigation plans prepared for California's 58 counties—the Lassen County hazard mitigation plan—lists natural gas pipeline rupture as a "hazard of interest." Hazards of interest are hazards that local communities consider to be important but for which a complete risk assessment is not performed due to the nature of the hazard. None of the county hazard mitigation plans assessed this hazard as a hazard of concern.

33.6. VULNERABILITY ANALYSIS

33.6.1. Exposure of State-Owned or -Leased Facilities, Critical Facilities, and Community Lifelines

All State-owned or -leased facilities, critical facilities, and community lifelines as listed in Table 4-1, Table 4-2, and Table 4-3, are vulnerable to the impacts from natural gas pipeline hazards. This includes 23,961 State-owned facilities, 1,893 State-leased facilities, and 755 community lifeline facilities.

33.6.2. Estimates of Loss

A pipeline explosion or other incident that results in property damage may displace residents or businesses for a prolonged period of time. This could create a need for long-term emergency housing or financial support for impacted small businesses.

An incident with a natural gas pipeline can result in complete devastation. Buildings and infrastructures located in areas that contain natural pipeline systems are more at risk if an incident were to occur. There are no standard generic formulas for estimating associated losses. Instead, loss estimates were developed representing 10 percent, 30 percent, and 50 percent of the replacement cost value of all State-owned facilities (see Table 33-2).

This allows the State to select a range of potential economic impacts based on an estimate of percent of damage to these assets. Damage in excess of 50 percent is considered substantial by most building codes and typically requires total reconstruction of the structure.

Table 33-2. Loss Potential of State-Owned Assets for Natural Gas Pipeline Hazards

Type of Facility	Total Replacement Cost Value (contents only)	Estimated Loss Potential Based on % Damage		
		10% Damage	30% Damage	50% Damage
Facilities Housing Vulnerable Populations				
Correctional Facility	$5,673,743,477	$567,374,348	$1,702,123,043	$2,836,871,738
Development Center	$696,669,418	$69,666,942	$209,000,825	$348,334,709
Hospital	$837,461,197	$83,746,120	$251,238,359	$418,730,598
Migrant Center	$996,980,976	$99,698,098	$299,094,293	$498,490,488
Special School	$128,610,363	$12,861,036	$38,583,109	$64,305,182
All Other Facilities	**$28,392,185,985**	**$2,839,218,598**	**$8,517,655,796**	**$14,196,092,992**
Total	**$36,725,651,416**	**$3,672,565,142**	**$11,017,695,425**	**$18,362,825,708**

33.6.3. Buildable Lands

Growth in population, urbanization, and land development near transmission pipelines, together with addition of new facilities to meet new demands, may increase the likelihood of pipeline damage due to human activity and the exposure of people and property to pipeline failures.

Throughout the State, over 11.7 million acres of land are available for development. Because the entire State is vulnerable to natural gas pipeline hazards, any type of development in buildable areas will be susceptible to damage and impacts from such events.

33.6.4. Equity Priority Communities

Natural gas pipelines across the United States tend to be concentrated in equity priority communities. Negative impacts associated with pipelines fall disproportionately on communities with limited capacity to deal with the impacts, exacerbating other issues of inequality.

Because the entire population of the State is exposed and vulnerable to natural pipeline hazards, the exposed population in equity priority communities is equal to the statewide percentage: 30.4 percent of the total population, or about 12 million people.

33.7. MITIGATING THE HAZARD

33.7.1. Existing Measures to Mitigate the Hazard

California's pipeline regulations prioritize safety of oil and gas production. Pipeline operators are required to prepare pipeline management plans, keep them up-to-date, and submit them to the California Geologic Energy Management Division (CalGEM) for evaluation of risk assessment. The rules establish that active, older pipelines near sensitive areas such as occupied buildings must undergo mechanical integrity testing (DOC 2019c).

The federal government establishes minimum pipeline safety standards. The Office of Pipeline Safety within the U.S. Department of Transportation has overall regulatory responsibility for hazardous liquid and gas pipelines under its jurisdiction in the United States. The Natural Gas Pipeline Safety Act authorizes the Department of Transportation to regulate pipeline transportation of natural gas and other gases.

33.7.2. Opportunities for Mitigating the Hazard

Even with rigorous safety measures in place, natural gas pipeline hazards cannot be completely eliminated. However, there are various mitigation measures the State can implement to reduce the severity of natural gas pipeline hazards.

A range of potential opportunities for mitigating the natural gas pipeline hazard is provided in Table 33-3. See Section 1.2.3 for a description of the different types of alternatives.

33.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address natural gas pipeline hazards:

- Action 2018-001: Support Legislative Efforts that Formalize California's Comprehensive Mitigation Program.
- Action 2018-002: Strengthen Inter-agency Coordination Actions Including State, Regional, and Local Linkages.
- Action 2018-003: Broaden Public and Private Sector Mitigation Linkages.

Table 33-3. Potential Opportunities to Mitigate the Natural Gas Pipeline Hazard

<table>
<tr><th>Community-Scale</th><th>Organizational Scale</th><th>Government-Scale</th></tr>
<tr>
<td>Manipulate the hazard:
None
Reduce exposure and vulnerability:
Locate outside of hazard area
Build local capacity:
Develop and practice a household evacuation plan</td>
<td>Manipulate the hazard:
None
Reduce exposure and vulnerability:
Locate outside of hazard area
Protect corporate critical facilities from potential impacts of chemical contamination
Build local capacity:
Develop and practice a corporate evacuation plan
Inform employees through corporate sponsored outreach</td>
<td>Manipulate the hazard:
None
Reduce exposure and vulnerability:
Locate outside of hazard area
Protect critical facilities from potential problems associated with chemical contamination
Build local capacity:
Public outreach, awareness</td>
</tr>
<tr><td colspan="3">Nature-based opportunities
There are no identified nature-based solutions to mitigate the impacts of natural gas pipeline hazards</td></tr>
</table>

Hazardous Materials Release

Climate Impacts:
More severe weather events can impact facilities with hazardous materials, increasing risk of release

Equity Impacts:
30.4% of exposed population (all persons in the State are exposed) identified as living in equity priority communities

State Facilities Exposed:
All facilities exposed

Community Lifelines Exposed:
All lifelines exposed

Impact Rating: Low (12)

34. Hazardous Materials Release

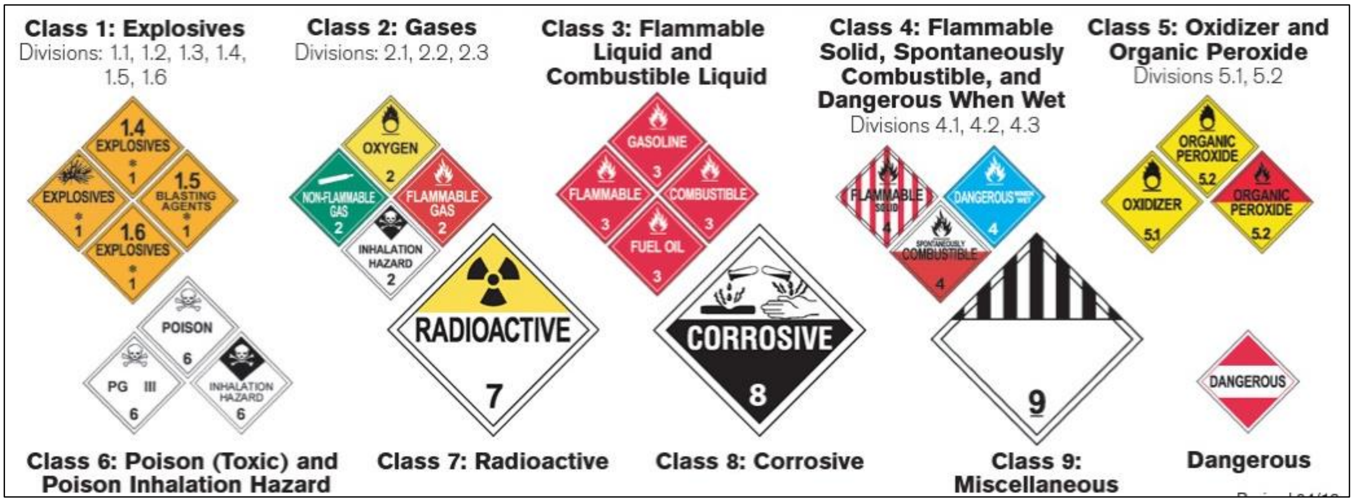
Hazardous material release has been identified as low-impact under the hazard impact rating protocol applied for this Plan. These events have occurred more than once over the past 25 years within the State. It has been estimated that less than 14 percent of State-owned or -leased facilities and community lifelines are exposed to this hazard. Only populations that reside near hazardous material facilities are considered to be exposed to this hazard—estimated to be 30 percent of the State's total population. The development of buildable lands is anticipated to have no impact on this hazard. The frequency and severity of the hazard is anticipated to increase due to the impacts of climate change. Increases in the frequency of natural hazard events with hazardous material facility exposure could increase the probability and frequency of hazardous material releases.

34.1. HAZARD OVERVIEW

Hazardous materials—materials that are flammable, corrosive or an irritant, oxidizing, explosive, toxic, thermally unstable or reactive, or radioactive—are ubiquitous in modern society. They are found at all stages of production, consumption, and disposal. Figure 34-1 shows classes of hazardous materials.

Federal and State laws permit the intentional release of some hazardous materials into the environment when the risk to human health and the environment is thought to be acceptable. However, unintentional releases resulting from leaks, accidents, or natural hazards can have significant impacts on people and the environment. General categories of hazardous material releases into the environment include chemical, biological, radiological, nuclear, and explosive.

Figure 34-1. Classes of Hazardous Materials



Source: (Federal Motor Carrier Safety Administration 2018)

Natural disasters can cause major damage to hazardous installations, hazardous substance releases, fires, and explosions, resulting in health effects, environmental pollution, and economic losses. Natural hazards that are generally considered minor, such as lightning or freeze, have been found to cause significant hazardous materials incidents (OECD n.d.).

Definition

A hazardous material is defined in California's State Hazardous Materials Incident Contingency Plan as "a substance or combination of substances which, because of quantity, concentration, physical, chemical, or infectious characteristics may: cause, or significantly contribute to an increase in deaths or serious illnesses; or pose a substantial present or potential hazard to humans or the environment."

Source: (State of California 1991).

34.2. HAZARD LOCATION

California has approximately 160,000 businesses regulated for storing, transporting, or handling hazardous materials. A hazardous material release may occur at any of these locations, whether stationary sources or during transportation through railways, waterways including ports, or highways (State of California 2017). Therefore, the entire State is vulnerable to this hazard.

Any educational institution with a science lab might be at risk for a chemical spill leading to adverse health outcomes following a natural hazard event or through human error. Such spills pose a risk to students, faculty, staff, and first responders. Utilities that are expected to be available—such as water, power, and communications—may not be available after the natural hazard event. Chemical safety personnel are likely to be preoccupied, and mitigation measures may not function as anticipated due to the disruptions from the event (Cruz, et al. 2004).

34.3. PREVIOUS HAZARD OCCURRENCES

34.3.1. Disaster and Emergency Declarations

The following disaster declarations or emergency proclamations related to hazardous materials releases have been issued for California (see Appendix F for details):

- Federal DR or EM declaration, 1953 – 2022: none
- California Emergency Proclamations, 1950 – 2022: five events, classified as "hazardous materials"
- USDA agricultural disaster declarations, 2012 – 2022: none

34.3.2. Event History

Accidental hazardous materials releases occur many times during any given day. The Cal OES Warning Center receives thousands of hazardous material spill reports each year, which results in hundreds of thousands of notifications to federal, State, and local government agencies (Cal OES 2022a). Most incidents are minor, but some cause significant impacts such as injuries, evacuation, and the need for cleanup.

Table 34-1 lists examples of notable hazardous materials release events in California. Table 34-2 lists the yearly number of spills reported to Cal OES from 2018 to July 2022.

Table 34-1. Notable Hazardous Materials Releases

Date	Location	Event Details
August 6, 2012	Richmond	A leak and ignition of diesel fuel caused a series of explosions and fires at Chevron's refinery in Richmond. Thousands of East Bay residents were ordered to stay in their homes with windows and doors closed. There were no fatalities; one refinery worker was treated for minor burns (Berton, Fagan and Ho 2012)
November 18, 2014	Santa Paula	A vacuum truck exploded at a wastewater treatment facility. A fire ensued, involving several waste streams. Residents, pets, and livestock were evacuated within a one-mile radius and residents within a three-mile radius sheltered in place. Highway 126 was closed. At least 37 people were treated for exposure to the volatile chemicals (EPA n.d.) (CBS Los Angeles 2014).
June 18, 2015	Antioch	A concentrated amount of pool chemicals was inadvertently pumped into one of five pools at a park while swimmers were present. Thirty-four children had symptoms that included trouble breathing, burning skin, and eye and throat irritation. Seventeen were treated at the pool and 17 were transported to local hospitals and released (Contra Costa Health Services 2015).
October 2015 to February 2016	Porter Ranch	A methane gas leak in a Los Angeles neighborhood became the largest methane leak in U.S. history. It spewed more than 97,000 metric tons of methane into the atmosphere. More than 11,000 nearby residents had to evacuate; many got sick (Wilson 2016).
June 14, 2016	Maywood	The Fruitland Magnesium Fire in Los Angeles County started in a facility that recovers scrap metal. Approximately 10,000 pounds of magnesium in the facility exploded twice, depositing Fruitland Avenue and the adjacent residential neighborhood with chunks of burning magnesium. The incident required the evacuation of 43 residents for nearly one month during cleanup operations (County of Los Angeles Department of Public Health 2016) (EPA n.d.-a).
October 3, 2018	Thousand Oaks	Seven children were taken to the hospital after they were exposed to pool chemical fumes. Another 12 children suffered moderate or minor injuries. The fumes came from excess chlorine being pumped into the pool after residue was left in the chemical feeder (J. Childs 2018).
June 13, 2019	Merced County	A farm worker was overcome by toxic fumes from farming chemicals and died. Another victim was hospitalized but survived. Responding deputies also had to be treated for exposure (ABC News 2019).

Table 34-2. Hazardous Materials Release Events by Year in the State of California (2018 to 2022)

Year	Types of Hazardous Materials Release	Number of Events
2022	Chemical, Petroleum, Radiological, Sewage, Vapor	4,216
2021	Biomedical, Chemical, Petroleum, Radiological, Sewage, Vapor	7,139
2020	Biomedical, Chemical, Petroleum, Radiological, Sewage, Vapor	6,804
2019	Biomedical, Chemical, Petroleum, Radiological, Sewage, Vapor	7,925
2018	Biomedical, Chemical, Petroleum, Radiological, Sewage, Vapor	8,846

Source: (Cal OES 2022f)

Natural Disasters and Hazardous Material Releases

Natural disasters pose risks of hazardous materials releases. Examples in California include the following:

- California State University (CSU) Northridge laboratories and chemical storage rooms experienced damage following the Northridge Earthquake (Los Angeles Times 1994).
- In 2021, the California Department of Toxic Substances Control (DTSC) helped remove household hazardous waste from more than 2,300 properties damaged by wildfire in 10 California counties (DTSC 2021).

Lightning, flood, and low temperature are the three most common natural hazard triggers of hazardous materials events.

34.4. PROBABILITY OF FUTURE HAZARD EVENTS

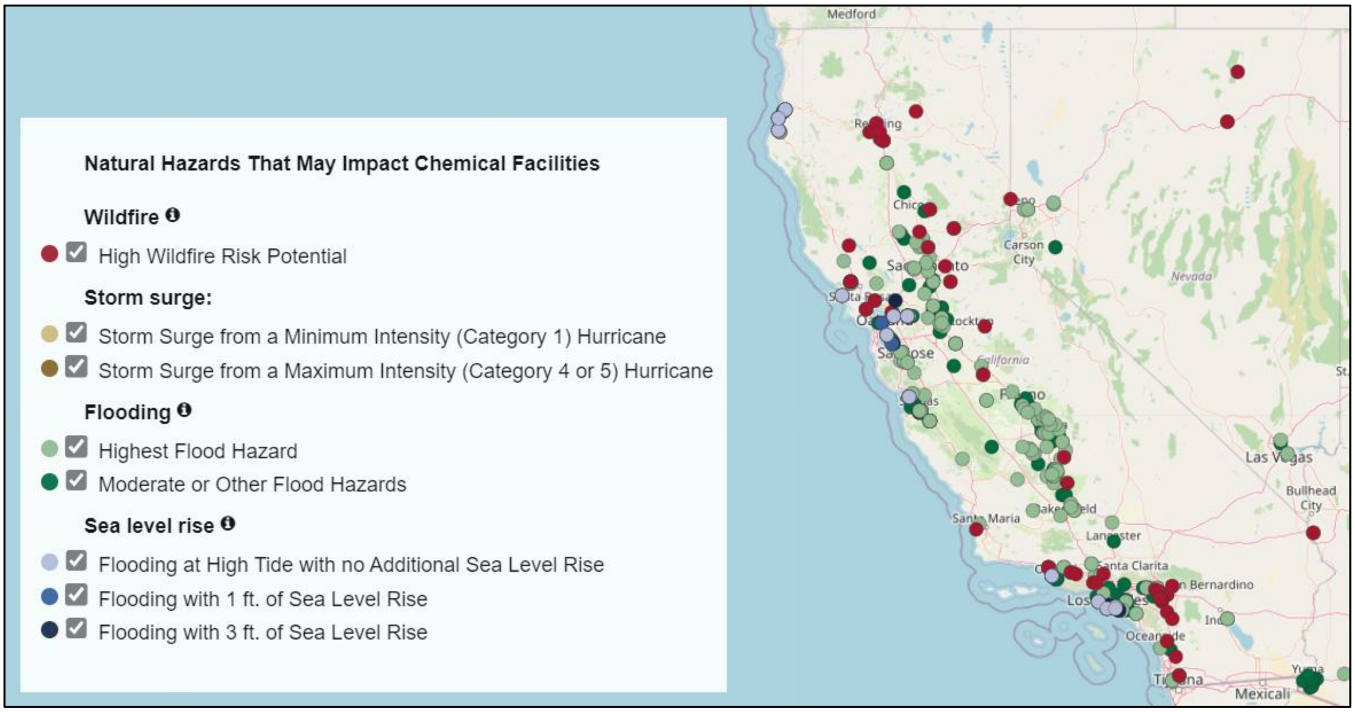
34.4.1. Overall Probability

California’s 34,940 recorded hazardous materials releases between 2018 and 2022 represent an average of almost 7,000 events per year—nearly 20 per day, which would correlate to an annual recurrence interval following FEMA’s guidance for benefit-costs analyses. The State is expected to continue to experience the same average numbers each year.

34.4.2. Climate Change Impacts

The U.S. Environmental Protection Agency regulates facilities that make, use, or store hazardous chemicals. Nationwide, about 31 percent of these facilities are in areas with at least one natural hazard that may be accelerated by climate change: flooding, storm surge, wildfire, or sea-level rise (Government Accountability Office 2022). Figure 34-2 shows the distribution of facilities and natural hazard exposure in California. Increases in the frequency of these natural hazard events could increase the probability and frequency of hazardous materials releases.

Figure 34-2. Chemical Facility Locations Threatened by Climate Change-Accelerated Hazards



Source: (Government Accountability Office 2022a)

34.5. IMPACT ANALYSIS

34.5.1. Severity

The severity of a hazardous materials release depends on factors such as time of day, type of hazardous material released, location of spill, etc. Hazardous materials released during and following industrial accidents and natural disasters pose risks to first responders, the impacted community, and the environment. While many of these incidents may be of a localized nature, they can cause both short- and long-term health and environmental impacts.

Examples of health impacts associated with hazardous material releases in California include the following:

- The 2016 Aliso Canyon methane gas leak, which caused temporary health problems for residents such as difficulty breathing and eye irritation (Wilson 2016).
- The 2016 Fruitland metal recycle plant fire in Maywood, which caused short-term symptoms such as irritation to the eyes, nose, throat, and lungs. This incident prompted a notice regarding "Health Related Information for First Responders and Workers" to be issued jointly by the EPA and Los Angeles County agencies, including the county public health and county fire departments (EPA 2017).
- Communities in the wildland urban interface (WUI) are increasingly at risk of hazardous materials incidents following wildfires. For example, benzene contaminated drinking water supplies after the 2017 Tubbs Fire and the 2018 Camp Fire (Proctor, et al. 2020).

34.5.2. Warning Time

Accidental hazardous material releases due to human error or technical failure, by their nature, occur without advance notice. Releases that are caused by natural hazards may be somewhat anticipated by any advanced forecast of the hazard that is available, especially in the case of weather-related natural hazards such as flooding.

34.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with hazardous materials release:

- Contaminated water supplies
- Contaminated buildings
- Soil contamination that results in mass die-off of vegetation
- Fire and explosions
- Public health impacts

34.5.4. Environmental Impacts

Hazardous releases can significantly harm wildlife in the surrounding area. The contamination also can make its way up the food chain, affecting the food supply. Open water and wetland environments experience significant exposure to hazardous materials events, which may indicate a loss of ecosystem services (OECD n.d.).

In a severe flood event, floodwaters are often contaminated with hazardous materials, posing a threat to public and animal health, groundwater, and other parts of the environment (CDPH 2017). These hazardous materials may be released from damaged or flooded underground tank sites (e.g., gas stations or chemical storage facilities), propane tanks, manure or human waste handling facilities, fertilizer and pesticide storage, agricultural sites, or households.

34.5.5. Local Hazard Impacts

Twenty-six of the hazard mitigation plans prepared for California's 58 counties list hazardous materials as a "hazard of interest." Hazards of interest are hazards that local communities consider to be important but for which a complete risk assessment is not performed due to the nature of the hazard. The following counties listed hazardous materials as a hazard of interest:

- Alpine
- Butte
- Colusa
- Del Norte
- Fresno
- Humboldt
- Imperial
- Inyo
- Lake
- Lassen
- Madera
- Merced
- Modoc
- Mono
- Monterey
- Nevada
- Orange
- San Benito
- San Diego
- San Francisco
- San Luis Obispo
- Santa Barbara
- Shasta
- Trinity
- Tulare
- Tuolumne

34.6. VULNERABILITY ANALYSIS

34.6.1. Exposure of State-Owned or -Leased Facilities

All State-owned or -leased facilities, as listed in Table 4-1 and Table 4-2, are vulnerable to the impacts from hazardous materials releases. This includes 23,961 State-owned facilities and 1,893 State-leased facilities. State assets near facilities that store or process hazardous materials or transportation corridors that permit the transport of hazardous materials have increased risks.

34.6.2. Exposure of Critical Facilities and Community Lifelines

All 755 community lifeline facilities, as listed in Table 4-3, are vulnerable to impacts from hazardous materials releases. All State roads and waterways that permit the transport of hazardous materials are potentially at risk of an incident. Hazardous material releases may lead to road or waterway closures until response and clean-up efforts are completed. This may impact access to communities, commuting to work, and the ability to deliver goods and services efficiently.

34.6.3. Estimates of Loss

A hazardous material release is not likely to result in any losses associated with damage or impairment to State assets. All losses from this hazard would be associated with impacts on the economy or operations.

In the event of a hazardous materials release at or near a State asset, State employees may need to evacuate a building, with resulting loss of productivity that can be measured by days and dollar equivalency. Critical facilities and community lifelines need to remain in operation before, during, and after disaster events. Loss of use will impact the services they provide, which may have public safety and economic implications. Ports and harbors are critical points of entry that need to remain open and operational. A large-scale hazardous materials release resulting in port closures could have cascading impacts statewide.

34.6.4. Buildable Land

An estimated 11.7 million acres of land is available for development in California. Because the entire State is vulnerable to hazard materials releases, any type of development of any of this land will be susceptible to damage and impacts from this hazard.

34.6.5. Equity Priority Communities

Certain populations are more vulnerable than others in the event of a hazardous materials release. Areas nearest to hazardous materials facilities are often primarily composed of low-income people of color (Orum, et al. 2014). Cascading events from a disaster are more likely to amplify and compound vulnerabilities.

Overall, the entire population of the State of California is exposed and vulnerable to hazardous material releases. The population exposed to the hazard in equity priority communities is equal to the statewide percentage: 30.4 percent of the total population (12 million people).

34.7. MITIGATING THE HAZARD

34.7.1. Existing Measures to Mitigate the Hazard

In California, any significant release or threatened release of a hazardous material requires immediate reporting by the responsible person to the Cal OES State Warning Center and the Unified Program Agency or 911 (Cal OES 2022f). Any person or organization responsible for a release or spill is required to notify the federal government when the amount reaches a federally determined limit.

Transportation carriers must have response plans in place to address accidents, otherwise the local emergency response team will step in to secure and restore the area. Quick response minimizes the volume and concentration of hazardous materials that disperse through air, water, and soil.

Mitigation for Hazardous Materials Risks After a Fire

Employers performing cleanup and other work in areas damaged or destroyed by fire are required to identify and evaluate hazardous materials, correct any unhealthful conditions, and provide training to employees. California Division of Safety and Health provides guidelines related to the following:

- Health hazards (carbon monoxide ash, soot, and dust; asbestos; hazardous liquids; other hazardous substances; heat illness)
- Safety hazards (fire and fire byproducts, electricity, flammable gases, unstable structures, demolition, sharp or flying objects, excavations)
- Confinement hazards

Source: (DIR 2021)

34.7.2. Opportunities for Mitigating the Hazard

The State, counties, and communities can influence the probability of incidents and the magnitude of their effects by emphasizing mitigation in hazardous materials emergency management. Efforts to eliminate or reduce risk can include the following (Pipeline and Hazardous Materials Safety Administration 2017):

- Improving methods and procedures for storing, transporting, handling, and processing hazardous materials
- Promoting compliance with safety codes, regulations, and statutes
- Developing and enforcing land use plans that regulate the location of facilities with hazardous materials
- Increasing public and community awareness and support for prevention

Table 34-3 presents a range of alternatives for mitigating the hazardous materials release hazard.

34.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address hazardous materials release:

- Action 2018-001: Support Legislative Efforts that Formalize California's Comprehensive Mitigation Program: Mitigation Legislation and Implementation.
- Action 2018-002: Strengthen Inter-agency Coordination Actions Including State, Regional, and Local Linkages.
- Action 2018-097: Refinery Safety: Improve public and worker safety through enhanced oversight of refineries and strengthen emergency preparedness.

Table 34-3. Potential Opportunities to Mitigate the Hazardous Materials Release Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ Identify and eliminate sources of potential hazardous material spills **Reduce exposure and vulnerability:** ▪ Increase distance between hazardous material sites and development **Build local capacity:** ▪ Personal planning for potential events	**Manipulate the hazard:** ▪ Identify and eliminate sources of potential hazardous material spills **Reduce exposure and vulnerability:** ▪ Increase inspection of hazardous material facilities and transport vehicles ▪ Ensure each facility has Safety Data Sheets for all hazardous materials on-site and staff know the location ▪ Educate staff on the correct way to handle hazardous materials ▪ Determine if high-risk chemical facilities are covered by Chemical Facility Anti-Terrorism Standards **Build local capacity:** ▪ Conduct training for response	**Manipulate the hazard:** ▪ Identify and eliminate sources of potential hazardous material spills **Reduce exposure and vulnerability:** ▪ Increase inspection of hazardous material facilities and transport vehicles **Build local capacity:** ▪ Conduct training for response ▪ Public outreach and education
Nature-based opportunities ▪ There are no identified nature-based solutions to mitigate the impacts of hazardous materials release		

Transportation Accidents Resulting in Explosion or Toxic Releases

Climate Impacts:
Climate change is projected to increase the frequency and intensity of weather events which will lead to damaging transportation infrastructure
Equity Impacts:
30.4% of exposed population (all persons in the State are exposed) identified as living in equity priority communities
State Facilities Exposed:
All facilities exposed
Community Lifelines Exposed:
All community lifelines exposed
Impact Rating: Low (12)

35. Transportation Accidents Resulting in Explosions or Toxic Releases

The transportation accidents resulting in explosions or toxic releases hazard has been identified as low-impact under the hazard impact rating protocol applied for this Plan. These types of events have occurred in the State more than once over the past 25 years. It is estimated that none of the State-owned and-leased facilities and community lifelines are exposed to this hazard. Only populations that reside near transportation corridors are considered to be exposed to this hazard—estimated to be up to 30 percent of the total population and equity priority community population. The development of buildable lands is anticipated to have no impact on this hazard. The frequency and severity of this hazard is anticipated to be increased due to the impacts from climate change.

35.1. HAZARD OVERVIEW

Transportation accidents generally result in limited impacts at the community level unless the vehicles involved carry toxic, volatile, or flammable substances and the accident occurs in a highly populated or densely forested area. In such cases, death, injuries, and damage to homes, infrastructure, and the environment, including forest fires, can occur. This chapter assesses the risk associated with transportation accidents that result in explosions or toxic releases that pose a threat to the surrounding public.

35.2. HAZARD LOCATION

35.2.1. Train

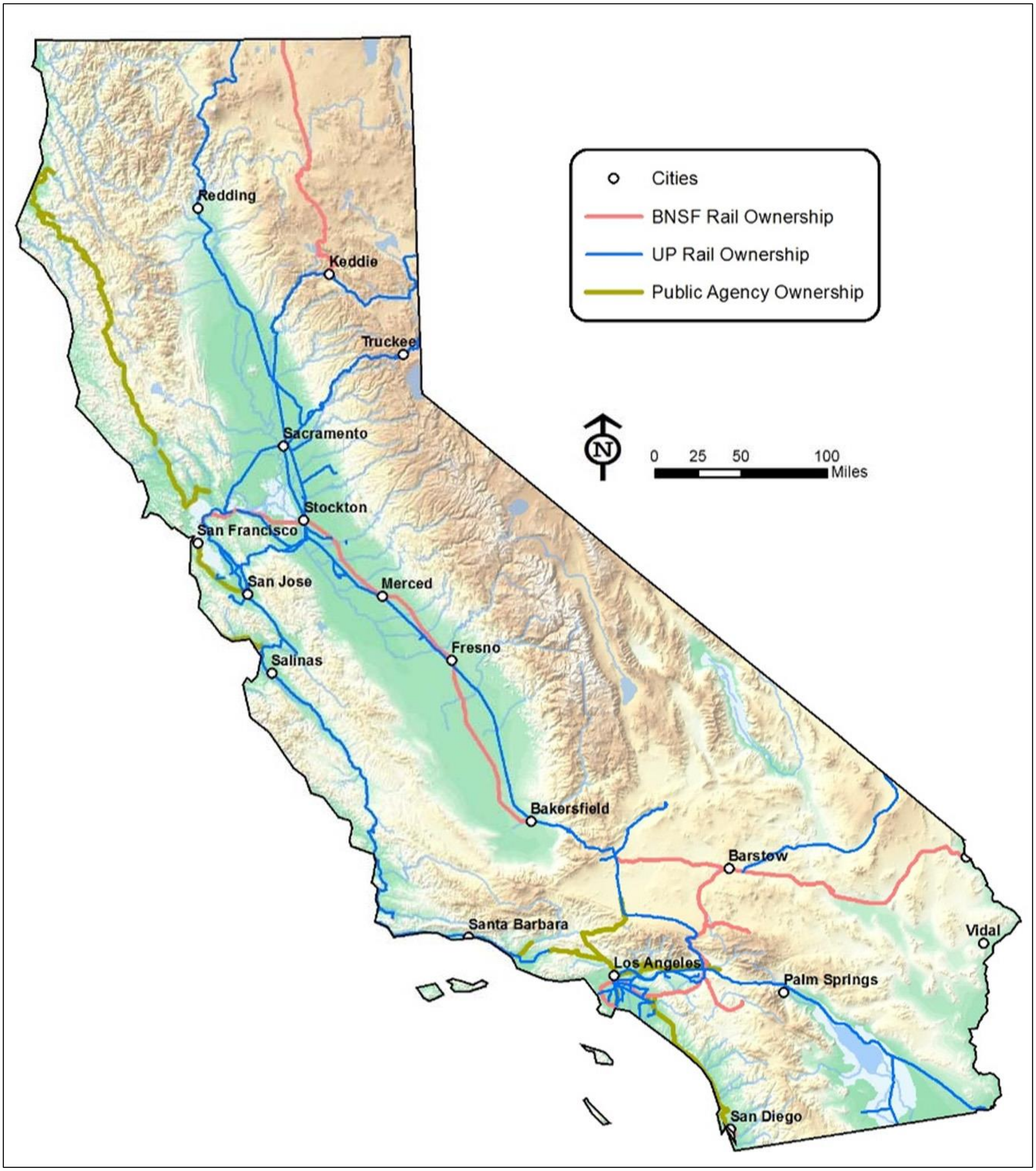
As of 2018, California has 7,009 miles of track owned by freight railroads. This includes 5,418 miles of Class I Railroad track (larger railroads like Union Pacific and BNSF Railway; see Figure 35-1), 1,317 miles of track from Class III Railroads (smaller local railroads, also called "short lines"; see Figure 35-2), and 275 miles at switching terminals (see Figure 35-2) (Caltrans 2018).

California also has 3,762 miles of track on which passenger rail operates, including Amtrak trains and commuter heavy rail. Passenger trains mainly run on tracks owned by Class I freight railroad companies.

California's railroad corridors and hubs are situated mainly along the Pacific coast, the Central Valley, and the urban regions around the Bay Area, Los Angeles, and San Diego, along with some routes that run through the Sierra Nevada Mountains (Caltrans 2018).

Currently, California receives on average of one unit train of crude oil per month at Kern Oil and Refining Company in Bakersfield. Beyond that there are individual carloads of crude oil that come into the State on various manifest trains, but none of those loads carry the highly volatile form of "light sweet crude oil." As of 2022, there is one active crude-by-rail company processing unit trains in California; Plains All American in Bakersfield processed only four trains in 2020 and has not received any trains since October 2020.

Figure 35-1. Class I and Public Agency Owned Rail System in California



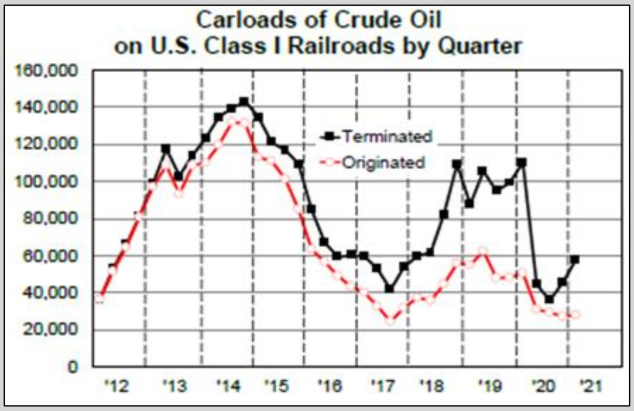
Source: (Caltrans 2018)

Figure 35-2. Short Line and Switching and Terminal Freight Railroads

Source: (Caltrans 2018)

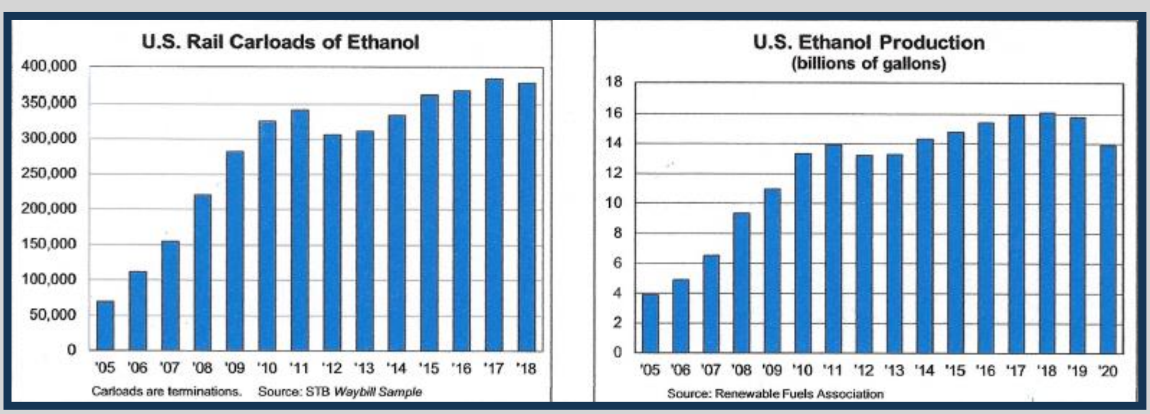
Oil and Ethanol Trains

One of the most significant concerns in rail accidents is related to the transport of largely crude oil by rail. Crude oil must be transported to facilities where it can be processed or transferred to marine tankers. These facilities are generally located in coastal areas, including California. With a sharp rise in U.S. crude oil production in recent years, pipelines linking refineries have reached capacity and railroads have helped fill the gap in transportation of crude oil.



Source: (AAR 2023)

Ethanol is classified as a chemical for rail traffic purposes and is the highest-volume chemical railroads carry. The more than 377,000 carloads of ethanol railroads carried in 2018 accounted for 1.2 percent of total carloads. Most ethanol carried by railroads moves in 30,000-gallon tank cars. Almost all these cars are owned by shippers or leasing companies, not railroads. Ethanol production is concentrated in the Midwest, where most of the corn that goes into ethanol production is grown. Many of the major markets for ethanol are on the East Coast, California, and Texas. Railroads account for 65 to 70 percent of ethanol transport from production to consumption areas. Each of the seven U.S. Class 1 railroads transports ethanol, with some serving several dozen plants. A significant share of ethanol rail movements originates on non-Class I railroads.



Source: (USDA n.d.-b)

35.2.2. Highway

According to the most recent estimates, California's interstate and other highways comprise 7,262 lane miles (U.S. Department of Transportation - Federal Highway Administration 2021). California is home to an estimated 27 million licensed drivers, has over 30 million registered motor vehicles, and approximately 80 percent of its daily commuters travel via private automobile (U.S. Department of Transportation - Bureau of Transportation Statistics 2020).

The State experiences tens of thousands of automobile accidents every year, thousands of which result in fatalities. The majority of accidents in California and the U.S. result from driver errors. Many accidents result from more than one cause, so several people and entities may be involved. Some common causes of highway accidents include but are not limited to:

- Drunk driving
- Distracted driving
- Other types of driver errors such as speeding, diving too close to other vehicles or aggressive driving
- Auto defects
- Road hazards
- Poor weather/visibility

35.2.3. Aviation

Aviation accidents can occur practically anywhere in the State. California has 265 airports, including 27 commercial airports, 19 metropolitan airports, 69 regional airports, 94 community airports, 33 limited use airports, one joint use airport, and 22 federal airfields (California Department of Transportation 2019). There is a history of aviation accidents in California. Common causes of the accidents include but are not limited to the following:

- **Pilot Error**—Pilot error is the most common cause of aviation accidents. While airline manufacturers can use technology to engineer as many risks as possible out of flying, it ultimately comes down to the pilot flying the aircraft to execute a safe takeoff and landing, respond to mechanical problems, and navigate the aircraft through inclement weather. A pilot must also maintain proper fuel levels, utilize the plane's de-icing system, follow instruction from air traffic control, maintain proper speed and altitude during the flight, and perform a host of other tasks. Even a slight error or delay in handling any one of these tasks correctly could result in a disaster.

- **Mechanical Error**—Mechanical errors are the second leading cause of aviation accidents, accounting for 22 percent of all crashes. Mechanical errors could occur because of a flaw inherent in the aircraft's design or because a mechanical part was not properly installed or maintained. Outside forces such as birds flying into plane engines have also been known to cause mechanical failures.
- **Inclement Weather**—Inclement weather is the cause of 12 percent of aviation accidents. While pilots and airlines monitor weather conditions and avoid rough patches of weather or refrain from flying in extreme weather conditions, weather can often be unpredictable. Lightning strikes are a particularly dangerous hazard for airplanes, as they can cause electrical failures or ignite fuel tanks and pipes. Other weather conditions that can cause aviation accidents are strong winds, heavy storms, and thick fog that limit a pilot's line of sight during takeoff or landing.
- **Air Traffic Controller Error**—Air traffic controllers are responsible for controlling the flow of all air traffic and ensuring that aircraft maintain proper distance from each other and take off and land safely. They are often dealing with dozens of aircraft at once, all while making countless split-second decisions regarding variables such as equipment, configuration, weather, and traffic levels. Any misstep or failure to follow proper air traffic control procedures can lead to a fatal plane crash.

35.3. PREVIOUS HAZARD OCCURRENCES

35.3.1. Disaster and Emergency Declarations

The following disaster declarations or emergency proclamations related to transportation accidents have been issued for California (see Appendix F for details):

- Federal DR or EM declaration, 1953 – 2022: None
- California Emergency Proclamations, 1950 – 2022: two events, classified as "air disaster (plane crash)"
- USDA agricultural disaster declarations, 2012 – 2022: None

35.3.2. Event History

Summary of Most Recent Events

The 2018 SHMP listed train accidents resulting in explosions or toxic releases in California through 2017. Table 35-1 summarizes train, highway, and aviation accidents since 2017. Refer to Appendix K for the complete history of past events.

Table 35-1. California Transportation Accidents Resulting in Explosions or Toxic Releases, 2018 – 2022

	2018	2019	2020	2021	2022 (January – October)
Train					
Total Accidents	96	70	50	47	29
Injuries	2	0	0	1	0
Fatalities	0	0	0	0	0
Highway					
Total Accidents	1,606	1,771	1,907	1,807	1,218
Injuries	8	12	3	1	0
Fatalities	0	1	0	0	0
Aviation					
Total Accidents	60	50	42	30	6
Injuries	0	0	0	0	0
Fatalities	0	0	0	0	0

Source: (U.S. Department of Transportation 2022)

Significant Events

Department of Defense Boxcar Fire in Roseville, 1973

On April 28, 1973, a Department of Defense boxcar carrying 250-pound bombs filled with TNT/aluminum caught fire in Roseville. The fire department was called, but before firefighters could act, a large explosion demolished a boxcar and spread the fire. Over a period of 32 hours, 18 boxcars exploded in succession. No one was killed, but about 100 people were injured. There was about $24 million in property damage to the railroad yard and surroundings. The litigation that followed lasted for several years and cost the government millions of dollars (Southern Pacific Transportation Company 1973).

Sacramento River Chemical Spill near Dunsmuir, 1991

On July 14, 1991, a Southern Pacific Railroad train jumped the track near Dunsmuir and a tanker carrying 19,000 gallons of a deadly soil sterilizing chemical spilled into the Sacramento River. The toxic cloud made local residents sick. A 41-mile stretch of the river was stripped bare of all plant life including thousands of trees and killed more than 1 million fish (DTSC 2022).

California Oil and Ethanol Train Traffic

As the crude oil trains entering California have decreased in number, the trains carrying ethanol into California have increased enormously. In 2021 California received 20-unit trains carrying crude oil, and 139-unit trains carrying ethanol, with each unit train carrying about 100 cars at a time.

35.4. PROBABILITY OF FUTURE HAZARD EVENTS

35.4.1. Overall Probability

California experienced hundreds of train, highway, and aviation accidents in recent years. Table 35-2 shows these statistics. On average, the State can experience over 1,750 transportation accidents resulting in explosions or toxic releases of any type each year, with highway accidents occurring most frequently.

Table 35-2. Probability of Future Transportation Accidents Resulting in Explosions or Toxic Releases

	Number of Occurrences Between 2018 and 2022	Annual Number of Events (average)
Train	292	58.4
Highway	8,309	1,661.8
Aviation	188	37.6
TOTAL	**8,789**	**1,757.8**

35.4.2. Climate Change Impacts

Climate change is projected to increase the frequency and intensity of weather events, which could damage transportation infrastructure. Heat waves will likely be more severe, sea-level rise can amplify storm surge in coastal areas, and precipitation will be more intense. These changes could increase the risk of delays, disruptions, damage, and failure across all modes of transportation in the State (EPA 2019).

Train

Railroads pass through hundreds of miles of California wilderness, leaving them vulnerable to many of the hazards covered elsewhere in this document, from severe storms to extreme heat and from floods to avalanches (Rossetti n.d.). Such hazards can negatively impact rail safety by damaging or destroying rail infrastructure such as tracks, bridges, and signals. As climate change causes more frequent and severe occurrences of these hazards, it can be assumed that these more frequent and severe occurrences will pose a greater threat to California's railroads and could lead to an increase in rail accidents.

Highway

An increase in severe weather events brought on by climate change will likely negatively impact California's highways. Highways are vulnerable to the effects of coastal flooding, wildfires, and increased extreme precipitation, which could lead to flooding and landslides along highways (U.S. Global Change Research Program 2018). Incidents of such hazards on or along California's highways could lead to additional traffic accidents, injuries, and fatalities (U.S. Department of Transportation - Federal Highway Administration n.d.).

Aviation

Increased storms and flooding could damage and destroy runways and other facilities at airports, and extreme heat can affect the performance of aircraft. Climate change will likely cause additional safety issues for California's aviation sector (EPA 2016).

35.5. IMPACT ANALYSIS

35.5.1. Severity

Dozens of train and aviation accidents and more than 1,600 highway accidents that result in explosions or toxic releases take place in California annually, leading to injuries and deaths. The frequency with which these accidents take place may make them comparatively more dangerous than other hazard types.

35.5.2. Warning Time

Accidents involving various modes of transportation occur with little to no notice, giving governments, communities, and officials little to no time to respond.

35.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with transportation accidents:

- Transportation accidents resulting in explosions or toxic releases can impact the health of people in surrounding communities.
- Events involving explosions may ignite nearby structures or forest lands, resulting in urban fires or wildfires.
- Accidents may result in closures of airports, highways, or railways and cause temporary supply chain interruptions.

35.5.4. Environmental Impacts

Hazardous materials and fires have the potential to cause environmental damage, contaminating or burning local natural areas. Spills and fires can contaminate potable water sources and soils, harming wildlife, and can have long-term ecological impacts.

35.5.5. Local Hazard Impacts

One of the hazard mitigation plans prepared for California's 58 counties—the Orange County hazard mitigation plan—lists aircraft accident as a "hazard of interest". Hazards of interest are hazards that local communities consider to be important but for which a complete risk assessment is not performed due to the nature of the hazard.

35.6. VULNERABILITY ANALYSIS

35.6.1. Exposure of State-Owned or -Leased Facilities, Critical Facilities, and Community Lifelines

All State-owned or -leased facilities, critical facilities, and community lifelines as listed in Table 4-1, Table 4-2, and Table 4-3, are vulnerable to the impacts from transportation accidents resulting in explosions or toxic releases. This includes 23,961 State-owned facilities, 1,893 State-leased facilities, and 755 community lifeline facilities.

35.6.2. Estimates of Loss

Transportation accidents are not likely to result in any losses associated with damage or impairment to State assets. All losses from this hazard would be associated with impacts on the economy, based on impaired operations and incident response costs.

35.6.3. Buildable Land

An estimated 11.7 million acres of land are available for development in California. Because the entire State is vulnerable to transportation accidents, any type of development of any of this land will be susceptible to damage and impacts from this hazard.

35.6.4. Equity Priority Communities

Land adjacent to highways, rail lines and yards, ports, airports, and other transportation routes and terminals tends to be less desirable, making it less expensive to purchase and develop housing. This makes for housing which equity priority populations are more likely to be able to afford, placing these populations in settings closer to areas that experience transportation accidents.

Because the entire population of the State of California is exposed and vulnerable to transportation accidents, the exposed population in equity priority communities is equal to the statewide percentage: 30.4 percent of the total population (12 million people).

35.7. MITIGATING THE HAZARD

35.7.1. Existing Measures to Mitigate the Hazard

Federal regulations for transportation safety focus on design standards and safety technologies. State regulations address inspection, enforcement, preparedness, and response.

Tougher tank car designs and technologies that monitor track and rail car health and first responder training result in more than 99.99 percent of all hazardous materials moved by rail reaching its destination without a release caused by a train accident.

Regional Hazardous Materials Response Program

The Regional Hazardous Materials Response Program was implemented in 2018. Cal OES embarked on an effort to increase local emergency response capability in identified gap areas by assigning 12 newly purchased Cal OES Type II Hazardous Materials response vehicles to be strategically located in rural and metropolitan fire departments. These agencies entered into a contractual agreement with Cal OES to staff the vehicles and respond to hazardous materials emergencies within the State upon request. Cal OES provided funds to train 25 personnel from each agency in hazardous materials and terrorism response and create a sustainment plan to ensure that the agencies would maintain the staffing for response to hazardous materials and terrorism emergencies. Cal OES funds all vehicle and equipment maintenance expenditures to ensure that the State-sponsored hazmat response teams are ready to respond to and mitigate any hazmat emergency release.

35.7.2. Opportunities for Mitigating the Hazard

Even with rigorous safety measures in place, transportation hazards cannot be completely eliminated. However, there are mitigation measures the State can implement to reduce the severity or seriousness of a transportation accident resulting in explosions or toxic releases. A range of potential alternatives for mitigating the transportation accidents hazard is provided in Table 35-3. See Section 1.2.3 for a description of the different types of alternatives.

Table 35-3. Potential Opportunities to Mitigate the Transportation Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ None **Reduce exposure and vulnerability:** ▪ None **Build local capacity:** ▪ Develop and practice a household evacuation plan	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Protect corporate critical facilities from potential impacts (air filtration capability) **Build local capacity:** ▪ Develop and practice a corporate evacuation plan ▪ Inform employees through corporate sponsored outreach	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Protect critical facilities from damage associated with explosions and toxic releases ▪ Build redundancy for critical facilities and functions **Build local capacity:** ▪ Public outreach, awareness
Nature-based opportunities ▪ There are no identified nature-based solutions to mitigate the impacts of transportation accidents		

35.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address transportation accidents resulting in explosions or toxic releases:

- Action 2018-001: Support Legislative Efforts that Formalize California's Comprehensive Mitigation Program.
- Action 2018-003: Broaden Public and Private Sector Mitigation Linkages.
- Action 2018-100: Rail Safety: Examine rail safety concerns related to the transport of crude oil.

WELL STIMULATION AND HYDRAULIC FRACTURING

Climate Impacts:
Unknown

Equity Impacts:
30.4% of exposed population (all persons in the State are exposed) identified as living in equity priority communities

State Facilities Exposed:
All facilities exposed

Community Lifelines Exposed:
All community lifelines exposed

Impact Rating: Low (9)

36. WELL STIMULATION AND HYDRAULIC FRACTURING

The well stimulation and hydraulic fracturing hazard has been identified as low-impact under the hazard impact rating protocol applied for this plan. These types of events have occurred in the State more than once over the past 25 years. It is estimated that none of the State-owned or -leased facilities and community lifelines is exposed to this hazard. Only populations that reside near well stimulation and fracturing sites are considered to be exposed to this hazard—estimated to be between 15 and 30 percent of the total population and less than 14 percent of the equity priority community population. The development of buildable lands is anticipated to have no impact on this hazard. The frequency and severity of this hazard is not anticipated to be increased due to the impacts from climate change.

36.1. HAZARD OVERVIEW

Well stimulation is defined in California State regulations as "a treatment of a well designed to enhance oil and gas production or recovery by increasing the permeability of the formation." Hydraulic fracturing is a well stimulation treatment that, in whole or in part, includes the pressurized injection of hydraulic fracturing fluid or fluids into an underground geologic formation in order to fracture or with the intent to fracture the formation, thereby causing or enhancing the production of oil or gas from a well (California Senate 2013).

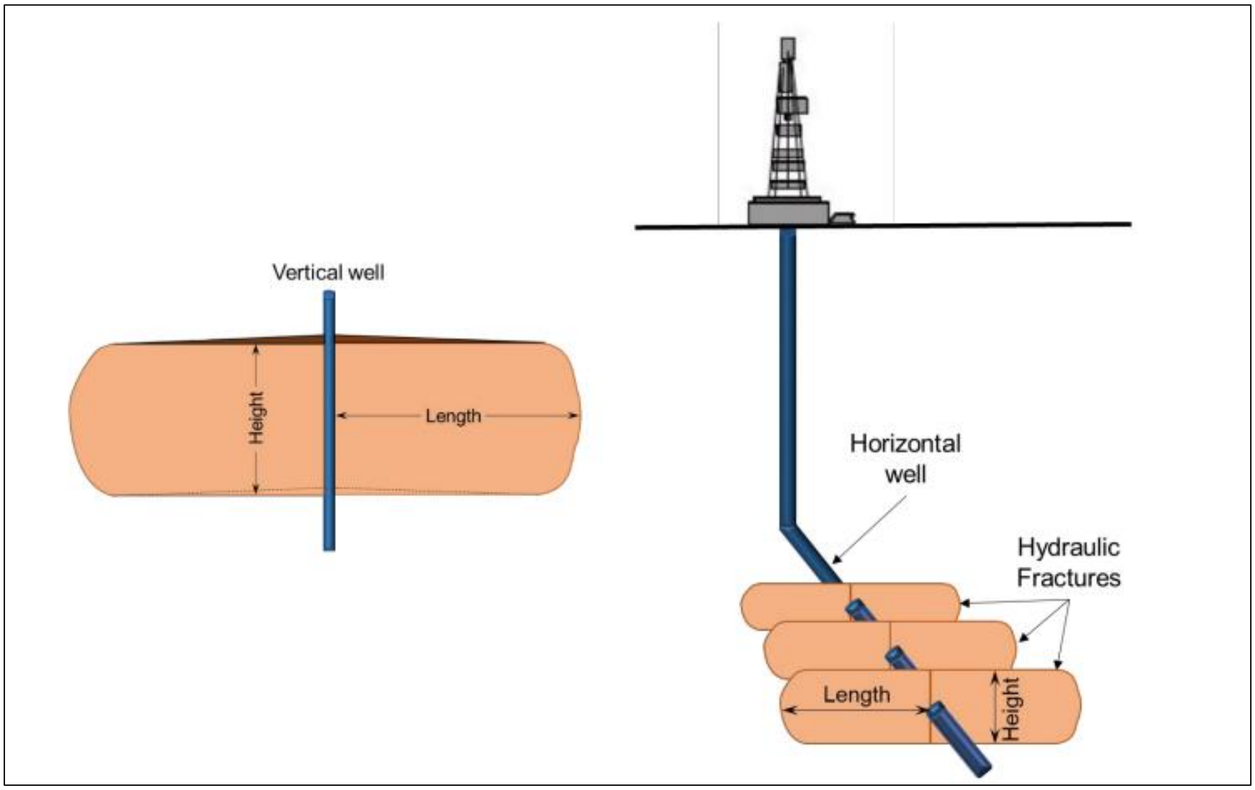
Another type of well stimulation treatment used to increase oil and gas production is acid well stimulation, which introduces one or more acids (applied at any pressure) to a well or geologic formation, either alone or in combination with hydraulic fracturing treatments (Infinity Energy Solutions 2018).

36.2. HAZARD LOCATION

Fracking has been documented in 10 California counties — Colusa, Glenn, Kern, Los Angeles, Monterey, Sacramento, Santa Barbara, Sutter, Kings, and Ventura. In Kern County, California's major oil-producing county, 50 to 60 percent of new oil wells are fracked. Fracking may have been done elsewhere in California, since State officials have not monitored or tracked the practice until recently (Center for Biological Diversity n.d.). Oil companies have also fracked offshore wells hundreds of times in the ocean near California's coast, from Seal Beach to the Santa Barbara Channel.

Between July 2015 and June 2016, 579 well stimulations were performed, with over 80 percent of them in diatomite formations. Wells in diatomite formation are generally shallow: average fracture height was 150 feet, average length was 76 feet, and average depth was 1,220 to 1,991 feet in 2016 (Division of Gas Oil and Geothermal Resources 2016). Less water is used in California wells than in wells outside of California. Related well dimensions are shown in Figure 36-1.

Figure 36-1. Use of Height and Length in Describing Well Stimulation Treatment Fractures in California.



Source: (DOC 2021)

36.3. PREVIOUS HAZARD OCCURRENCES

36.3.1. Disaster and Emergency Declarations

No FEMA, USDA, or State disaster declarations or proclamations related to well stimulation or hydraulic fracturing have been issued relevant to California or any of its counties.

36.3.2. Event History

According to the California Department of Conservation (DOC), there were 652 oil and gas wells stimulated using hydraulic fracturing in 2014. In 2015, California had 56,653 active oil and natural gas wells.

36.4. PROBABILITY OF FUTURE HAZARD EVENTS

Fracking is a standard practice for the oil and gas production industry. It is reasonable to expect that the State of California will experience direct or indirect impacts from fracking annually.

36.5. IMPACT ANALYSIS

36.5.1. Severity

The application of fracking in California differs from elsewhere in the United States in two important ways (California Council on Science and Technology; Lawrence Berkeley National Laboratory 2015):

- Wells in California are most often stimulated to produce oil, not natural gas.
- Fracturing in California tends to occur in shallower, vertical wells at depths of less than 2,000 feet. As a result, fracking in California uses far less water per well, on average, than is used in other states. While using less water, fracking at shallow depths increases the risk of near-surface groundwater contamination.

36.5.2. Warning Time

Well stimulation treatment permits issued by the State are posted within five business days of issuance (DOC n.d.).

36.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The California oil and gas industry uses a large number of hazardous chemicals during hydraulic fracturing and acid treatments. The use of these chemicals underlies all significant potential direct impacts of well stimulation in California (LAO 2016).

36.5.4. Environmental Impacts

Environmental impacts that could result from fracking and well stimulation include the following (Jackson, et al. 2014):

- Contamination of groundwater with chemicals
- Air pollution from dispersion of chemicals and gases
- Contamination of sub-surface rock formations from the injected chemicals

These concerns exist anywhere fracking is used as a gas and oil extraction method.

36.5.5. Local Hazard Impacts

One of the hazard mitigation plans prepared for California's 58 counties—Santa Barbara County—lists well stimulation as a hazard of interest.

36.6. VULNERABILITY ANALYSIS

36.6.1. Exposure of State-Owned or -Leased Facilities, Critical Facilities, and Community Lifelines

All State-owned or -leased assets, as listed in Table 4-1 and Table 4-2, are exposed to this hazard. This includes 23,961 State-owned facilities, and 1,893 State-leased facilities.

All 755 State critical facilities and community lifelines, as listed in Table 4-3, are exposed to this hazard as well.

36.6.2. Estimates of Loss

Well stimulation is not likely to result in any losses associated with damage or impairment to State assets. All losses from this hazard would be associated with impacts on the economy, based on public health or environmental impacts.

36.6.3. Buildable Land

An estimated 11.7 million acres of land is available for development in California. Any new development could be susceptible to damage and impacts from well stimulation and hydraulic fracturing.

36.6.4. Equity Priority Communities

Equity priority communities are disproportionately exposed to the negative impacts of fracking and well-stimulation. A 2015 study demonstrated that wells were concentrated mainly in areas of high poverty and with high populations of older adults (Ogneva-Himmelberger and Huang 2015).

Due to the lack of data to clearly quantify this exposure, it has been assumed that the entire population of California is exposed and vulnerable to well stimulation and hydraulic fracturing. The exposed population in equity priority communities is equal to the statewide percentage: 30.4 percent of the total population (12 million people).

36.7. MITIGATING THE HAZARD

36.7.1. Existing Measures for Mitigating the Hazard

There are various mitigation measures the State can implement to reduce the severity or seriousness of a well stimulation and hydraulic fracturing hazard event, especially in relation to contamination of groundwater.

The California Legislature passed Senate Bill (SB) 4 in 2013 to regulate well stimulation treatments, including fracking. SB 4 amends the Public Resources Code and the Water Code (California Senate 2013). It encourages development of new science information related to impacts of well stimulation treatments. As part of its requirements, the California Natural Resources Agency (CNRA) conducted an independent study on well stimulation treatments. The review surveyed three types of well stimulation treatments for both onshore and offshore oil and gas production in the State to provide independent, scientific, peer-reviewed information to inform policymakers (California Council on Science and Technology n.d.).

The following State agencies and a national laboratory are involved in oversight and regulatory activities:

- Division of Oil, Gas, and Geothermal Resources
- OEHHA
- Department of Toxic Substances Control (DTSC)
- State Water Resources Control Board
- CARB
- Lawrence Berkeley/Livermore National Laboratories

The collective objectives of these agency efforts are to lower the probability of well failure and to identify any contamination problems quickly and act on measures to limit contamination impacts.

As of July 1, 2015, all well stimulation treatment performed in California must be permitted on an individual treatment-by-treatment basis. Prior to performing the treatment, the operator must submit a permit application for review and approval. Well stimulation treatment cannot be performed on any well without a valid permit issued by the State. Well stimulation treatment permits issued by the State are posted within five business days of issuance (DOC n.d.).

36.7.2. Opportunities for Mitigating the Hazard

A range of potential opportunities for mitigating the well stimulation and hydraulic fracturing hazard is provided in Table 36-1. See Section 1.2.3 for a description of the different types of alternatives.

Table 36-1. Potential Opportunities to Mitigate the Well Stimulation and Hydraulic Fracturing Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ None **Reduce exposure and vulnerability:** ▪ Locate outside of hazard area **Build local capacity:** ▪ Develop and practice a household evacuation plan	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Locate outside of hazard area ▪ Protect corporate critical facilities from potential impacts of chemical contamination **Build local capacity:** ▪ Develop and practice a corporate evacuation plan ▪ Inform employees through corporate sponsored outreach	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Locate outside of hazard area ▪ Regulate well drilling permitting ▪ Monitor groundwater quality ▪ Monitor air quality ▪ Protect critical facilities from potential problems associated with chemical contamination **Build local capacity:** ▪ Public outreach, awareness
Nature-based opportunities ▪ There are no nature-based solution identified to mitigate the impacts of this hazard		

36.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address well stimulation or hydraulic fracturing:

- Action 2018-001: Support Legislative Efforts that Formalize California's Comprehensive Mitigation Program.
- Action 2018-006: Enhance Collaboration on the Development and Sharing of Data Systems and GIS Modeling.
- Action 2018-007: Support and Coordinate Monitoring of Progress on State Goals and Objectives.

Oil Spills

Climate Impacts:
Warmer waters have made oil transportation and development possible or more achievable in cold areas, increasing the risk of spills in more areas

Equity Impacts:
15 -30% of exposed population (all persons in the State are exposed) identified as living in equity priority communities

State Facilities Exposed:
All facilities exposed

Community Lifelines Exposed:
All lifelines exposed

Impact Rating: Low (8)

37. Oil Spills

The oils spill hazard has been identified as low-impact under the hazard impact rating protocol applied for this Plan. These types of events have occurred in the State more than once over the past 25 years. It is estimated that all of the State-owned or -leased facilities and community lifelines are exposed to this hazard to some degree. Only populations that reside near oil production and storage facilities are considered to be exposed to this hazard—estimated to be between 15 and 30 percent of the total population and the equity priority community population. The development of buildable lands is anticipated to have no impact on this hazard. The frequency and severity of this hazard could increase due to impacts from climate change.

37.1. HAZARD OVERVIEW

An oil spill is a release of liquid petroleum into the environment due to human activity, resulting in pollution of land, water, or air. Oil spills can result from the release of crude oil from offshore oil platforms, drilling rigs, wells, pipelines, tank trucks, and marine tank vessels (Castranova 2016). Refined petroleum products, such as gasoline or diesel, and heavier fuels, such as bunker fuel used by cargo ships, are also sources of potential oil spill releases (NASA n.d.). Oil spills can be caused by people making mistakes or being careless, by equipment breaking down, by natural disasters, and by deliberate acts of terrorism, vandalism, or illegal dumping (NOAA 2019). Oil seeps, in which oil releases naturally on land or under water, usually happen slowly and are not considered to be spills (NOAA 2021).

Spills, Slicks, and Sheens

During an oil spill on water, the oil floats, spreading out across a large area. This is called an oil slick. As the oil slick spreads, it becomes thinner and is called an oil sheen (NOAA 2019).

37.2. HAZARD LOCATION

37.2.1. On Land

The complex array of petroleum-related industries and distribution networks throughout California makes the State vulnerable to oil spills. According to the CalGEM WellSTAR data dashboard, there are 161,727 oil and gas wells in the State of California, of which 31,117 are active. A total of 33 California counties produce oil (DOC 2019e).

37.2.2. Offshore

There are 11 oil and gas leases in waters off the coast of California. As part of these leases, there are 26 production platforms and one processing platform. Of the 27 platforms, 23 are in federal waters offshore of Santa Barbara, Ventura, and Los Angeles counties; four are in State waters offshore of Santa Barbara and Orange counties. A platform called Holly, in State waters offshore of Santa Barbara County, is in the process of well plugging and abandonment. There are five artificial oil and gas production islands located in the waters offshore of California. One of these islands, Rincon Island off the coast of Ventura County, is no longer producing oil (State of California 2022g).

37.3. PREVIOUS HAZARD OCCURRENCES

37.3.1. Disaster and Emergency Declarations

A State emergency proclamation was issued in May 2015 for spill response in Santa Barbara County to address an oil spill near Refugio State Beach (Office of Governor 2015). No FEMA or USDA disaster declarations or proclamations related to oil spills have been issued relevant to California or any of its counties.

37.3.2. Event History

Table 37-1 summarizes major oils spill events in California since 1911.

Table 37-1. Summary of California Oil Spills, 1911 Through 2022

Spill	Location	Date	Area Affected	Estimated Amount	Wildlife Impacts	Estimated Costs
Amplify Spill	Offshore of Huntington Beach, Orange County, San Diego County	October 2021	Pacific Ocean	25,000 gallons	Not specified	Not specified
Cymric Oil Field	Kern County	May – August 2019	Multiple spills in the oil field/dry stream bed	1.34 million gallons of oil/water mix, of which 400,000 gallons is petroleum	Not specified	Not specified
Refugio Oil Spill – Plains All America Pipeline	Refugio State Beach, Santa Barbara County	May 19, 2015	Approximately 7 miles of coastline	123,000 gallons	Birds, marine mammals, fish, coastal and subtidal habitats	$22 million for case settlement, about $20 million for habitat restoration, recreational and human uses, and administrative costs
Cosco Busan	San Francisco Bay	November 7, 2007	Bay and coastline	53,000 gallons	6,800 birds, fish embryo, marine mammals, and other wildlife	$44.4 million settlement with responsible parties
Kinder Morgan Suisun Marsh	Solano County	2004	A managed salt marsh	123,774 gallons	A range of wildlife in the marsh were harmed	Not specified
ARCO Santa Clara River Spill	Santa Clarita County	1994	Santa Clara River to Piru	190,000 gallons	100 acres of riparian vegetation	$7.1 million in restitution

Spill	Location	Date	Area Affected	Estimated Amount	Wildlife Impacts	Estimated Costs
American Trader	Offshore of Huntington Beach, Orange County	February 7, 1990	About 13 miles of coastline plus offshore area	416,598 gallons	3,400 birds; fish	$3.45 million settlement for bird and fish-related injuries; $360,000 for water monitoring projects; $11.6 million for recreational damage
Huntington Beach	Orange County	1990	Pacific Ocean and 15 miles of beach near the Bolsa Chica wetlands	310,195 gallons	1,000 birds	$35 million from local agencies and $27 million in resulting settlements
Shell Martinez Spill	McNabney Marsh, Carquinez Strait, Contra Costa County	1988	Marsh, bay, and creek, Carquinez Strait	400,000 gallons	Wetland areas	$20 million in fines from Shell
Apex Houston Spill	Offshore San Francisco County, San Mateo County, Santa Cruz County, Marin County, Monterey County	1986	Pacific Ocean	25,800 gallons	Not specified	Not specified
Arizona Standard	San Francisco	1971	San Francisco Bay	831,222 gallons	50 miles of shoreline from Point Reyes to Half Moon Bay. 10,000 birds.	Not specified

Spill	Location	Date	Area Affected	Estimated Amount	Wildlife Impacts	Estimated Costs
Santa Barbara/ Union Spill	Santa Barbara County	January 28, 1969–February 8, 1969	35 miles mainland coastline; 800-square mile slick	3,000,000 gallons	3,600 birds, seals, dolphins, fish, intertidal invertebrates	$17 million in lawsuit settlements for property damage
Guadalupe Oil Field - San Luis Obispo	Offshore Avila Beach, San Luis Obispo County	1950s–1994	2,700 acres	9,000,000-12,000,000 gallons	Soil and water contamination; impacts on dune habitat, wetlands, groundwater, intertidal habitat	$44 million in penalties to Unocal, including $9 million for restoration
Avila Beach	San Luis Obispo County	1950 – 1996	Underground beneath Avila Beach	400,218 gallons	Not specified	$200 million
San Francisco Bay Spill	San Francisco	1937	San Francisco Bay	2,730,000 gallons	20,000 birds	Not specified
Lakeview Gusher	Kern County	May 14, 1910–September 1911	Not available	378,000,000 gallons	Unknown	Unknown

Source: (Clarke 2015), (Orange County Coast Keeper n.d.), (CDFW 2022b), (CDFW 2022c), (NOAA 2021a), (Goldberg 2019)

An example of a recent event is a large spill from a pipeline displacement on October 1, 2021, that deposited between 25,000 and 131,000 gallons of crude oil on Huntington Beach in Orange County (Los Angeles Times 2021). The U.S. Coast Guard monitored the spill several times daily from the air and estimated that it covered 8,320 acres of the ocean’s surface (Fry, et al. 2021). Investigations found a 17.7-mile pipeline connecting offshore oil platforms with the shore had been displaced, possibly by being dragged by a ship’s anchor (Fry, et al. 2021).

37.4. PROBABILITY OF FUTURE HAZARD EVENTS

37.4.1. Overall Probability

California’s 16 recorded major oil spill events between 1910 and 2022 represent an average of about one event every seven years, a rate likely to continue in the future.

A 2003 report predicted that "based on the amount of offshore oil expected to be produced in California over the next 28 years and the number of spills that have occurred in the past, the risk of a spill of 1,000 barrels or greater occurring during that period is estimated at 41.2 percent for federal operations and 8.4 percent for state operations." (McCrary, Panzer and Pierson 2003).

37.4.2. Climate Change Impacts

Warmer waters and declining sea ice have made oil transportation and development possible or more achievable in cold areas like the Arctic by opening waters that were not traditionally accessible due to ice. Oil collection and development each carry the risk of a spill (NOAA 2020). Therefore, with changing climate conditions that favor the collection and transportation of oil, the chances of spills in these areas increases.

37.5. IMPACT ANALYSIS

37.5.1. Severity

Depending on the origin, size, and duration of the release, an oil spill can have serious impacts on air and water quality, public health, plant and animal habitat, and biological resources. Large spill clean-up and remediation activities may cost millions of dollars and impacts from the spills can last for years (Environmental Pollution Centers 2022).

Oil spills can range in size depending on the source and situation. Most are relatively small but large spills still occur (NOAA 2020). California's largest recorded oil spill released 4.2 million gallons of fuel off the coast of Santa Barbara in 1969 (Cart and Becker 2022).

37.5.2. Warning Time

Oil spills usually occur with little to no warning and often are difficult to stop. However, prevention measures such as inspections play a large role in minimizing spills (NOAA 2021b). The CDFW Office of Spill Prevention and Response (OSPR) is the State's lead for response to oil spills in its inland and marine waters. OSPR aims for best achievable protection of California's natural resources. In 2014, the OSPR program expanded to cover all State surface waters at risk of oil spills from any source, including pipelines, production facilities, and the increasing shipments of oil transported by railroads. This expansion provided critical administrative funding for industry preparedness, spill response, and continued coordination with local, State, and federal government along with industry and NGOs.

In 2021, California lawmakers enacted legislation on renewable fuels and oil spill preparedness and response. Assembly Bill (AB) 148 updated sections of the Lempert-Keene-Seastrand Oil Spill Prevention & Response Act, addressing renewable fuels. Facilities and vessels that handle renewable fuels are now within the jurisdiction of OSPR, including two new categories: renewable fuel production and renewable fuel receiving facilities.

37.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with oil spills:

- Oil spills can impact public health.
- Oil spills can contaminate drinking water.
- Oil spills can disrupt the economy.
- Oil spills can devastate the environment.
- Those assisting with cleaning up oil spills can be impacted by being exposed to oil byproducts, dispersants, detergents, and degreasers. Drowning, heat-related illnesses, and falls also are potential hazards to those cleaning up (OSHA 2010).
- Oil spills can cause serious damage to fisheries and mariculture resources.

37.5.4. Environmental Impacts

A spill can result in habitat loss from the physical oil slick or the release of chemicals into an area (Environmental Pollution Centers 2022). Similarly, individual organisms can be directly affected as layers of oil can prevent thermoregulation, respiration, feeding, or mobility. They can also be affected by the chemicals released that act as toxins to the organism, which can lead to stunted growth, heart damage, immune system effects, and death (NOAA 2020). Impacts are based on extent of the spill and type of oil, but one spill has the potential to harm or kill thousands of organisms. Cleaning up a spill is difficult and results in wildlife losses even with extensive efforts (Wong 2022).

37.5.5. Local Hazard Impacts

Three of the hazard mitigation plans prepared for California's 58 counties list oil spills as a "hazard of interest." Hazards of interest are hazards that local communities consider to be important but for which a complete risk assessment is not performed due to the nature of the hazard. The following counties listed oil spills as a hazard of interest:

- Humboldt
- Orange
- Santa Barbara

37.6. VULNERABILITY ANALYSIS

This section discusses the State's vulnerability of exposed State assets, critical facilities, and community lifelines to the oil spill hazard.

37.6.1. Exposure of State-Owned or -Leased Facilities

All State-owned or -leased facilities, as listed in Table 4-1 and Table 4-2, are vulnerable to the impacts from oil spills. This includes 23,961 State-owned facilities and 1,893 State-leased facilities.

State assets near the shoreline, large inland waterways, oil terminals and pipelines, or transportation corridors that permit the transport of oil have an increased risk of exposure. Depending upon the incident, State employees may need to evacuate the area if exposure may impact human health. This may result in loss of productivity that can be measured by days and dollar equivalency. In terms of facility-related and property damage, damage may include contaminated soil, groundwater, and nearby waterbodies.

37.6.2. Exposure of Critical Facilities and Community Lifelines

All 755 critical facilities and community lifelines, as listed in Table 4-3, are vulnerable to the impacts from oil spills. All State roads that permit the transport of oil are potentially at risk of an incident. Transportation carriers must have response plans in place to address accidents; otherwise, the local emergency response team will step in to secure and restore the area. Quick response minimizes the volume and concentration of oil that disperses through the water and soil.

The degree of damage to critical facilities and community lifelines depends on the scale of the incident. Oil spills may lead to road and harbor closures until response and clean-up efforts are completed. This may impact access to communities, work commutes, and the ability to deliver goods and services efficiently.

Ports and harbors are critical points of entry that need to remain open and operational to maintain the vital shipping logistics required to sustain California's communities. In the event of a large-scale oil spill resulting in port closures, there will be cascading impacts statewide.

37.6.3. Estimates of Loss

Oil spills do not typically impact buildings; however, losses may be associated with the disruption of operations and with environmental impacts. The environmental impacts of oil spills contribute to short- and long-term effects on economic activities in the affected areas. Moratoriums may be temporarily imposed on fisheries, and tourism may decline in beach communities (ITOPF 2022), resulting in economic hardship on individuals dependent on those industries for their livelihood and on the economic health of the community as well.

37.6.4. Buildable Lands

Growth in population, urbanization, and land development near oil facilities, together with addition of new facilities to meet new demands, may increase the exposure of people and property to oil spills.

Throughout the State, over 11.7 million acres of land are available for development. It is not exactly known how much of that land is suitable for production facilities. Local planning efforts that choose to assess this hazard of concern are encouraged to perform a buildable lands survey. Because the entire State is vulnerable to the oil spill hazard, any type of development in buildable areas will be susceptible to damage and impacts from such events.

37.6.5. Equity Priority Communities

Indigenous populations can be impacted heavily by oil spills since they rely on the resources for food and culture. Other vulnerable populations include those that heavily rely on the oil for heat or other needs, and local industries that rely on oil for jobs (Gray 2019). Communities that live near potential spill sites are at greater risk of exposure and harm as well. California has the highest percentage of Black, Indigenous, Latina/e/o, Asian, and Pacific Islander communities living in proximity to hazardous sites, compared to all other states in the U.S. Nearly 5.4 million people live within a mile of oil and gas drilling sites, and the majority of them are Latina/e/o, Black, Asian American, Indigenous or other People of Color. Of the 1.8 million Californians living within 2,500 feet of an oil and gas well, 92 percent are Latina/e/o, Black, Asian American, Indigenous, or other People of Color (Srebotnjak and Rotkin-Ellman 2014).

Broadly speaking, equity priority communities (estimated to be 15 to 30 percent of the State population) are affected by oil spills in three ways:

- Oil can affect ecological processes that cause direct harm (e.g., health impacts from eating seafood with bioaccumulated oil toxins).
- Oil spill stressors can change intermediary processes (e.g., economic impacts on fishers from oil spill impacts on fish).
- Stressors can directly harm humans (e.g., health impacts from breathing oil vapors).

37.7. MITIGATING THE HAZARD

37.7.1. Existing Measures to Mitigate the Hazard

Oil spills are human-caused hazards. The State, its counties, and its communities can influence the probability of incidents and the magnitude of their effects by emphasizing prevention and mitigation in oil spill emergency management.

Notable preventative measures have been initiated after large oil spill events. In 1969, the oil spill off the coast of Santa Barbara triggered stringent regulations covering outer continental shelf operation and environmental safety, a rigorous inspection program, continuous evaluation, improvement in outer continental shelf facilities' oil spill response, and the development of an organized oil spill response structure.

Office of Spill Prevention and Response

Following the Exxon Valdez oil spill in Alaska in 1989 and the American Trader oil spill off Huntington Beach in 1990, California established the Office of Spill Prevention and Response. OSPR is authorized to direct spill response, cleanup, and natural resource damage assessment activities, as well as regulate all private vessels over 300 gross tons that enter California ports.

In 2014, OSPR's mission was expanded to cover all State surface water at risk from oil spills from any source. These sources may include pipelines, production facilities, and shipments of oil transported by railroads. The mission of OSPR is to provide best achievable protection of California's natural resources by preventing, preparing for, and responding to spills and restoring affected resources (State of California 2022). OSPR also is tasked with preparing the California State Oil Spill Contingency Plan.

OSPR partnered with University of California (UC) Davis to form the Oiled Wildlife Care Network, which provides response activities and research on oil spills. To date, OSPR has treated more than 10,000 oiled birds, mammals, reptiles, and amphibians and provided support for large scale spills (UC Davis n.d.).

California requires a Non-Tank Vessel Contingency Plan and Certificate of Financial Responsibility, which means vessels must prove to OSPR that they have a plan in case of an oil spill and that they carry an insurance policy to cover the cost of a spill.

California State Lands Commission

The California State Lands Commission (SLC) has oversight of all marine oil terminals in the State, with a mandate to protect the public health, safety, and the environment by preventing spills at these facilities. SLC exercises oversight over the oil production operation on oil platforms and oil transfer operations between the ships and the shore. Commission staff periodically inspect and regularly monitor the operations at oil platforms and in marine oil terminals for conformance to performance standards.

The Commission also has oversight for the prevention of oil spills from offshore oil platforms in State waters and onshore and offshore marine oil terminals. At these marine facilities, large ocean-going tank vessels and smaller barges transfer oil between the shore and the tank vessels (State of California 2022h). State law requires the operator of each marine facility to conduct hazard and operability studies to identify hazards associated with operations of the facility due to operating error, equipment failure, and external events like a natural disaster that triggers a technological accident. These studies form the basis for permitted operations of oil production, handling, transportation, and preparedness for contingencies (California Public Law 2016).

CalGEM

Facilities located in State waters less than 3 nautical miles from shore are regulated by CalGEM. CalGEM maintains data and updates nightly the WellSTAR Data Dashboard. This database identifies every well with a well identification number, status, type, operator, lease name, production volume, permit information, and other characteristics of oil and gas wells. WellSTAR is interfaced by CalGEM's Well Finder, an online well mapping tool (DOC 2019e).

Federal Oversight

Platforms in federal waters are regulated by the U.S. Department of the Interior's Bureau of Safety and Environmental Enforcement through the Outer Continental Shelf Lands Act (Bureau of Safety and Environmental Enforcement n.d.).

The U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration plays a role in federal oversight of oil spills. This agency's mission is to protect people and the environment by advancing the safe transportation of energy and other hazardous materials that are essential to daily lives. To do this, the agency establishes national policy, sets and enforces standards, educates, and conducts research to prevent incidents. The agency also prepares the public and first responders to reduce consequences if an incident does occur.

Office of the State Fire Marshal, Pipeline Safety Division

The California Office of the State Fire Marshal (OSFM) currently regulates the safety of intrastate hazardous liquid pipelines in California. OSFM Pipeline Safety Division staff inspect pipeline operators to ensure compliance with federal and State pipeline safety laws and regulations, and consist of engineers, GIS/mapping staff, analytical staff, and clerical support located throughout California.

37.7.2. Opportunities for Mitigating the Hazard

In addition to existing mitigation plans and regulations, a range of potential opportunities for mitigating the oil spill hazard is provided in Table 37-2. See Section 1.2.3 for a description of the different types of alternatives.

Table 37-2. Potential Opportunities to Mitigate the Oil Spills Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ Identify and eliminate sources of potential oil spills **Reduce exposure and vulnerability:** ▪ Increase distance between potential oil spill locations and development **Build local capacity:** ▪ Personal planning for potential event	**Manipulate the hazard:** ▪ Identify and eliminate sources of potential oil spills **Reduce exposure and vulnerability:** ▪ None **Build local capacity:** ▪ Increase inspection of oil storage facilities, pipes, and transport vehicles ▪ Conduct training for response	**Manipulate the hazard:** ▪ Identify and eliminate sources of potential oil spills **Reduce exposure and vulnerability:** ▪ Increase inspection of oil storage facilities, pipes, and transport vehicles **Build local capacity:** ▪ Increase inspection of oil storage facilities, pipes, and transport vehicles ▪ Conduct training for response ▪ Public outreach ▪ Coordinate with interagency coalitions to enhance information sharing and mitigation efforts
Nature-based opportunities ▪ There are no nature-based solutions identified to mitigate the impacts of oil spills		

37.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address oil spills:

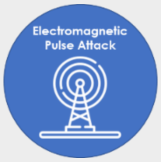
- Action 2018-001: Support Legislative Efforts that Formalize California's Comprehensive Mitigation Program.
- Action 2018-002: Strengthen Inter-agency Coordination Actions Including State, Regional, and Local Linkages.
- Action 2018-098: Oil Spill Planning: Prevent and mitigate the effects of oil spills impacting both land and water environments.

ELECTROMAGNETIC PULSE ATTACK

Climate Impacts:
None
Equity Impacts:
30.4% of exposed population (all persons in the State are exposed) identified as living in equity priority communities
State Facilities Exposed:
All facilities exposed
Community Lifelines Exposed:
All lifelines exposed

Impact Rating: Low (7)

38. ELECTROMAGNETIC PULSE ATTACK



Electromagnetic pulse (EMP) attack has been identified as low-impact under the hazard impact rating protocol applied for this Plan. These types of events have not occurred in the State within the past 100 years. All State-owned or -leased facilities and community lifelines are exposed to this hazard. Up to 30 percent of the total population and the equity priority community population is considered to be exposed. The development of buildable lands is anticipated to have a no impact on this hazard. The frequency and severity of this hazard is not anticipated to be increased due to impacts from climate change.

38.1. HAZARD OVERVIEW

An electromagnetic pulse (EMP) attack is the deliberate use of the pulse from a nuclear explosion high in the atmosphere to damage or destroy vulnerable electronics over a vast area (Mitre 2020). As described in Presidential Executive Order 13865, "[A]n EMP event has the potential to disrupt, degrade, and damage technology and critical infrastructure systems" (Federal Register 2019). California SB 468 (2022) added EMP attacks to the grounds for which a California Governor may declare a State of Emergency (California Senate District 3 2022). California SB 1076 (2018) requires Cal OES to develop preparedness recommendations to harden the critical infrastructure of the electrical utilities against an EMP attack, geomagnetic storm event, or another long-term electrical outage. This legislation was a principal driver for the inclusion of these hazards in the 2023 SHMP and future Plan updates.

The Potential Damage from an EMP

An EMP attack can disable any electrical systems within range. The electromagnetic fields produced by weapons designed and deployed with the intent to produce EMP have a high likelihood of damaging electrical power systems, electronics, and information systems upon which American society depends. Their effects on dependent systems and infrastructures could be sufficient to qualify as catastrophic to the State.

Source: (Foster, et al. 2004)

38.2. HAZARD LOCATION

EMP events can occur in any location, as noted at a 2014 hearing before the U.S. House of Representatives Subcommittee on Cybersecurity, Infrastructure Protection, and Security Technologies (U.S. Government Publishing Office 2014):

> Nuclear weapon EMPs are most catastrophic when a nuclear weapon is detonated at a high altitude at approximately 30 kilometers, or 20 miles, above the intended target. The consequences of such an attack could be catastrophic. All electronics—I mention all electronics, power systems, and information systems—could be shut down. This could then cascade into interdependent infrastructure such as water, gas, and telecommunications. While we understand that this is an extreme case, we must always be prepared in case a rogue state decides to utilize this technology.

38.3. PREVIOUS HAZARD OCCURRENCES

38.3.1. Disaster and Emergency Declarations

No FEMA, USDA, or State disaster declarations or proclamations related to EMP attack have been issued relevant to California or any of its counties.

38.3.2. Event History

The State of California has no record of past EMP attacks.

38.4. PROBABILITY OF FUTURE HAZARD EVENTS

38.4.1. Overall Probability

With no record of past events in the State, a low probability has been assigned for this hazard based on the hazard impact rating protocol that has been applied to this plan (see Appendix I). A low probability hazard has been defined as a hazard event that is not likely to occur within 100 years or has no historical record of occurrence.

38.4.2. Climate Change Impacts

EMP events are not climate driven, so it is not anticipated that climate change will have an impact on the frequency or severity of this type of event.

38.5. IMPACT ANALYSIS

38.5.1. Severity

An EMP attack could disrupt critical infrastructure in the State, including the electrical grid, communication equipment, water and wastewater systems, and modes of transportation (Graham 2022).

38.5.2. Warning Time

Many of the most harmful effects caused by electromagnetic incidents would occur within seconds. These effects may simultaneously damage critical energy distribution nodes and industrial control systems over wide geographic areas through damage to microprocessors and power transformers (DHS 2018).

The simultaneous disruptions over large areas that could result from an EMP attack would likely undermine the implementation of mutual aid plans and agreements, a cornerstone of government approach to disaster response. Response and recovery may be complicated by the relative lack of awareness of electromagnetic threats and hazards in government and industry, the potential unavailability of communication systems to dispatch warnings, and the dearth of operational experience in dealing with the aftermath of electromagnetic incidents (DHS 2018).

38.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The cascading impacts from an EMP attack would be considerable and likely to have significant short-term and long-term impacts on the State.

38.5.4. Environmental Impacts

There are no known environmental impacts from EMP attacks.

38.5.5. Local Hazard Impacts

None of the 58 counties in California assessed EMP attack as a hazard of concern in their hazard mitigation plans.

38.6. VULNERABILITY ANALYSIS

38.6.1. Exposure of State-Owned or -Leased Facilities, Critical Facilities, and Community Lifelines

All State-owned or -leased assets, as listed in Table 4-1, are exposed to EMP attack Table 4-1. This includes 23,961 State-owned facilities, and 1,893 State-leased facilities. All 755 State critical facilities and community lifelines are exposed to this hazard as well, as listed in Table 4-3.

38.6.2. Estimates of Loss

System failures caused by an EMP attack could impact the structure or contents of State assets. However, there are no standard generic formulas for estimating such losses. Instead, loss estimates were developed representing 10 percent, 30 percent, and 50 percent of the replacement cost value of all State-owned facilities (see Table 38-1). This allows the State to select a range of potential economic impacts based on an estimate of the percentage of damage to these assets. Damage in excess of 50 percent is considered substantial by most building codes and typically requires total structure reconstruction.

Table 38-1. Loss Potential of State-Owned Assets for EMP Attack

Type of Facility	Total Replacement Cost Value (contents only)	Estimated Loss Potential Based on % Damage		
		10% Damage	30% Damage	50% Damage
Facilities Housing Vulnerable Populations				
Correctional Facility	$5,673,743,477	$567,374,348	$1,702,123,043	$2,836,871,738
Development Center	$696,669,418	$69,666,942	$209,000,825	$348,334,709
Hospital	$837,461,197	$83,746,120	$251,238,359	$418,730,598
Migrant Center	$996,980,976	$99,698,098	$299,094,293	$498,490,488
Special School	$128,610,363	$12,861,036	$38,583,109	$64,305,182
All Other Facilities	**$28,392,185,985**	**$2,839,218,598**	**$8,517,655,796**	**$14,196,092,992**
Total	**$36,725,651,416**	**$3,672,565,142**	**$11,017,695,425**	**$18,362,825,708**

38.6.3. Buildable Land

An estimated 11.7 million acres of land is available for development in California. Because the entire State is vulnerable to EMP attacks, any type of development on this land will be susceptible to damage and impacts from this hazard.

38.6.4. Equity Priority Communities

The loss of critical infrastructure functions resulting from an EMP attack would have a greater impact on equity priority populations. Critical facilities such as hospitals, police departments, and fire stations are less likely to be in low-income or majority minority neighborhoods, meaning less assistance will be present in the event of a mass loss of electricity (The Rockefeller Foundation 2021).

38.7. MITIGATING THE HAZARD

38.7.1. Opportunities for Mitigating the Hazard

A range of potential opportunities for mitigating the EMP attack hazard is provided in Table 38-2. See Section 1.2.3 for a description of the different types of alternatives.

Table 38-2. Potential Opportunities to Mitigate the EMP Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ None **Reduce exposure and vulnerability:** ▪ Unplug power, data, and antenna lines from equipment and appliances ▪ Turn off equipment and appliances that cannot be unplugged when not actively in use ▪ Use lightning rated surge protectors throughout the household ▪ Have either EMP-protected backup power or a generation source that is not connected to the grid with one week of fuel ▪ Store one week of food, water, and any other necessary supplies for each person in household ▪ Protect equipment enclosures **Build local capacity:** ▪ None	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Relocate essential equipment into EMP-protected equipment enclosures ▪ Place critical equipment in EMP-protected shelters ▪ Place critical equipment in EMP-protected rooms or buildings ▪ Identify assets located outside of a facility's boundary and determine methods in protecting those assets ▪ Develop a concept of operations plan **Build local capacity:** ▪ None	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Relocate essential equipment into EMP-protected equipment enclosures ▪ Place critical equipment in EMP-protected shelters, rooms, or buildings ▪ Identify assets outside of a facility's boundary and determine ways to protect those assets ▪ Develop a concept of operations plan for the State and each county ▪ Develop a hardness maintenance/surveillance plan for the State and for each county **Build local capacity:** ▪ None
Nature-based opportunities ▪ There are no nature-based solutions identified to mitigate the impacts of EMP attack		

38.7.2. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address EMP attack:

- Action 2018-001: Support Legislative Efforts that Formalize California's Comprehensive Mitigation Program: Mitigation Legislation and Implementation.
- Action 2018-002: Strengthen Inter-agency Coordination Actions Including State, Regional, and Local Linkages.
- Action 2018-003: Broaden Public and Private Sector Mitigation Linkages.

Radiological Accidents

Climate Impacts:
No direct impacts but can contribute to radiological accidents due to the increased wildfire risk and sea-level rise

Equity Impacts:
30.4% of exposed population (all persons in the State are exposed) identified as living in equity priority communities

State Facilities Exposed:
All State-owned or -leased facilities and community lifelines are considered to be exposed, with those in emergency planning zones (EPZs) and protective action zones more vulnerable

Community Lifelines Exposed:
Lifelines in EPZs and protective action zones are exposed

Impact Rating: Low (4)

39. RADIOLOGICAL ACCIDENTS

The radiological accident hazard has been identified as low-impact under the hazard impact rating protocol applied for this Plan. Such events have a low probability of occurrence based on only one reported event in the State within the past 100 years. All State-owned or -leased facilities and community lifelines are considered to be exposed to this hazard. It has been estimated that less than 14 percent of the total population as well as the equity priority community population is considered to be exposed to this hazard. The development of buildable lands is anticipated to have a no impact on this hazard. The frequency and severity of this hazard is not anticipated to be increased due to the impacts from climate change.

39.1. HAZARD OVERVIEW

Hazardous materials routinely transported in California include radioactive medical, industrial, and other waste. Many of these shipments come from research and cleanup efforts at national laboratories and military bases. Others are generated from the oil and gas industry. The following are examples of potential radiological releases:

- Releases or loss of control at facilities that handle radioactive materials
- Releases during the transportation of radiological materials
- Discovery of uncontrolled, unlicensed, or unidentified radiological materials
- Nuclear power plant incidents
- Terrorist acts involving radiological or nuclear materials (e.g., radiological dispersion device or an improvised nuclear device)

The wide use of radioactive and nuclear material in research, education, medicine, and industry, as well as the potential for terrorism, requires all levels of government to be prepared for response, mitigation, and recovery efforts should a radiological or nuclear emergency occur (Cal OES 2018).

39.2. HAZARD LOCATION

Diablo Canyon Power Plant in San Luis Obispo County is the only operating nuclear power plant in California. PG&E submitted a joint proposal to phase out nuclear power production at the plant in 2025, at the end of its current Nuclear Regulatory Commission operating licenses. In 2022, the Legislature passed SB 846, allowing Diablo Canyon to remain operational through October 2030. PG&E is also seeking a permit from federal regulators to keep the facility operational for an additional 20 years (Lopez 2023).

California is home to three nuclear power plants that are either decommissioned or are decommissioning: San Onofre Nuclear Generating Station in San Diego County, Humboldt Bay Power Plant in Humboldt County, and Rancho Seco Nuclear Generating Station in Sacramento County. These sites are non-operational but have spent fuel stored on site.

39.3. PREVIOUS HAZARD OCCURRENCES

39.3.1. Disaster and Emergency Declarations

No FEMA, USDA, or State disaster declarations or proclamations related to radiological accidents have been issued relevant to California or any of its counties.

39.3.2. Event History

The only significant recorded radiological event in California was a partial reactor meltdown on July 13, 1959, at Santa Susana Field Laboratory in Ventura County (Rochester 2009). A third of a reactor core at the laboratory experienced melting. Power levels rose uncontrollably, and coolant channels were blocked, causing fuel temperatures to rise. Large amounts of radioactivity were released into the coolant, and radioactive gases were intentionally vented into the atmosphere for weeks after the accident. The full extent of this event was not disclosed to the public for many decades, and cleanup activities are still underway.

Table 39-1 summarizes past occurrences of nuclear power plan emergencies in California.

Table 39-1. Levels of Nuclear Power Plant Emergencies

Emergency Classification Level	Description and Purpose	Populations Affected*	Occurrences in California
Notification of Unusual Event	Issued when events are in progress or have occurred that indicate a potential degradation of the level of safety of the plant or indicate a security threat to facility protection. No releases of radioactive material requiring offsite response or monitoring are expected unless further degradation of safety systems occurs.	On-site only	Average 1 to 2 per year
Alert	Issued when events are in progress or have occurred that involve an actual or potential substantial degradation of the level of safety of the plant or a security event that involves probable life-threatening risk to site personnel or damage to site equipment because of hostile action. Any releases are expected to be limited to small fractions of the U.S. Environmental Protection Agency Protective Action Guides.	On-site only	3 declared. All were rescinded after further investigation
Site Area Emergency	Issued when events are in progress or have occurred that involve actual or likely major failures of plant functions needed for protection of the public or hostile action that results in intentional damage or malicious acts 1) toward site personnel or equipment that could lead to the likely failure of, or 2) that prevent effective access to, equipment needed for the protection of the public. Any releases are not expected to result in exposure levels that exceed EPA Protective Action Guides exposure levels beyond the site boundary.	Designated areas within the EPZ	0
General Emergency	Issued when events have occurred that involve substantial core degradation or loss of containment integrity. Radioactive releases are expected to exceed federal exposure guidelines.	Designated areas within the EPZ	0

* Includes only populations with special planning and response operations.
Source: (U.S. Nuclear Regulatory Commission 2021, Cal OES 2022b)

39.4. PROBABILITY OF FUTURE HAZARD EVENTS

39.4.1. Overall Probability

Based on historical events in California and the fact that all nuclear plants in the State are currently decommissioned or scheduled for decommissioning, the State has a low probability of radiological events in the future. Since the 1959 incident at the Santa Susana Field Laboratory, nuclear power has become heavily regulated. While the probability of an incident is low, there is still the potential of one happening.

39.4.2. Climate Change Impacts

While climate change may not directly affect radiological accidents as it affects other hazard events, it could contribute to radiological accidents through increased wildfire risk and sea-level rise. If wildfire causes facilities containing radiological materials to burn, they could release radioactive material to the surrounding areas. Rising sea level could lead to flooding of facilities along the coast. This could pose a problem at the San Onofre and Humboldt Bay nuclear plants which, though they are no longer operational, act as storage sites for nuclear waste (Kahn 2011). At Humboldt Bay, it is believed that by 2030 the rising sea level will inundate much of the complex and isolate the independent spent fuel storage installation where nuclear waste is stored on an island; by 2090 the water will consume that island as well (Laird 2019). In the short term, access to nuclear power will continue to be needed as the State transitions to more renewable energy sources.

39.5. IMPACT ANALYSIS

39.5.1. Severity

Due to strict regulation of nuclear power plants in the United States, the probability of a catastrophic event involving a nuclear power plant is low. However, as evidenced by the March 2011 events at the Fukushima Daiichi plant in Japan caused by the Tohoku earthquake and tsunami, the consequences of a severe accident or a terrorist attack on a nuclear power plant resulting in a release of radioactive materials could be significant.

39.5.2. Warning Time

State and local governments having jurisdiction within emergency planning zones (EPZs) of an operating nuclear power plant in the U.S. must plan, train for, and conduct emergency exercises annually in accordance with federal regulations. An "emergency phasing zone" is a zone identified to facilitate a pre-planned strategy for protective actions during a defined emergency. These detailed emergency plans are maintained by each affected agency. Four emergency classification levels have been established in federal regulations to characterize the severity of the emergency and the response actions required. The levels must be used as the foundation for emergency response planning, training, and exercises.

The EPZ for the Diablo Canyon Power Plant is shown in Figure 39-1. The Nuclear Regulatory Commission requires an approximate 10-mile radius EPZ around each plant site. California and local governments around Diablo Canyon Power Plant established an EPZ that follows the coastline and extends 18 miles to the north and 22 miles to the south. The EPZ is established to provide for substantial reduction in early severe health effects in the event of a worst-case core melt accident.

39.5.3. Cascading Impacts

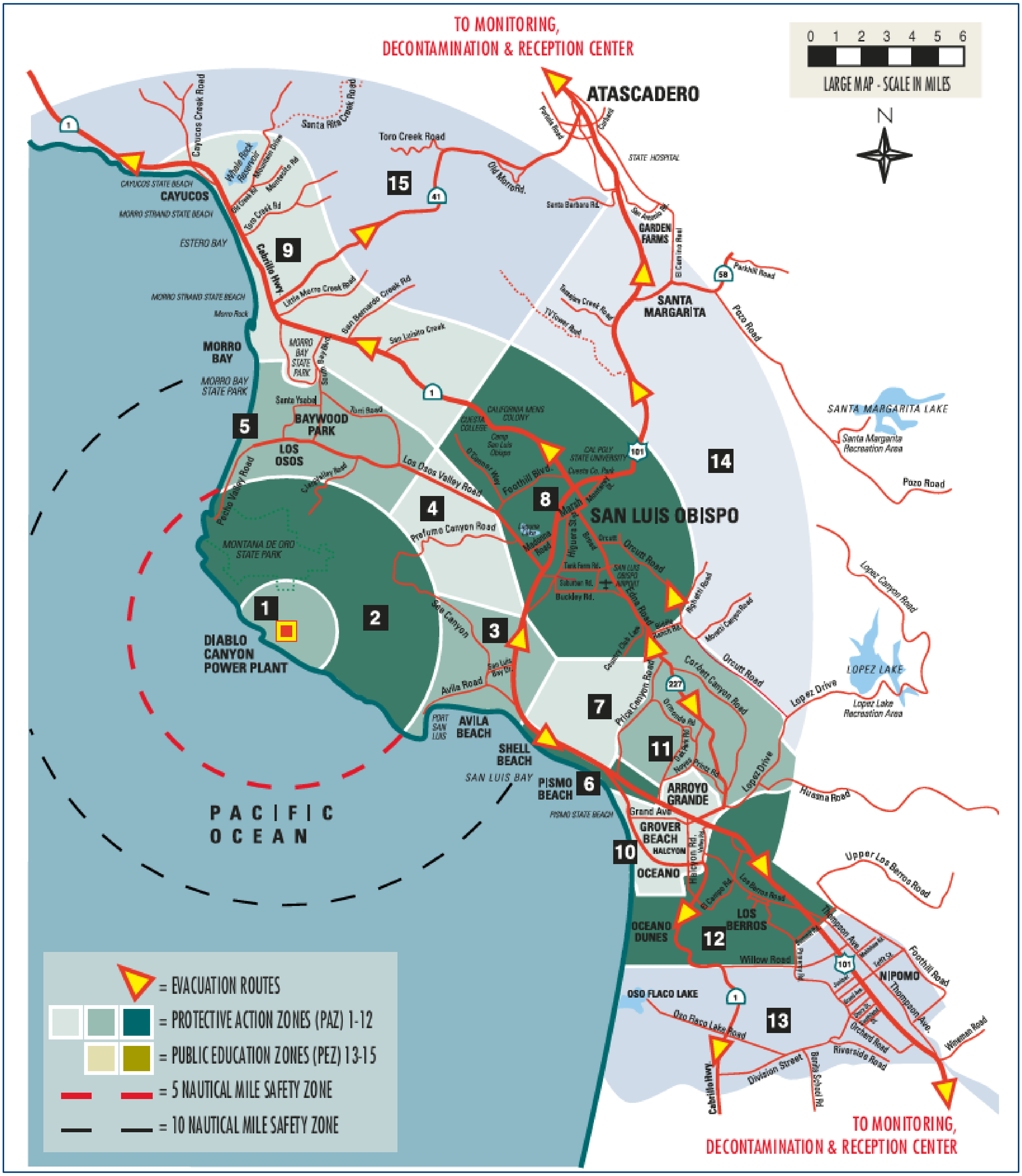
Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with radiological accidents:

- Increased incidents of thyroid cancer by those exposed to the accident
- Radioactive contamination to the environment
- Radiation sickness or death resulting from high doses of radiation

39.5.4. Environmental Impacts

The impact on the environment that a radiological event will have depends on where the event is located, and the amount of radiological material released. Animals, plants, and other wildlife in the surrounding areas of the event can see devastating impacts. Radiation pollution within waterways also accumulates within fish and other aquatic organisms, and runoff from radiation within the soil causes additional contamination (Sciencing 2021).

Figure 39-1. EPZs for Diablo Canyon Power Plant



Source: (ReadySLO 2023)

39.5.5. Local Hazard Impacts

None of the hazard mitigation plans prepared for California's 58 counties list radiological accidents as a primary hazard of concern.

39.6. VULNERABILITY ANALYSIS

39.6.1. Exposure of State-Owned or -Leased Facilities

All State-owned or -leased assets, as listed in Table 4-1 and Table 4-2, are exposed to radiological release. This includes 23,961 State-owned facilities, and 1,893 State-leased facilities.

Assets located within a 10-mile radius from a nuclear power plant are more vulnerable during an accident due to their proximity to the plant. California has two operating nuclear power reactors at the Diablo Canyon Power Plant, three nuclear facilities at various stages of decommissioning, and multiple research reactors that are operational or undergoing decommissioning (CEC 2022c). In the event of an accident, those living and working within a 10-miles radius from the nuclear power plant are more vulnerable to health and safety impact from the accident.

39.6.2. Exposure of Critical Facilities and Community Lifelines

All State critical facilities and community lifelines, as listed in Table 4-3, are exposed to potential radiological release. Like State-owned or -leased facilities, critical facilities and lifelines located within a 10--mile radius of a nuclear power plant are more vulnerable.

39.6.3. Estimates of Loss

Radiological accidents are not likely to result in any losses associated with damage or impairment to State assets. All losses from this hazard would be associated with impacts on the economy, based on impaired operations.

39.6.4. Buildable Land

An estimated 11.7 million acres of land are available for development in California. The development of this land will have no impact on increasing the frequency of radiological accidents. The development of this land would increase the populations in the State, but the percentage of buildable land in counties with nuclear facilities is not known. Local planning efforts that choose to include radiological accidents as hazards of concern in their local planning efforts are encouraged to include a buildable lands analysis to better understand this exposure.

39.6.5. Equity Priority Communities

The accidental or intentional release of radiological materials or radiation may threaten public health, property, and the environment, especially those identified as highly vulnerable. Because the presence of nuclear facilities in the State is limited to just four counties and only one of the four facilities is operational, the population exposure to this hazard is considered to be low (less than 14 percent of the total population) for both the general population and equity priority community population.

39.7. MITIGATING THE HAZARD

39.7.1. Existing Measures for Mitigating the Hazard

Across the United States, nearly 3 million people live within 10 miles of an operating nuclear power plant. In 2021, there were 56 commercial nuclear power plants in 29 states producing approximately 20 percent of the nation's power. In California, the following agencies provide emergency planning and programs to protect the health and safety of State residents:

- **Cal OES Nuclear Power Preparedness Program** covers emergency planning issues related to the State's one operating nuclear power plant – Diablo Canyon Power Plant. The Nuclear Power Preparedness Program also continues coordination with one decommissioning nuclear power plant—San Onofre Nuclear Generating Station—and two retired nuclear power plants—Humboldt Bay Nuclear Power Plant and Rancho Seco Nuclear Generating Station. The program works with federal, State, local, and utility officials in emergency planning, training, and exercises to test emergency readiness (Cal OES 2022b).
- **California Department of Health Division of Radiation Safety and Environmental Management** protects and improves the health of all California residents through its environmental programs, including radiation safety, inspection, laboratory testing, and regulatory activities. This division is made up of the

Radiologic Health Branch, the Environmental Management Branch, and the Drinking Water and Radiation Laboratory Branch.

39.7.2. Opportunities for Mitigating the Hazard

In addition to the mitigation measures the State has put in place, there are a range of potential alternatives for mitigating radiological accidents that can be implemented on the personal, corporate, and government-scale. These are listed in Table 39-2. See Section 1.2.3 for a description of the different types of alternatives.

39.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address the radiological accident hazard:

- Action 2018-001: Support Legislative Efforts that Formalize California's Comprehensive Mitigation Program.
- Action 2018-002: Strengthen Inter-agency Coordination Actions Including State, Regional, and Local Linkages.
- Action 2018-003: Broaden Public and Private Sector Mitigation Linkages.

Table 39-2. Potential Opportunities to Mitigate Radiological Accidents

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ None **Reduce exposure and vulnerability:** ▪ Increase distance between nuclear plants and development **Build local capacity:** ▪ Personal planning for potential events	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Increase distance between nuclear plants and development **Build local capacity:** ▪ Conduct training for emergency response	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Increase inspections of nuclear facilities and transport vehicles ▪ Identify shelters and evacuation routes in the event of an accident **Build local capacity:** ▪ Develop and implement emergency plans for facilities ▪ Conduct training for response ▪ Public outreach
Nature-based opportunities ▪ There are no nature-based solutions identified to mitigate this hazard		

Geomagnetic Storm (Space Weather)

Climate Impacts:
Unknown

Equity Impacts:
30.4% of exposed population (all persons in the State are exposed) identified as living in equity priority communities

State Facilities Exposed:
All facilities exposed

Community Lifelines Exposed:
All lifelines exposed

Impact Rating: Low (4)

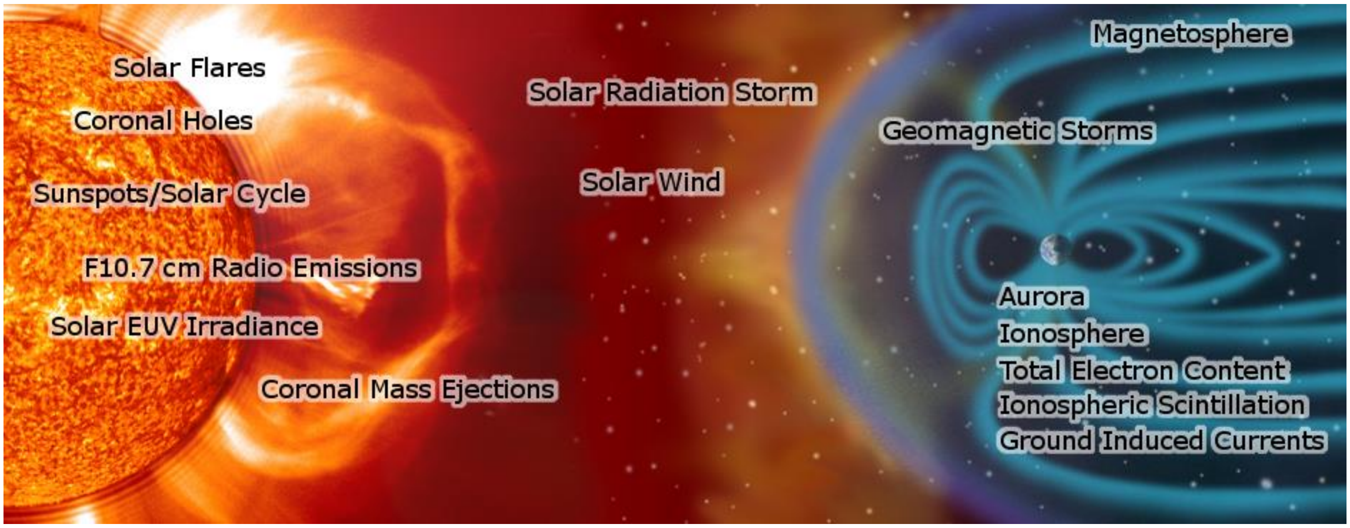
40. Geomagnetic Storm (Space Weather)

The geomagnetic storm (space weather) hazard has been identified as low-impact under the hazard impact rating protocol applied for this Plan. These types of events have a low probability of occurrence based on no reported occurrences in the State within the past 100 years. While all State-owned or -leased facilities and community lifelines are exposed to this hazard, the vulnerabilities of these facilities are very low based on how this hazard would likely impact each facility (no major structural damage). Likewise, the total population and equity priority communities would be exposed, but their vulnerability is considered low. The development of buildable lands is anticipated to have no impact on this hazard. The frequency and severity of this hazard is not anticipated to be increased due to impacts from climate change.

40.1. HAZARD OVERVIEW

A geomagnetic storm is caused by a significant transfer of energy from solar wind into the space environment surrounding the Earth (Bennett 2017). The term "space weather" is used to describe conditions in the region of space close to the Earth, especially the presence of electromagnetic radiation and charged particles emitted by the sun that can affect human activity and technology (see Figure 40-1). An EMP is a common effect from geomagnetic storm events. For more information on EMPs, see Chapter 38.

Figure 40-1. Space Weather Phenomena



Source: (SWPC n.d.-a)

According to National Aeronautics and Space Administration (NASA), two major phenomena contribute to space weather (NASA 2022):

- **Solar wind**—The sun's constant outflow of solar wind fills space with particles, fields, and plasma that influence the nature of space and can interact with the magnetic systems of Earth.
- **Atmospheric weather events**—The space environment around Earth can vary in response to upwelling atmospheric events from below. The resulting space weather can interfere with satellite electronics, radio communications and global positioning system (GPS) signals, spacecraft orbits, and even power grids on Earth.

40.2. HAZARD LOCATION

There is no defined area of space weather exposure. The entire State of California is potentially exposed to the direct and indirect impacts of space weather events.

40.3. PREVIOUS HAZARD OCCURRENCES

40.3.1. Disaster and Emergency Declarations

No FEMA, USDA, or State disaster declarations or proclamations related to space weather have been issued relevant to California or any of its counties.

40.3.2. Event History

The strongest geomagnetic storm on record is the Carrington Event that occurred in September 1859. This storm caused telegraph lines to electrify, in some cases shocking technicians and setting telegraph paper on fire. The aurora generated by the magnetic effects could be seen as far south as Hawaii and Cuba (Emerson 2017). More recent events include the following (Space Weather Enterprise Forum 2010):

- A space weather storm on March 13, 1989, disrupted the hydroelectric power grid in Quebec, Canada. This system-wide outage lasted for 9 hours and left 6 million people without power.
- In October 2003, space weather caused a simultaneous shutdown of satellites and air traffic precision navigation for several hours.
- In December 2006, geomagnetic storms and solar flare activity disabled GPS signal acquisition over the United States.

40.4. PROBABILITY OF FUTURE HAZARD EVENTS

40.4.1. Overall Probability

Due to a lack of historical occurrences specifically impacting California, and the rarity of severe event overall, a rate of future occurrence based on past events cannot be determined.

40.4.2. Climate Change Impacts

There are no known climate change impacts on space weather.

40.5. IMPACT ANALYSIS

40.5.1. Severity

During events known as radio blackout storms, solar flares can produce strong x-rays that degrade or block high-frequency radio waves used for radio communication. Solar energetic particles (energetic protons) can penetrate satellite electronics and cause electrical failure. These energetic particles also block radio communications at high latitudes during solar radiation storms. Coronal mass ejections can cause geomagnetic storms at Earth and induce extra currents in the ground that can degrade power grid operations (SWPC n.d.-b).

Sectors that are particularly vulnerable to space weather impacts include electric power transmission, HF radio communications, satellite communications, satellite drag, and GPS systems (Space Weather Operations, Research, and Mitigation Working Group 2019).

NOAA Space Weather Scales were introduced as a way to communicate to the general public the current and future space weather conditions and their possible effects on people and systems. Many of the Space Weather Prediction Center (SWPC) products describe the space environment, but few have described the effects that can be experienced as the result of environmental disturbances.

These scales are useful to users of SWPC products and those who are interested in space weather effects. The scales describe the environmental disturbances for three event types: geomagnetic storms, solar radiation storms, and radio blackouts. The scales have numbered levels—analogous to hurricanes, tornadoes, and earthquakes—that convey severity. They list possible effects at each level. They also show how often such events happen and give a measure of the intensity of the physical causes. Figure 40-2 shows the NOAA Space Weather Scales.

Figure 40-2. NOAA Space Weather Scales

Scale	Description	Effect	Physical measure	Average Frequency (1 cycle = 11 years)
R 5	Extreme	**HF Radio:** Complete HF (high frequency) radio blackout on the entire sunlit side of the Earth lasting for a number of hours. This results in no HF radio contact with mariners and en route aviators in this sector. **Navigation:** Low-frequency navigation signals used by maritime and general aviation systems experience outages on the sunlit side of the Earth for many hours, causing loss in positioning. Increased satellite navigation errors in positioning for several hours on the sunlit side of Earth, which may spread into the night side.	X20 (2×10^{-3})	Less than 1 per cycle
R 4	Severe	**HF Radio:** HF radio communication blackout on most of the sunlit side of Earth for one to two hours. HF radio contact lost during this time. **Navigation:** Outages of low-frequency navigation signals cause increased error in positioning for one to two hours. Minor disruptions of satellite navigation possible on the sunlit side of Earth.	X10 (10^{-3})	8 per cycle (8 days per cycle)
R 3	Strong	**HF Radio:** Wide area blackout of HF radio communication, loss of radio contact for about an hour on sunlit side of Earth. **Navigation:** Low-frequency navigation signals degraded for about an hour.	X1 (10^{-4})	175 per cycle (140 days per cycle)
R 2	Moderate	**HF Radio:** Limited blackout of HF radio communication on sunlit side, loss of radio contact for tens of minutes. **Navigation:** Degradation of low-frequency navigation signals for tens of minutes.	M5 (5×10^{-5})	350 per cycle (300 days per cycle)
R 1	Minor	**HF Radio:** Weak or minor degradation of HF radio communication on sunlit side, occasional loss of radio contact. **Navigation:** Low-frequency navigation signals degraded for brief intervals.	M1 (10^{-5})	2000 per cycle (950 days per cycle)

Source: (SWPC n.d.-b)

40.5.2. Warning Time

Geomagnetic storms can be predicted, providing some time to prepare for a potential disturbance. The time from the prediction of a geomagnetic storm to its onset typically varies between 16 and 90 hours, although an event may begin within tens of minutes of an observed sunspot eruption. After a space weather event begins, it may still take hours or days to reach its maximum (DHS 2019).

NOAA's SWPC provides the following alerts, warnings, watches, and forecasts for geomagnetic storms (SWPC n.d.):

- A **Geomagnetic Storm Watch** is based on a forecast of an impending geomagnetic storm in one to three days. The lead time is largely determined by the velocity of the driving coronal mass ejection. Some of the historically fastest coronal mass ejections arrived in well under a day—16- to 18-hour transits have been observed. A watch carries a lower degree of confidence in intensity and in timing than a warning, but it provides longer-range notification.
- A **Geomagnetic Storm Warning** is based on upstream solar wind observations. A warning carries a higher degree of confidence in timing and intensity than a watch but is generally issued only minutes to a couple of hours in advance. SWPC's space weather forecasters can supply additional comments in a warning and may be able to indicate the specific level of intensity expected.
- A **Geomagnetic Storm Alert** is based on ground-based magnetometer observations and indicates a specific storm threshold being reached. In other words, an alert describes an event already underway.

- A **Geomagnetic Sudden Impulse Expected Warning** is issued when a shock has been observed in the upstream solar wind data. Based on the post-shock velocity, space weather forecasters generate a warning period of when this disturbance is expected at Earth.
- The **Geomagnetic Sudden Impulse Summary** is issued when a shock is observed at Earth, as indicated by the response of ground-based magnetic observatories. This can confirm the arrival of an anticipated coronal mass ejection.

40.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with geomagnetic storm:

- 911 and all emergency communications could be affected.
- GPS systems could be made in-operable.
- Air traffic control could be impacted.
- People traveling in airplanes could be dosed with radiation.
- Utility losses can cause a reduction in employment and in wholesale and retail sales, require utility repairs, and increase medical risk.
- Impacted local governments may lose tax revenue.
- Disruption of the electric power grid could hinder government and business operations and impact residents' lives.

40.5.4. Environmental Impacts

There are no known environmental impacts from space weather.

40.5.5. Local Hazard Impacts

Two counties in California have assessed space weather as a hazard of concern in their hazard mitigation plans. Monterey County fully profiles space weather under its utility interruption section and Santa Clara County includes space weather under its severe weather discussion. Utility interruption was ranked as seventh on its countywide hazard risk ranking and was considered to have a "substantial" degree of risk.

40.6. VULNERABILITY ANALYSIS

40.6.1. Exposure of State-Owned or -Leased Facilities, Critical Facilities, and Community Lifelines

All State-owned or -leased assets, as listed in Table 4-1 and Table 4-2, are exposed to this hazard. This includes 23,961 State-owned facilities, and 1,893 State-leased facilities. All 755 State critical facilities and community lifelines, as listed in Table 4-3, are exposed to this hazard as well.

40.6.2. Estimates of Loss

Although the risk of impact from space weather is small, California has many systems in its built environment which could be affected severely. There are no standard generic formulas for estimating associated losses. Instead, loss estimates were developed representing 10 percent, 30 percent, and 50 percent of the replacement cost value of the contents all State-owned facilities (see Table 40-1). This allows the State to select a range of potential economic impacts based on an estimate of percent of damage.

Table 40-1. Loss Potential of State-Owned Asset Contents for Geomagnetic Storm

Type of Facility	Total Replacement Cost Value (contents only)	Estimated Loss Potential Based on % Damage		
		10% Damage	30% Damage	50% Damage
Facilities Housing Vulnerable Populations				
Correctional Facility	$2,254,012,157	$225,401,216	$676,203,647	$1,127,006,079
Development Center	$390,885,847	$39,088,585	$117,265,754	$195,442,924
Hospital	$454,638,764	$45,463,876	$136,391,629	$227,319,382
Migrant Center	$341,691,270	$34,169,127	$102,507,381	$170,845,635
Special School	$63,904,858	$6,390,486	$19,171,457	$31,952,429
All Other Facilities	**$14,057,592,693**	**$1,405,759,269**	**$4,217,277,808**	**$7,028,796,347**
Total	**$17,562,725,589**	**$1,756,272,559**	**$5,268,817,677**	**$8,781,362,795**

40.6.3. Buildable Land

An estimated 11.7 million acres of land is available for development in California. Because the entire State is vulnerable to space weather, any type of development of any of this land will be susceptible to damage and impacts from this hazard.

40.6.4. Equity Priority Communities

Any loss of function in critical infrastructure resulting from the impacts of space weather would have a greater impact on equity priority populations. Critical facilities such as hospitals, police stations, and fire stations are less likely to be in low-income or majority minority neighborhoods, meaning less assistance will be present in the event of a mass loss of electricity (The Rockefeller Foundation 2021).

Because the entire population of the State of California is exposed and vulnerable to geomagnetic storms, the exposed population in equity priority communities is equal to the statewide percentage: 30.4 percent of the total population (12 million people).

40.7. MITIGATING THE HAZARD

40.7.1. Existing Measures to Mitigate the Hazard

Extreme geomagnetic events can interfere with communications, satellites, and power grids. The best way to protect against these types of events is forecasting them in advance and implementing the necessary procedures to protect infrastructure and critical facilities (Boyle 2017).

NASA maintains a fleet of spacecraft to monitor the sun, the space around the Earth, and the space environment between the sun and the Earth to assist in forecasting (NASA Science 2022). In addition, the National Weather Service (NWS) and NOAA coordinate the Space Weather Prediction Center that provides alerts, watches, and warnings to the public about the severity of the solar activity expected to impact the Earth's environment (SWPC 2022).

40.7.2. Opportunities for Mitigating the Hazard

Table 40-2 provides potential alternatives for mitigating the geomagnetic storm hazard. See Section 1.2.3 for a description of the different types of alternatives.

Table 40-2. Potential Opportunities to Mitigate the Space Weather Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ None **Reduce exposure and vulnerability:** ▪ Build an emergency kit ▪ Prepare for power outages and surges **Build local capacity:** ▪ None	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Prepare for power outages and surges **Build local capacity:** ▪ Equip vital facilities with emergency power sources	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Utilize the alerts, watches, and warnings provided by the Space Weather Prediction Center ▪ Ensure utility companies developed operating procedures for weathering geomagnetic storms ▪ Work with utility companies to assess their systems to ensure they are prepared for space weather events **Build local capacity:** ▪ Equip vital facilities with emergency power sources ▪ Investigate alternate communications methods ▪ Educate the local populace about the hazards of space weather and what they can do to protect themselves
Nature-based opportunities ▪ There are no nature-based solutions identified to mitigate this hazard.		

40.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address the geomagnetic storm hazard:

- Action 2018-082: Existing Buildings Energy Efficiency Action Plan: Double the energy efficiency savings of existing buildings by 2030.
- Action 2018-002: Strengthen Inter-agency Coordination Actions Including State, Regional, and Local Linkages.
- Action 2018-003: Broaden Public and Private Sector Mitigation Linkages.

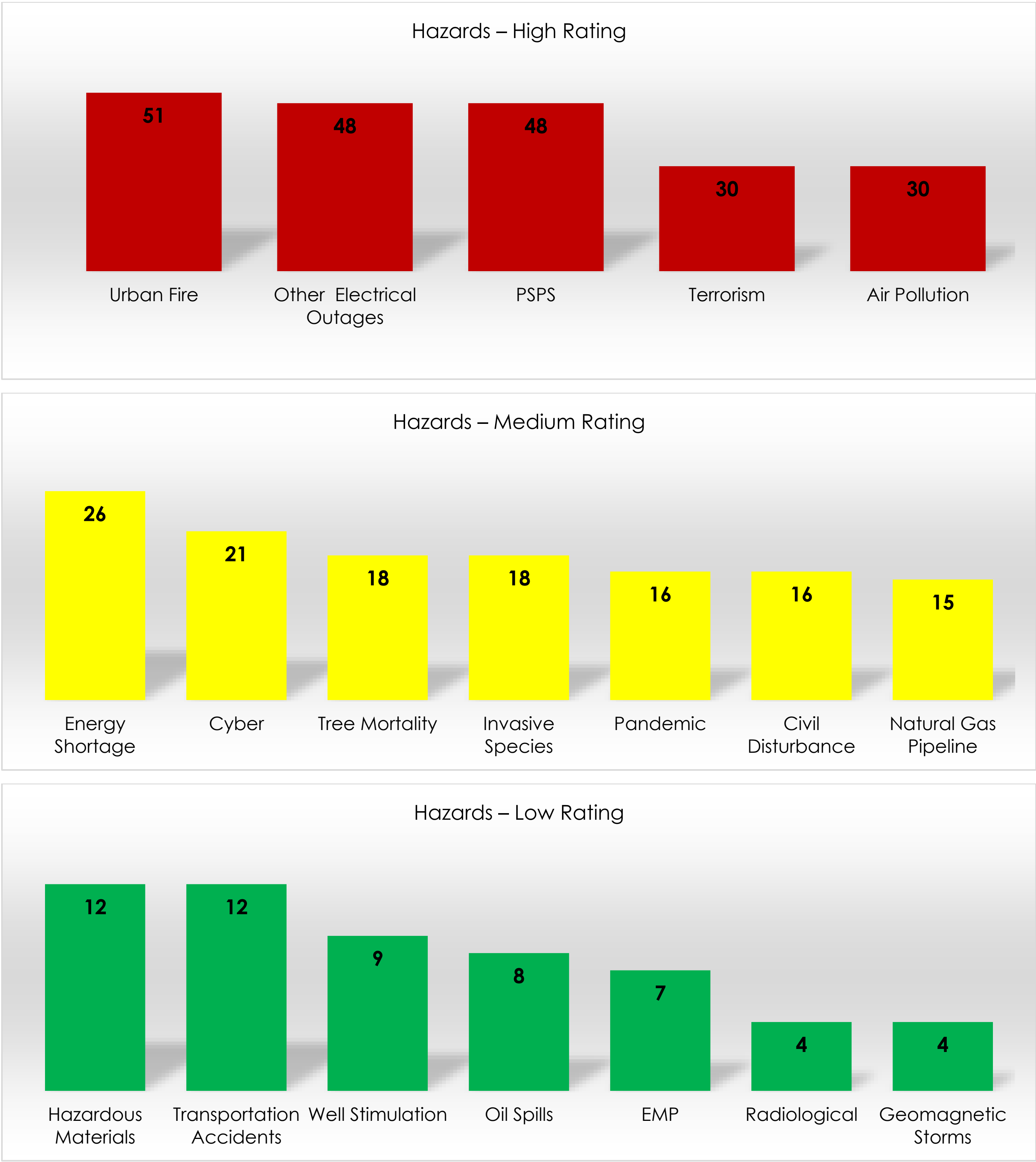
41. Risk Assessment Summary for Other Hazards

This SHMP assessed 19 "other hazards on interest," which are hazards that are considered to be ineligible hazards under FEMA HMA programs, including human-caused hazards or natural hazards for which mitigation actions are limited to preparedness or response activities. Identifying these hazards as a distinct category in the SHMP establishes for local planning efforts in the State which hazards do not need be considered baseline hazards for risk assessment. However, local communities should determine the hazards of concern to be addressed for their plans through a planning process. The role of the SHMP is to provide guidance and alternatives to support these planning processes.

Of the 19 other hazards of interest assessed in this SHMP, five were identified as high-impact hazards, seven were identified as medium-impact, and seven were identified as low-impact hazard as shown in Figure 41-1. The parameters for these ratings are discussed in detail in Appendix I.

These rankings are based on impacts to State-owned or -leased facilities and identified critical facilities and lifelines that are essential to the State's ability to respond to and recover from hazard events. These rankings should not be interpreted as applicable locally. Local planning efforts should assess, and rank risk individually based on the impacts of these hazards to the defined planning areas for local planning efforts. The metrics to measure those impacts should be determined locally by the local hazard mitigation planning process.

Figure 41-1. Other Hazards of Interest Hazard Impact Ratings



Part 4—Hazard Mitigation for Local Jurisdictions

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42. Local Capability Assessment

S13 – 44 CFR 201.4(c)(3)(ii): Does the plan generally describe and analyze the effectiveness of local government mitigation policies, programs, and capabilities?
Chapters 42 and 43 summarize and describe the effectiveness of local government policies, programs, and capabilities in implementing mitigation, including challenges and opportunities identified by Cal OES. California, through Assembly Bills, Senate Bills, General Plan requirements, and other mechanisms, encourages hazard mitigation to be integrated with other local planning instruments.

HHPD6: Did Element S13 (local coordination) generally describe and analyze the effectiveness of local mitigation policies, programs, and capabilities that address high hazard potential dams?
Chapter 42 outlines high hazard potential dam-specific local mitigation policies, programs and capabilities. See 42.8 for specific assets covered under HHPD.

Hazard mitigation begins at the local level, and the State supports local governments with their mitigation planning activities. This ensures that local communities are aware of the best available hazard data, planning resources, and State priorities for mitigation. A mutual understanding between states and local governments better aligns mitigation strategies and directs available resources toward effective mitigation planning.

While California cities and counties are autonomous, State law, policies, and programs have a substantial influence on local land use and hazard mitigation activities. This chapter addresses State-mandated and locally adopted capabilities that can provide a basis for implementing hazard mitigation actions.

Demonstrations of Successful Local Hazard Mitigation

California's local communities have demonstrated the value of well-done hazard mitigation, with the completion of projects that have been found to fulfill their purpose in the face of subsequent hazard events. Examples are presented in the Risk Assessment portion of the 2023 State Hazard Mitigation Plan (SHMP or Plan), including the following:

- Earthquake Mitigation—Earthquake Brace + Bolt Program (EBB) (see Chapter 5)
- Riverine Flood Mitigation— Sonoma County Flood Elevation Program, Russian River (see Chapter 6)
- Wildfire Mitigation—Wildfire Reduction at the Lick Observatory in Santa Clara County (see Chapter 9)

42.1. LEGAL FOUNDATIONS OF LOCAL GOVERNMENT CAPABILITY

Local governments in California include cities, towns, counties, and special districts. Their powers are determined by the State constitution and by State legislation. All units of local government have powers or authorities to undertake hazard mitigation planning and projects. Special districts typically lack the authority to dictate land use, as that responsibility lies with municipal local governments.

In California, there are more than 7,000 local government institutions. Most are special districts, including over 1,000 school districts. The remaining entities include 58 counties, 459 incorporated cities, and 22 incorporated towns. Each of these institutions is involved in local planning, but cities and counties have the most prominent role.

42.1.1. Cities, Towns, and Counties

Cities, towns, and counties are independent political entities with elected governing boards. The authority for cities and counties comes from Article XI, Section 7 of the California Constitution, which states that "[a] county or city may make and enforce within its limits all local, police, sanitary and other ordinances and regulations not in conflict with general laws."

State law requires that each county and city have a legislative body and a planning agency, and adopt a comprehensive, long-term general plan for physical development.

Through general plans, local jurisdictions document official decisions and future strategies regarding the following:

- The location of housing, business, industry, roads, parks, and other land uses
- Protection of the public from environmental hazards
- Conservation of natural resources

Each city, town, and county formally adopted its own general plan and developed implementing regulations, including zoning ordinances, subdivision ordinances, and building codes. Cities, towns, and counties are obligated by law to confer with adjoining jurisdictions when developing a general plan and regulatory ordinances. However, there is no requirement that adjoining cities or counties have identical, or even similar, plans and ordinances.

42.1.2. Special Districts

Special districts are local government units with separate taxing authority and elected governing boards, formed to address specific issues such as fire protection, geologic hazard abatement, or flood control. According to the California Special Districts Association, "[s]pecial districts are local governments created by the people of a community to deliver specialized services essential to their health, safety, economy, and well-being. A community forms a special district, which are political subdivisions authorized through a state's statutes, to provide specialized services the local city or county does not provide" (California Special Districts Association 2022).

Cities, towns, and counties can jointly form special districts and joint powers authorities to address specific issues. Examples include the Sacramento Area Flood Control Agency, a regional flood control district with taxing authority; and the Association of Bay Area Governments, a joint powers authority functioning as a regional planning advisory body.

A distinction exists between independent special districts and dependent special districts:

- **Independent special districts** obtain their authority directly from the community they serve and have a governing body that is independent from other government agencies. Members of the governing body have a high degree of autonomy to fulfill the mission of the district and are directly accountable to the community they serve. Most independent special districts are governed by a constituent-elected board of directors. In some cases, the board may be appointed by one or more other local elected officials, so long as the board members serve fixed-terms and none of the board members serve in an ex-officio capacity.

- **Dependent special districts** are closely tied to another unit of local government. Typically, city council members, a county's elected executive board members, or their appointees, serve as the board of directors for a dependent special district and control the budget, management, and operation. Members of the board of a dependent special district may serve in an ex-officio capacity and serve at the pleasure of an appointing body. In this respect, dependent special district governance is subject to the interests, influence, and authority of other governmental bodies.

Both independent and dependent special districts can be eligible to fully participate in and adopt an approved local hazard mitigation plan (LHMP). As of December 2022, more than 370 special districts had approved hazard mitigation plans.

42.2. PLANNING PROCESS INTEGRATION WITH HAZARD MITIGATION PLANS

The Federal Emergency Management Agency (FEMA) stresses the importance of integrating hazard mitigation planning with comprehensive planning (e.g., local general plans, regional blueprint plans, regional transportation plans, emergency operations plans, response plans, and evacuation plans). Doing so reduces vulnerability to disasters, stimulates decision-making, forms partnerships between planners and emergency managers, expands funding opportunities, facilitates post-disaster return of the community to normalcy, and resolves locally sensitive issues with community-based solutions.

42.2.1. Integration With General Plans

The California Governor's Office of Emergency Services (Cal OES) works with the California Governor's Office of Planning and Research (OPR) to incorporate information on hazard mitigation planning into State General Plan Guidelines, which provide guidance to cities and counties in the preparation of their general plans. The 2017 General Plan Guidelines update includes new guidance to local jurisdictions to support response to recent hazard mitigation legislation. The OPR Plan Alignment

Toolkit provides local jurisdictions with an interactive web-based application to get tips, best practices, and guidance specific to climate hazards and plans most relevant to a community. See Section 43.2.4 for additional details.

California Assembly Bill (AB) 2140 encourages cities and counties to adopt a FEMA-approved LHMP into the safety element of their general plan. This adoption makes the county or city eligible to be considered for part of all of its local-share costs on eligible Public Assistance (PA) funding to be provided by the State through the California Disaster Assistance Act (CDAA).

42.2.2. Integration With Climate Planning

Senate Bill (SB) 379 (2015) requires general plans and LHMPs to include climate adaptation and resiliency strategies in the safety element of their general plans. The climate adaptation portions of these plans need to include goals, policies, and objectives for cities and counties based on a vulnerability assessment, as well as implementation measures, including the conservation and utilization of natural infrastructure that may be used in adaptation projects.

42.3. GENERAL PLAN REQUIREMENTS

In California, general plans are the vehicle used to outline the policies and regulatory framework for land use decisions at the local level. Tools used to implement local general plans include zoning, development review, subdivision review, capital improvement programs, land acquisitions, and redevelopment.

The State legislature has declared that decisions involving the future growth of the State, most of which are made at the local level, should be guided by an effective planning process, including a local general plan. It has also declared that the State's land is an exhaustible resource, not just a commodity, and is essential to the economy, environment, and general well-being of the people of California.

A local government's general plan acts as a "constitution" for future development, bridging the gap between a community's values, vision, and goals, and physical development actions, such as the subdivision of land and public works projects. Information in the general plan underlies most local land use decisions.

Community growth can involve issues such as housing, transportation, natural resources, and hazards. The general plan provides goals, objectives, and policy statements that outline the vision of what a municipality plans to be in the future. Each city and county adopt zoning, subdivision, and other ordinances to regulate land use and to implement general plan policies.

A general plan offers many opportunities for local agencies to identify, plan for, and mitigate local hazardous conditions such as floods, fires, and earthquakes. Local governments can place policies within their general plans that require new development to have little or no susceptibility to hazards. Growth can then be controlled and concentrated in areas where hazards are far less likely to affect buildings and people. Many jurisdictions have written hazard mitigation provisions into local zoning, subdivision, and environmental assessment ordinances for reference in routine project review.

Example Regulatory Approaches Addressing Natural Hazards

The following are examples of common zoning and subdivision regulatory approaches to new developments in natural hazard areas:

- Transfer of allowable density from hazardous parts of a site to safer areas
- Restriction of residential densities, reducing the numbers of structures at risk
- Enforcement of building setbacks from flood, landslide, and fault zones
- Adoption of slope-density formulas to limit the number of dwellings on hillsides
- Modification of parcel boundaries and street locations to avoid hazardous areas
- Requirement of multiple access points for emergency access and evacuation
- Provision of adequate street widths for two-directional movement in an emergency
- Assurance of sufficient water pressure for adequate fire flows
- Assurance of sufficient water supply during drought conditions

Source: (Cal OES 2018)

42.3.1. Statutory Mandates

California law contains many provisions regulating land use planning, including general plans, specific plans, subdivisions, and zoning (see Government Code Section 65000-66499.58). Every city and county in the State must adopt a general plan for the physical development of the county or city and any land outside its boundaries that bears relation to its planning. The general plan must cover a local jurisdiction’s entire planning area and address the broad range of issues associated with local development. It must be adopted by the local legislative body so that it is implemented with the weight of law. General plans may also be known as comprehensive plans or master plans.

In accordance with Government Code Section 65302, a general plan must contain eight elements: land use, circulation, housing, conservation, open space, noise, safety, and environmental justice. The safety element identifies hazard mitigation policies to guide local decisions related to zoning, subdivisions, and entitlement permits. Each element's data, analyses, goals, policies, and implementation programs must be consistent with and complement one another. For example, allowed land uses defined in land use element maps must take into account hazards defined in safety element maps.

The California Planning and Zoning Law and the Subdivision Map Act require all cities and counties to adopt specific plans and other regulations to implement the general plan. Counties and cities must have zoning and specific plans that are consistent with the general plan. The Subdivision Map Act requires that land subdivision also be consistent with the general plan.

42.3.2. State Guidance

The State is seldom directly involved in local land use decisions. These have been delegated to city councils and county boards of supervisors. Local decision makers adopt their own land use policies based on State laws and approve individual development projects based on these policies.

OPR is the principal State agency that oversees community planning issues for California. One of its tasks is to develop guidelines for counties and cities to follow for developing general plans. The most recent version of the General Plan Guidelines was published in 2017 and includes detailed information on what needs to be included in each mandated element. Of most relevant importance to hazards management is the guideline for developing a safety element. In addition, there are summaries of laws and government codes that apply to community planning.

OPR's 2017 General Plan Guidelines encourage best practices and emphasize consideration of each local general plan within its regional context. For example, OPR encourages local governments to coordinate planning issues that transcend city or county boundaries. Wildfire, flooding, and air pollution are examples of hazards that can cross jurisdictional boundaries.

The role of OPR is not to regulate local government planning, but to provide cities and counties with planning assistance and resources. OPR prepares numerous publications on a variety of planning topics and provides advice and assistance to local planners by phone and email (OPR 2017).

42.3.3. Mandated General Plan Elements

The Government Code specifies requirements for the minimum content in each element of a general plan (Government Code Section 65302). Local governments are welcome to go beyond the minimum requirements and to include other elements or sections. The elements can be organized in whatever method best fits the policies of the municipality, as long as all the required components are addressed. The following is a brief description of the requirements that are most relevant to hazard mitigation for each element.

Safety Element

The safety element is the most important element for hazard management. It contains the most significant requirements to protect people and property from hazards. At a minimum, the safety element must address seismic, geologic, fire, and flood hazards. Local governments often include other components such as crime, hazardous materials, airports, and emergency operations. The first priority for the local government is to identify the hazards that are within its boundaries. Hazard identification will include mapping of the hazardous areas. Then, the local government must determine the strategies and policies that will reduce the risks from these hazards. The safety element unifies components from other elements into a single element that guides hazard-related policy- and decision-making.

Land Use Element

The land use element outlines land use categories and their locations within the community. The categories can include residential, commercial, agriculture, and public facilities. Included in the requirements for this element is a statement of the standards of population density and building intensity for each of the identified land use categories. A requirement added by AB 162 (2007) is that areas within the community that are subject to flooding must be identified and mapped by floodplain mapping prepared by FEMA or the California Department of Water Resources (DWR). This must be reviewed each year.

In addition to providing the required flood mapping, the land use element offers other opportunities for hazard mitigation. Local governments can include policies that land uses of higher value, such as commercial or residential, be located outside likely hazardous areas, which might encompass areas subject to hazards such as landslides, wildfires, and floods or potential human-caused hazards. Keeping high-value land uses such as industrial plants and rail yards out of potentially hazardous locations can greatly reduce the loss of life and property.

Circulation Element

The circulation element involves the transportation routes within a city and county. This element can include policies on what the transportation routes will be in the future and where they are located. Transportation can be both vehicular and pedestrian. Vehicular circulation includes local roads, highways, bicycles, and rail. Road widths, street parking, and intersections are a few of the components to planning for vehicular circulation. Pedestrian circulation may include sidewalks, walking trails, and crosswalks. Public utilities to support circulation, such as street signs and traffic lights, are also addressed within this element. Also included are transit facilities, such as bus terminals and railway lines and stations.

The circulation element has substantial potential to promote hazard mitigation within the community. Many transportation routes will be used by emergency services to respond to incidents. They will also be used as evacuation routes for people leaving areas that have been or are about to be affected by a disaster. In their circulation elements, local governments can include requirements that critical roads be wide enough to allow larger vehicles (such as emergency vehicles) to pass other vehicles so that there are no traffic jams during a disaster event. The element could also require that new developments have multiple access points to expedite response and evacuation in the event that any access points or roads become inaccessible.

Housing Element

The housing element includes projected housing needs for the community and strategies for the community to increase housing supply. The housing projections and strategies analyze a variety of factors, including population projections and market conditions. Once a strategy is adopted, the city or county may implement the strategy through zoning ordinance modifications or through housing development project approvals.

Under California law, the housing element is the only general plan element requiring periodic review by the State of California and requiring updates every five years. Given the update requirement, the housing development strategy is a five-year plan of actions to implement the goals and objectives of the element. Under AB 162, local governments must add the latest flood hazard information to their housing elements before forwarding the elements to the California Department of Housing and Community Development (HCD) for review.

Conservation Element

The conservation element covers natural resources within the city or county. In addition to conservation of natural resources, this element addresses the responsible development and use of these resources. Because growth and development can lead to increased demand for natural resources such as open land, the strategies within this element are developed in accordance with the strategies of other elements such as housing, open space, and transportation.

Natural resources are an important component in safety elements in that they include the natural conditions that could lead to hazards for the community. Examples include forested areas within high fire severity zones, rivers, and streams within floodplains, coastal regions susceptible to tsunamis, and hills with landslide risks. Under AB 162, conservation elements must include information on waterways that contribute to or support floodplains.

Open Space Element

The open space element contributes to hazard mitigation primarily through policies for setting aside land for non-development. Motivations behind such policies could include preventing development in hazardous areas. Instead of accommodating development, high-hazard areas could be preserved as open space. Examples include land along earthquake fault zones or within floodplains. Setting aside land can reduce current risk through protection and preservation of natural resources in floodplains. Natural resources such as wetlands and marshes can provide a buffer and absorb the impact of floods. If development is permitted in hazardous areas, open space could serve as a buffer between the development and the hazard. For protection from wildfires, this buffer would provide a built-in firebreak surrounding the development.

Noise Element

The noise element addresses excessive noise levels in areas of the community. It is included in the general plan to minimize unhealthful impacts from sources of excessive commercial, industrial, and transportation noise. Although the noise element does not directly address natural hazards, it has a bearing on placement of noise-sensitive land uses such as schools, hospitals, and retirement centers that may also be vulnerable to hazards and risks. Areas near the ends of airport runways are characterized not only by extreme noise but also by higher risk of airplane crashes and therefore are not suitable for such land uses.

Environmental Justice Element

California Government Code Section 65040.12 defines environmental justice as "the fair treatment and meaningful participation of people of all races, culture, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies." Environmental justice seeks to minimize and equalize effects of environmental hazards among the entire community regardless of income, ethnicity, or race.

A general plan must contain an environmental justice element, or integrate environmental justice goals, policies, and objectives into the other plan elements, if the city or county has a "disadvantaged community" (a community so designated by the California Environmental Protection Agency (CalEPA)) or a low-income area that is disproportionately affected by environmental pollution and other hazards that can lead to negative health effects, exposure, or environmental degradation.

42.3.4. General Plan Consistency

The required general plan elements are an important component of community planning, but their value can easily be negated if they conflict with one another. For this reason, State general plan law requires both internal and external consistency. A general plan is internally consistent if the content of each individual element is consistent with other parts of the same element and with other general plan elements. For example, maps and diagrams must be consistent with the text within the element. External consistency refers to the consistency of the general plan with zoning and other general plan implementation programs and actions. For more information regarding related laws, see Appendix L.

Consistency Among General Plan Elements

According to Government Code Section 65300.5, the general plan and elements make up an integrated, internally consistent, and compatible statement of policies for the adopting agency. Therefore, the policies outlined in the general plan must be unified and support one another. Components governing land use must not conflict with circulation, housing, or safety policies. For example, a land use element map designating a high-density residential area in the middle of a landslide area identified on a safety element map would conflict with safety element policies calling for protection of housing from landslide hazards.

Consistency of Implementing Actions

Actions implementing general plans, such as re-zonings, site plan reviews, subdivision map approvals, and capital improvement programs, must be consistent with the general plan. This is an important underpinning of hazard mitigation because it requires that policies related to minimizing impacts of natural hazards identified in the general plan be followed in the day-to-day actions of city and county governments.

42.4. ADOPTION OF LHMPS WITHIN SAFETY ELEMENTS

Under the federal Disaster Mitigation Act of 2000 (DMA), each municipality must develop an LHMP or participate in a multi-jurisdictional LHMP in order to be eligible for pre-disaster mitigation grants or post-disaster recovery assistance from the federal government.

At the State level, AB 2140 (2006) authorizes and encourages local governments to adopt their LHMPs into the safety elements of their general plans. Such adoption is not mandated by this law. However, communities that do so may be considered, upon request of the State, to receive available funds from the CDAA to cover a portion of the community's share of federal-grant-funded post-disaster projects. Adoption of an LHMP in the safety element under AB 2140 is one of the requirements to be eligible for such funding.

AB 2140 is one of the most important links between general plans and hazard mitigation in California. Integration of an LHMP into a safety element allows hazard mitigation strategies to be implemented and local hazard awareness to be upgraded and enhanced. In addition, all other elements of the general plan, as well as implementation programs (such as zoning, subdivision maps, specific plans, and capital improvement programs), are required to comply with an LHMP that is adopted with the safety element.

To help California cities and counties comply with State LHMP requirements under AB 2140, SB 379 (2015), and SB 1241 (2012), Cal OES is developing sample adoption resolution language indicating that compliance with all three pieces of legislation is met by adopting the LHMP into the safety element of the general plan. The sample language, when completed, will be available on the Cal OES website.

42.5. GENERAL PLAN IMPLEMENTATION

The following sections discuss the tools and processes that are involved in achieving the goals and objectives set by a general plan.

42.5.1. Zoning

Government Code Section 65850 establishes the legal authority for cities and counties in California to enact zoning ordinances. A community's zoning ordinance places land into a variety of use categories, known as zones. Examples of zones include residential, commercial, public facility, industrial, open space, and agriculture. It is common to find different types of zones for each category; for example, residential zones may include single-family, multi-family, or rural areas. For each zone, the zoning ordinance establishes building requirements, including restrictions on the range of uses allowed limits on building size and type, requirements for building setbacks (how far a structure must be from the property lines), and minimum parcel sizes. Zoning has functions that relate to hazard management as summarized below.

Hazard Overlay Zones

Overlay zones establish regulations beyond those set by the base zoning of a property. Generally, they address issues that typical zoning classifications do not.

Hazard overlay zones address risks created by a defined hazard. Common sources of overlay zone mapping include Special Flood Hazard Areas (SFHAs), Fire Hazard Severity Zones (FHSZs), and seismic/geologic hazard zones. These zones identify the location of the hazards and their potential risks to the community. Restrictions on development and land use are developed locally for each hazard overlay zone. Local governments can use hazard overlay zones to implement hazard mitigation strategies.

Zoning Changes

Landowners who wish to develop or build on their property may be restricted because of its current zoning. For example, land zoned for agriculture may have minimum lot size requirements and restrictions on how many houses can be built. In these cases, the landowner could request a zoning change. Local legislative bodies such as city councils and boards of supervisors have the authority to change zoning on parcels. The zoning change request is brought before a public meeting for comment. Significant opposition from the public can sway the council or board to deny the change. Any changes in zoning must be consistent with the general plan and other requirements on the property. Otherwise, the change can be challenged in court.

Variances

A variance allows variation from a standard zoning requirement. California law does not allow variances from the permitted land uses specified by zoning, but it does allow variances from other zoning requirements if certain conditions are met. An example would be a variance from standard building setback requirements on a lot where a geologic obstruction, such as a fault zone or landslide, would prohibit construction of a home that complies with the standard requirements.

Usually, variances are granted only if it is proven that compliance with the standard zoning would create a hardship for the landowner. In the case of the geologic obstruction, being forced to build a much smaller house or no house at all could reasonably be considered a hardship for the landowner.

Site Plan Review

A local planning agency reviews proposed site plans to confirm that they comply with zoning requirements. Site plan review offers the planning staff the opportunity to apply lessons learned from previous disasters to proposed new development. This could include assessing drainage, vegetation landscaping, building design and locations, soil integrity, and adequate access.

42.5.2. Specific Plans

California Government Code Section 65450 establishes the legal authority for specific plans, which may be used to implement the general plan in a certain area. Specific plans are created when unique development standards are needed for a location. While general plans must meet mandated requirements, specific plans are subject to more general legal guidance. This allows specific plans to establish zoning and other development standards appropriate for a development project.

Specific plans are required by law to be consistent with general plans. According to Government Code Section 65455, all zoning ordinances, tentative subdivision maps, parcel maps, and public works projects in an area subject to a specific plan must be consistent with the specific plan.

42.5.3. Subdivision Map Act

The Subdivision Map Act (Map Act) is the overarching law for the development of subdivisions in California (Government Code Section 66410, et seq.). The first version of the Map Act was written in 1907, making it one of the oldest planning laws in California and in the United States. It was written in response to rapid growth in California at the time and provides a process for local governments to follow in order to grow responsibly.

The Map Act has been amended several times. At present, it gives local governments authority to regulate proposed subdivisions within their jurisdiction. Local procedures under the Map Act are uniform and applied statewide. Subdivisions are defined as having more than four lots and are required to include a map that shows approximately what the subdivision would look like if completed.

A key requirement of the Map Act is that a city or county must deny any tentative subdivision map if the map, design, or improvements are inconsistent with the general plan or any applicable specific plan. For example, a general plan may include policies requiring that subdivisions have adequate water supply for fire suppression, multiple access points, and building design that protects people from earthquakes, fires, and floods.

A city or county must deny any tentative subdivision map if the design or improvements are likely to cause environmental damage, substantially and avoidably injure fish or wildlife or their habitat, or cause public health problems. This provides a basis for linking natural hazards to environmental damage and public health, letting city and county planners deny or modify maps not meeting these criteria.

42.5.4. Unreinforced Masonry Building Act

In 1986, the California legislature enacted the Unreinforced Masonry Building Act (Government Code Section 8875, et seq.). This law requires that local governments identify every building that has unreinforced masonry (URM) located within a Seismic Zone 4. Once the buildings are identified, local governments must develop and submit to the State a plan for reducing URM loss during a seismic event. This plan should provide for retrofitting or removing URM buildings. California has forbidden the construction of URM buildings since 1933; however, there are still over 22,000 of these buildings in the State.

As of 2006, approximately 70 percent of all URM buildings in California had been retrofitted. In Los Angeles and Orange Counties, the percentage is 87 percent and 89 percent, respectively. San Francisco has retrofitted 86 percent of all URM buildings. As of 2022, some cities, such as Berkeley have achieved URM retrofit progress in all but a handful of their URM buildings.

Sources: (Seismic Safety Commission 2006, City of Berkeley 2022)

42.5.5. Capital Improvement Programs

Transportation, water, power, and sewage systems play a critical role in the health of communities, and they must be maintained and modernized to continue to meet the community's needs. Local jurisdictions typically maintain ongoing capital improvement programs. These programs are required to be consistent with the general plan of the community.

New development often requires construction of capital improvements such as parking, roads, and water and sewer services. Local governments can require developers to build these improvements or levy fees on the development project to help fund the improvements.

After a disaster, one of the critical functions for short-term recovery is to rebuild and restore critical infrastructure and key resources. This can involve reconstruction of many of the systems that are included in capital improvement programs. Thus, one of the keys to community resilience is to ensure that infrastructure is built to promote public safety after a disaster. One example is requiring that new developments have wider roads with redundant routes and multiple access points to facilitate evacuation and response operations.

42.5.6. Land Acquisition

Local government can buy all or part of a property from a landowner to benefit the community. Examples include land acquired to allow road widening, construction of new roads and freeways, or sale to developers for redevelopment.

Land acquisitions have increasingly been used as tool for hazard mitigation, primarily because they are extremely effective at reducing risk within communities. In California, land acquisitions have been used for property susceptible to landslides and other geologic and seismic hazards.

Most buyouts occur after a disaster or after repeated events on the property. This is largely because land acquisition is the most expensive form of hazard mitigation, and sufficient funds are usually not available until after a disaster has been declared.

42.5.7. Land Conservancies

Quasi-public organizations often undertake hazard mitigation and environmental protection functions to supplement local governments. Land conservancies can become land holders with the goal of preserving the natural environment, which may also have hazard mitigation benefits. Land with flood or geologic hazard issues may be kept out of development through the purchase of the land for open space or purchase of the land's development rights. For example, federally sponsored resource conservation districts perform such functions. The Nature Conservancy is a land conservancy that has worked on more than 100 projects and preserves in California since its founding in 1951, although many of its projects are now managed by other organizations.

42.6. COASTAL LAND USE REGULATION

The California Coastal Commission was established in 1972 to protect California's coastal environment. California's coastal management program is carried out through a partnership between State and local governments. The California Coastal Act of 1976 extended the Coastal Commission's authority indefinitely (Public Resources Code Section 30000, et seq.). Section 30253 of the California Coastal Act requires that new development minimize risks to life and property in areas of high geologic, flood, and wildfire hazard.

Implementation of Coastal Act policies is accomplished primarily through the preparation of Local Coastal Programs (LCPs) that are required to be completed by each of the 15 counties and 61 cities located in whole or in part in the coastal zone. Completed LCPs must be submitted to the Coastal Commission for approval.

An LCP includes a land use plan, which may be the relevant portion of the local general plan, including any maps necessary to administer it, and the zoning ordinances, zoning district maps, and other legal instruments necessary to implement the land use plan. Coastal Act policies are the standards by which the Coastal Commission evaluates the adequacy of LCPs.

Amendments to certified land use plans and LCPs only become effective after approval by the Coastal Commission. To ensure that coastal resources are effectively protected in light of changing circumstances, such as new information and changing development pressures and impacts, the Coastal Commission is required to review each certified LCP at least once every five years.

42.7. CALIFORNIA BUILDING CODES

The California Building Standards Code—contained in California Code of Regulations (CCR) Title 24, Parts 2 through 11—is a compilation of three types 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 national model codes to address California's ever-changing conditions
- Building standards authorized by the California legislature that constitute amendments not covered by national model codes; these are created and adopted to address particular California concerns

All occupancies in California are subject to national model codes adopted into Title 24, to amendments adopted by State agencies, and to ordinances implemented by local jurisdictions' governing bodies. Building and fire codes adopted under the State's laws have created a solid foundation for mitigating impacts of floods, fires, earthquakes, and other natural hazards in new development. Key elements of the building codes are as follows:

- California adopts the most recently published International Building Residential and Fire Codes, Uniform Plumbing and Mechanical Codes, and National Electric Code, with proposed California amendments to ensure they are in compliance with new or changing laws and regulations for adoption in California.
- The California Green Buildings Standards (CALGreen) Code and the California Energy Code are among the leading U.S. codes related to green building standards and energy conservation.
- Title 24, Part 6—the California Energy Code—contains energy conservation standards applicable to residential and non-residential buildings throughout California, including schools.
- Title 24, Part 8—the California Historical Building Code—contains regulations of the State Historical Building Safety Board and contains alternative solutions for the preservation of qualified historical buildings or properties, to provide access for persons with disabilities, to provide a cost-effective approach to preservation, and to provide for the reasonable safety of the occupants or users.
- Title 24, Part 9—the California Fire Code—addresses fire provisions for life safety.
- The California Building Standards Commission (CBSC) adopts residential and non-residential standards and certain provisions of Title 24, Part 10.
- Title 24, Part 11—the CALGreen Code—addresses green building standards.
- Lake, Kern, Marin, and Ventura counties have also adopted the International Urban-Wildland Interface Code.

42.7.1. Temporary Modification to the Building Code to Aid Post-Disaster Emergency Housing

It is time-consuming and costly to design and construct buildings in full compliance with the requirements of the 2022 CBSC for the purpose of housing victims of a declared emergency. Local jurisdictions often must establish and approve emergency housing in a very short timeframe. However, they also need to ensure that the housing provided is durable and safe.

Relying on the code is the routine process for permitting and approving residential housing. However, according to HCD, there are options for housing that are available but not recognized in the code. These housing options may provide a quick, cost-effective, and safe shelter permanently or temporarily.

Under certain post-disaster conditions, building codes may be temporarily modified to allow for more rapid construction of emergency housing. AB 932 (2017) directs HCD to review and approve draft ordinances from seven local jurisdictions to ensure that they address minimum health and safety standards. This legislation became effective in 2018, and there were no building standards available to specifically address emergency housing. In order to provide a consistent minimum standard by which local agencies may develop emergency housing or shelter ordinances, HCD prepared emergency regulations for review and adoption by CBSC.

42.7.2. Applicable Regulatory Agencies

Building and fire codes are locally enforced by city and county staff, including building inspectors, fire department personnel, and sometimes law enforcement officers. Cities and counties review detailed plans for new construction for conformance with California building codes. Local code enforcement agencies arbitrate disputes concerning portions of facilities involved in repairs or upgrades and make final decisions on such matters.

According to California Health and Safety Code Section 16006, the "enforcement agency" is the agency of a city, city and county, or county responsible for building safety within its jurisdiction. The Division of the State Architect, within the California Department of General Services (DGS), is the review agency for the design and construction of public kindergarten through 12th grade school facilities and State-owned and State-leased essential services facilities.

Under the National Earthquake Hazards Reduction Program (NEHRP), the California Geological Survey (CGS) and the U.S. Geological Survey (USGS) prepare periodic updates of seismic zone maps for inclusion in the earthquake provisions for model building codes. These agencies operate strong-motion programs that record and analyze the response of engineered structures during earthquakes that form a basis for improved building codes.

Other State agencies with code development or regulatory authority include the California Department of Health Care Access and Information (HCAI) for hospitals, HCD for mobile homes, the California Department of Water Resources (DWR) for construction in areas protected by the facilities of the Central Valley Flood Protection Plan (CVFPP), the California State Lands Commission (SLC) for engineering standards for marine oil terminals, and CBSC.

42.7.3. Applicable State Fire Codes

Local fire safety requirements are governed by State laws established through the legislature and administered through the State Fire Marshal and the California Department of Forestry and Fire Protection (CAL FIRE). Fire safety enforcement is an important part of local hazard mitigation. The California Fire Code contains regulations consistent with nationally recognized and accepted practices for safeguarding life and property from the hazards of:

- Fire and explosion
- Dangerous conditions arising from the storage, handling, and use of hazardous materials and devices
- Hazardous conditions in the use or occupancy of buildings or premises

The California Fire Code also contains provisions to assist emergency response personnel. These fire-safety-related building standards are referenced in other parts of Title 24. It is a fully integrated code based on the 2021 International Fire Code.

The Code Development and Analysis Division of the California Office of the State Fire Marshal (OSFM) reviews all of California's regulations relating to fire and life safety for relevancy, necessity, conflict, duplication, or overlap. The division also prepares the California State Fire Marshal's fire and life safety regulations and building standards for review and adoption by CBSC.

42.7.4. The Building Code Effectiveness Grading Schedule

Administered by Verisk, the Building Code Effectiveness Grading Schedule (BCEGS) assesses community building codes and their enforcement, with emphasis on mitigation of losses from natural hazards. The BCEGS program assesses a community's building code enforcement in three areas:

- Code administration
- Plan review
- Field inspection

Verisk collects 1,243 data points to calculate two scores: One for one- and two-family residential construction and another for commercial or industrial construction. Scoring ranges from 0 to 100. For insurance rating guidance, the scores are translated to a scaled class rating of 1 (best rating for building code enforcement) to 10 (worst rating for building code enforcement). The classifications apply to communities under the jurisdiction of each building code department and are used by the insurance community to help establish insurance rates.

With strong building code mandates, California communities tend to fare very well under the BCEGS evaluation process, as shown in Figure 42-1. With an average classification of 3 for both commercial and residential construction, California ranks first in the nation for state average score. Of the 15 communities that have achieved an "exemplary" (BCEGS Class 1) rating, eight are in California. The City of Palo Alto is the only city in the nation to have received a Class 1 rating for both commercial and residential development.

The FEMA Building Science Branch uses BCEGS data to track the rate of code adoption. A performance goal is to increase the percent of communities in hazard-prone areas (flood, wind, and earthquake) that adopt disaster-resistant building codes. Building Science produces national-level reports that include hazard maps listing each reporting BCEGS jurisdiction by county and state, grouped by FEMA region. The hazard maps and reports show the degree of resistance to building code adoption by jurisdictions at high risk. BCEGS scores are also used under the Building Resilient Infrastructure and Communities (BRIC) grant program and are an evaluation factor for scoring grant applications under a nationally competitive process.

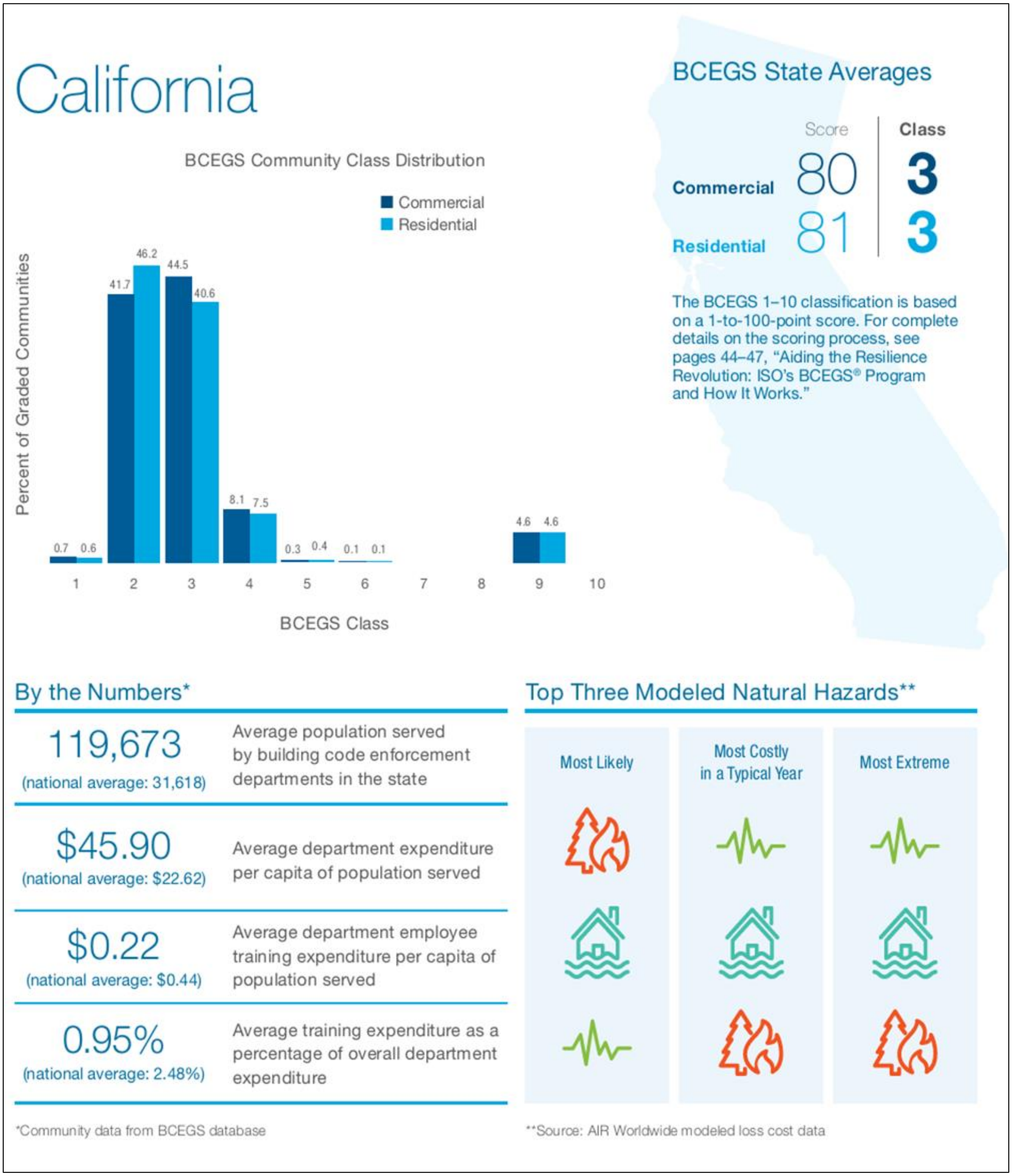
42.8. HIGH HAZARD POTENTIAL DAM PROGRAM

FEMA's Rehabilitation of High Hazard Potential Dams (HHPD) grant program provides technical, planning, design, and construction assistance for rehabilitation activities that reduce dam risk and increase community preparedness. To be eligible, recipients must have a FEMA-approved hazard mitigation plan that includes all dam risks.

The HHPD Planning Requirements for local plans are as follows:

- Incorporation of existing plans, studies, reports, and technical information for eligible dams.
- Addressing eligible dams in the risk assessment.
- Including mitigation goals to reduce long-term vulnerabilities from eligible dams.
- Prioritizing mitigation actions to reduce vulnerabilities from eligible dams.

Figure 42-1. California State BCEGS Profile



Source: (ISO 2019)

The HPPD program is new since the completion of California’s 2018 State Hazard Mitigation Plan (SHMP or Plan), and it has not had much time to influence local hazard mitigation planning in California. The State has always included the dam failure risk in its SHMPs and required the assessment of this risk as a hazard of concern for communities downstream of listed “high” or “significant” hazard dams. A recent enhancement of the Department of Safety of Dams website that makes dam failure inundation mapping for State-owned and regulated dams readily accessible has been a significant help for local planning efforts in assessing their risk to dam failure (DSOD 2022).

As of this 2023 SHMP update, less than 1 percent of the approved LHMPs within the State have requested a review for the HHPD requirements. This can be attributed to the newness of the HHPD program. It is likely that enhancements will need to be made to most plans in the State to meet the HHPD requirements, especially the goal setting and action planning requirements.

To draw attention to the HHPD Planning Requirements, FEMA and the State have added the HHPD Planning Requirements as an “optional” field to the Local Hazard Mitigation Plan Review Tool. This enhancement, plus increased outreach efforts that are being made by both FEMA and Cal OES, should result in more local plans meeting the HHPD requirements during the five-year performance period of this SHMP.

42.8.1. Policies, Programs, and Capabilities that Address High Hazard Potential Dams

HHPD6: Did Element S13 (local coordination) generally describe and analyze the effectiveness of local mitigation policies, programs, and capabilities that address high hazard potential dams?
Section 42.8.1. specifically addresses ways that local policies, programs, and capabilities mitigate risk to high hazard potential dams in California.

All local capabilities identified in this chapter could have application to reducing risk from the impacts of dam failures, especially those associated with the management of identified floodplains. While mapped dam failure inundation areas often exceed the area of mapped and regulated floodplains, the portion of these inundation areas that would be subject to these floodplain management capabilities is extensive. Programs like FEMA’s Community Rating System (CRS) promote regulating areas outside of FEMA’s regulatory floodplain to include other areas of known flood risk such as dam failure inundation areas. The CRS program has classification prerequisites that mandate oversight of dam failure inundation areas for communities seeking CRS Class 4 or better classifications.

The biggest challenge to implementing policies, programs, and capabilities to mitigate impacts from high hazard potential dams is risk communication and awareness. The State program that has most addressed this challenge is the DWR's Division of Safety of Dams (DSOD) Dam Breach Inundation Mapping Program, directed by California Water Code Section 6161. The availability and accessibility of this level of risk data on dam failure inundation has been a significant benefit for local capacity to address risk from high hazard potential dams. Prior to the establishment of this program and DSOD, information on extent and location of dam failure risk was not readily available to support local planning and programs. Now that this tool is available, and with sufficient detail to assess risk, local governments will have a better understanding of that risk. This should lead to enhanced programs for managing risk. It represents a significant opportunity to identify and implement mitigation actions that address the risk posed by high hazard potential dams. DSOD is fully committed to maintaining and updating this mapping program as new data becomes available.

DSOD's regulatory and enforcement functions are key elements of the State's capabilities to address high hazard potential dams. SB 92 requires all high-hazard and extremely-high-hazard dam owners to prepare dam inundation maps based on regulations prepared by DWR for use in enhanced dam emergency action plans (EAPs) once every 10 years. California also requires that county clerks include a dam inundation notification in the hazard disclosure statement for all properties, which is updated by the counties at the time of sale.

The DWR Division of Floodplain Management (DFM) has a one-time project to install new gauges in or downstream of ungauged dams to monitor releases to support emergency response and real-time alert systems. During periods of intense rainfall, DSOD monitors the outflows from dams via their spillways to help alert Cal OES to potential downstream inundation.

The DFM also provides assistance to downstream communities enrolled in the CRS to apply to FEMA for credits for any implementation of dam safety actions. California has a dedicated CRS Coordinator to provide technical assistance to communities pursuing these and other CRS credits.

The HHPD6 requirement for state hazard mitigation plans requires LHMPs to generally describe and analyze the effectiveness of local mitigation policies, programs, and capabilities that address high hazard potential dams. The HHPD Planning Requirements for LHMPs do not require a capability assessment related to dealing with high hazard potential dams. Therefore, reviewing local plans to identify capabilities is not a feasible way to meet this requirement. This section offers an identification of capabilities and capacities developed without a review of the local plans.

Of the 58 counties in California, 54 assessed dam failure as a hazard of concern in their hazard mitigation plans. Of these, 28 ranked dam failure as high risk, 17 ranked it as medium risk, and nine ranked it as low risk. Of these plans, only three have been approved by FEMA as meeting the HHPD Planning Requirements for LHMPs. This represents fewer than 1 percent of total approved plans in the State. The planning team for this SHMP performed a review of the three plans to see how each of them addressed the four HHPD Planning Requirements for LHMPs. A summary of findings from this review is provided in Table 42-1.

Table 42-1. HHPD Review of LHMPs

	Stanislaus County Hazard Mitigation Plan	Shasta County Hazard Mitigation Plan	South Lake Tahoe Hazard Mitigation Plan
#Number of High Hazard Potential Dams Assessed	13 high or significant hazard dams	1, Lake Shasta Dam	2 high, 1 significant and 1 low hazard dams included in the risk assessment
Does the Plan Assess Vulnerability from High Hazard Potential Dams	Exposure analysis for both general building stack and critical facilities and infrastructure. No loss estimation was performed	Qualitative assessment. No exposure or vulnerability analysis of general building stock or critical facilities and infrastructure was performed. Dam Failure was ranked as "limited" under the criteria applied in the plan	Exposure analysis for general building stock and for critical facilities and infrastructure. No loss estimation was performed
Does the Plan Describe How High Hazard Potential Dam Owners Were Involved in the Process	Yes. Section 3.4.2 of the plan discusses agency coordination, including with dam owners/operators	Yes. The oversight Steering Committee included U.S. Bureau of Reclamation and DWR	Yes. Page 3-17 of the plan discusses agency coordination including with dam owners/operators

	Stanislaus County Hazard Mitigation Plan	Shasta County Hazard Mitigation Plan	South Lake Tahoe Hazard Mitigation Plan
High Hazard Potential Dam Goals/ Objectives	Goal: Build resilient infrastructure and communities that withstand climate-related impacts. Plan includes five dam Incident hazard-specific objectives	Goals were identified individually for Shasta County and the City of Anderson. Both plans include the following goal: Reduce the possibility of damage and losses to existing assets —particularly people, critical facilities/ and infrastructure, and County-owned facilities—due to flood, wildfire, extreme weather, earthquake, hazardous materials, volcano, multi casualty, or dam failure	Goal: Reduce impact of future disaster events and the disruption of critical facilities and essential community services by building adaptive capacity to a changing climate
High Hazard Potential Dam Actions	Six dam Incident actions (#18 – #23) were identified and prioritized. These actions centered upon planning, public education, and emergency services (training and exercise)	Shasta County, 1 dam failure action identified and prioritized. City of Anderson, no dam failure actions identified. The one identified action was a public education and outreach action	One dam incident action identified and prioritized. The action is an agency coordination action centered on training and exercise

Key findings of this review are as follows:

- All three plans used inundation mapping from the DSOD website, which is a new capability available to support local hazard mitigation planning since the 2018 SHMP.
- Meeting HHPD elements in an LHMP is optional. The majority of local planning efforts in the State have chosen not to meet the HHPD requirements or did not know about these requirements since the HHPD program is a fairly new initiative.
- It is likely that many of the plans that assessed dam failure risk could easily be adapted to meet HHPD requirements with guidance.
- All of the plans reviewed contained goals specific to critical facilities and infrastructure, which have been implied to include dams. None of the plans included a goal specifically mentioning dams.
- The actions identified in the plans reviewed centered on public education and outreach, agency coordination, and training and exercise (See Appendix S).

42.9. LOCAL CAPABILITY EFFECTIVENESS

All counties and a majority of the eligible local governments within the State have identified, leveraged, and developed capabilities that are effective in mitigating risk from natural hazards and support the development of LHMPs. These capabilities are discussed in their LHMPs and serve as the basis for the implementation of many successful actions. Capabilities assessments typically evaluate the community abilities described in Table 42-2.

Table 42-2. Community Abilities Typically Reviewed in Capability Assessments

Capability Category	General Description	Specific Examples
Planning and Regulatory Capabilities	▪ Federal/State/local statutes ▪ Land use ▪ Building codes	▪ Floodplain requirements ▪ General plans ▪ Capital improvement plans ▪ Stormwater management plans ▪ Emergency operations plans ▪ State regulations ▪ Building codes
Education and Outreach Capabilities	▪ Training ▪ Public involvement	▪ Firewise communities ▪ Listos California
Administrative and Technical Capabilities	▪ Organization ▪ Roles and responsibilities	▪ Floodplain administration ▪ Geographic information systems (GIS) specialist ▪ Mutual aid agreements ▪ Mitigation planning committee ▪ Emergency manager
Financial Capabilities	▪ Internal funding sources ▪ External funding sources	▪ General fund ▪ Authority to tax ▪ Community Development Block Grants (CDBG) ▪ State and federal grants

Sources: (FEMA 2013a, FEMA 2022q)

For communities that participate in the National Flood Insurance Program (NFIP), capability assessments also include an evaluation of the jurisdiction’s capacity to implement that program’s requirements.

Cal OES reviews approved and adopted LHMPs for each update of the SHMP. These reviews foster partnerships, promote more resilient communities, and promote hazard mitigation activities consistent with SHMP goals and objectives.

The reviews aim to accomplish the following:

- Determine how the local governments are evaluating the effectiveness of their plans
- Determine challenges, barriers, and unmet needs the counties identified in reaching their mitigation goals
- Identify opportunities to address challenges and leverage existing capabilities

42.9.1. Effectiveness

The review of county LHMPs found limited discussion of the effectiveness of mitigation actions and overall plan effectiveness. When plans are updated, each participating local government is required to reconcile its past recommended actions. This is where plan effectiveness should be measured and where any course correction needed to increase the effectiveness of the plan should be identified. However, the effectiveness of prior actions typically is not evaluated because it is not specifically required in the FEMA planning guidance.

Local governments should be encouraged to include mitigation success stories in their plans and to identify obstacles or barriers to effectiveness that presented themselves during the performance period of the plan being updated.

42.9.2. Challenges and Barriers

Challenges and barriers to implementing LHMP recommended actions can vary based on the size or type of hazard mitigation planning (single jurisdiction vs. multi-jurisdiction, large scale vs. small scale, etc.). Cal OES has made it a priority of this SHMP to provide tools and resources that local governments can use in preparing and updating their hazard mitigation plans.

Appendix M of this SHMP includes a guide for local hazard mitigation planning resources. The guide answers common questions that local governments have based on identified barriers and provides suggested practices for steps in the mitigation planning process. This guide will be updated as new resources and practices are identified over the performance period for this SHMP.

As part of this SHMP update, Cal OES State Mitigation Planning Unit (SMP Unit) and Local Mitigation Planning Unit (LMP Unit) conducted a series of listening sessions to foster local participation in the State hazard mitigation planning process and support local communities with the development of tools, resources, and technical assistance to produce local plans for safer communities and a more resilient state.

A total of 15 listening sessions were held, with attendance kept to a small number of participants during each session to allow time for local communities to share feedback. Invitations were sent to representatives from all 58 California counties, resulting in the participation of 32 counties, or 55 percent of invitees. The grouping of local communities for the listening sessions was based on common attributes such as hazards, geography, disaster history, plan experience (new and seasoned planners), and planning challenges and strengths to ensure depth and breadth in the feedback collected. The discussion questions were provided to communities in advance to establish the purpose and focus and to provide participants an opportunity to think through their input or engage other individuals who may be able to offer better insights. Table 42-3 summarizes typical challenges identified by these listening sessions, which the State's guidance document attempts to address.

42.9.3. Opportunities

The following are some of the opportunities identified in LHMPs to address challenges and leverage capabilities.

- Including progress reporting as part of a plan maintenance strategy helps to keep the plan dynamic and track changes that could impact the implementation of the plan. This also provides an opportunity to expand continuing public involvement as a part of plan maintenance.
- Forming partnerships with community and non-profit organizations to maximize limited financial resources.
- Linking mitigation planning with funding. With the increased funding that California has received and is poised to continue to receive, many local governments with approved LHMPs are well positioned for funding of actions identified in those plans.
- Emphasizing equity and climate change. This will create an opportunity to revise plans that have followed the same path for more than 20 years.

Table 42-3. Local Capability Challenges

Capability Category	Challenges
Planning and Regulatory Capabilities	▪ The definition of a local government (who is eligible to participate in an LHMP) ▪ The elimination of silos in hazard mitigation planning ▪ Turnover of staff ▪ Experience of staff
Education and Outreach Capabilities	▪ Defining the "public" for engagement in a planning effort ▪ Integrating representatives of equity priority communities to actively engage in planning efforts
Administrative and Technical Capabilities	▪ Selecting best available data and science for local hazard mitigation planning ▪ Natural vs. non-natural hazards ▪ Understanding capabilities and capacities ▪ Defining an equity lens for planning ▪ Understanding State mandates such as AB 2140, SB 379, and AB 747 ▪ The impact of key personnel turnover ▪ GIS capability and data to support risk assessments
Financial Capabilities	▪ The ramifications of plan expiration ▪ When to apply for funding for plan updates ▪ The reliance on grant funding for local hazard mitigation planning

- Expanding the scope of an LHMP by including local government planning partners that own and operate community lifelines (special districts) in multi-jurisdictional planning efforts.
- Integrating LHMPs with land use plans to remove some of the silos for mitigation planning that have been created over the past 20 years.
- Engaging the public to touch more audiences, which provides more diverse input on risk and vulnerability.
- Employing technology and innovation, such as the use of ESRI Story Maps, to expand the reach of LHMPs during implementation. This expanded reach has made it more efficient to communicate risk that these plans identify.

43. LOCAL GOVERNMENT PLANNING COORDINATION

S14 – 44 CFR 201.3(c)(5) and 201.4(c)(4)(i): Does the plan describe the process to support the development of approvable local government mitigation plans?
Chapter 43 describes the process by which the State supports the development of local hazard mitigations within California.

In their LHMPs, local jurisdictions address hazards and risk that could affect their area, aligning their planning efforts to be in concert with the SHMP. Jurisdictions are encouraged to address the hazards unique to their community and ensure that any State planning requirements associated with the LHMP are included. Cal OES provides support, training, and technical assistance to local jurisdictions throughout the planning and adoption process. Because of the history of disasters throughout California, encouraging communities to adopt LHMPs is a priority.

The DMA requires that states review LHMPs as part of their state hazard mitigation planning process. The intent is three-fold:

- To gather hazard, vulnerability, and mitigation information from the local level for use in state-level planning
- To ensure that state and local hazard mitigation planning is coordinated to the greatest extent practical
- To ensure that local jurisdictions are made aware of the hazards and vulnerabilities within their jurisdiction and to develop strategies to reduce those vulnerabilities

This process ensures that mitigation actions are based on sound planning processes that account for the risks and capabilities of California communities.

Cal OES's LHMP program continues to evolve based on the changing needs of LHMPs and ongoing updates to federal requirements. Cal OES adapts its outreach and educational approaches to align with current policies and resources. Program changes include new and emerging technologies for addressing and tracking hazards and gathering related data to successfully support local hazard mitigation planning.

43.1. RESOURCES FOR LOCAL HAZARD MITIGATION PLANNING

Mitigation plans form the foundation for a community's long-term strategy to reduce disaster losses and break the cycle of disaster damage, reconstruction, and repeated damage. The DMA encourages states, Tribal Nations, and local governments to take a new approach to mitigation planning. FEMA's interim final rule for this law in the Federal Register (44 CFR Part 201, Section 201.6) established mitigation planning requirements. It states that local jurisdictions must demonstrate that proposed mitigation actions are based on a sound planning process that is inclusive of the whole community and that accounts for the inherent risk and capabilities of the communities.

43.1.1. FEMA Guidance

FEMA has developed many tools to support hazard mitigation planning by local jurisdictions. FEMA guidance provides a basic structure from which the hazard mitigation planning process may proceed. The following sections describe the main FEMA resources that are the primary guidance documents for local jurisdictions to address required elements in their LHMPs. For a comprehensive listing of all FEMA planning resources, visit the FEMA website.

Local Mitigation Planning Policy Guide

FEMA's Local Mitigation Planning Policy Guide (released April 19, 2022, effective April 19, 2023) is the official interpretation of federal regulations and statutes relevant to local mitigation planning. This guide replaces previous FEMA guidance from 2011, although the federal regulations relating to local planning requirements have not changed. The guide focuses on using local mitigation planning to assist local jurisdictions in whole-community planning to build resilience through climate adaptation, land use, and economic development. The guiding principles informing this guidance are planning and investing in the future, collaborating and engaging all stakeholders and community members, and community planning based on local capabilities.

Local Mitigation Planning Handbook

The primary federal guidance tool for local jurisdictions to use in developing or updating LHMPs is the FEMA Local Mitigation Planning Handbook. FEMA updates this handbook every few years to ensure that guidance to jurisdictions is as current as possible. As of the preparation of this SHMP, the most recent Local Mitigation Planning Handbook was updated in 2013.

The handbook assists local jurisdictions in meeting the requirements of 44 CFR Section 201.6 by offering tools, worksheets, and examples. Included in this publication are detailed descriptions and examples of how to meet each required planning element successfully in the LHMP.

Mitigation Ideas Guide

Key considerations for evaluating mitigation planning actions include the following:

- Compatibility with community goals
- Legal authority
- Ability to implement and enforce mitigation actions
- Technical feasibility
- Financial capability
- Benefit-cost review of a proposed solution
- Priority level of a proposed project among the hazards addressed
- Completeness of the solution

FEMA's Mitigation Ideas Guide (January 2013) is a resource that communities can use to identify and evaluate a range of potential mitigation actions for reducing risk to natural hazards and disasters. The identified mitigation actions are organized by disaster type and by action type (local planning and regulations, structure and infrastructure projects, natural systems protection, and education and awareness programs). This publication can assist in identifying mitigation actions to include in a jurisdiction's LHMP and determining potential mitigation projects for funding under FEMA's Hazard Mitigation Assistance (HMA) program.

43.1.2. Other Resources for Local Hazard Mitigation Planning

Table 43-1 lists additional resources that support local hazard mitigation planning.

Table 43-1. Resources Supporting Local Hazard Mitigation

Agency	Guidance/Tool	Resource Website
General		
Local Jurisdiction	Jurisdictions should review their previous LHMP at the beginning of the LHMP update process for background on goals and priorities and to assess implementation of previous mitigation actions	Local jurisdiction website
FEMA	Local Mitigation Planning Handbook	https://www.fema.gov/sites/default/files/2020-06/fema-local-mitigation-planning-handbook_03-2013.pdf
FEMA	Local Mitigation Plan Review Guide	https://www.fema.gov/sites/default/files/2020-06/fema-local-mitigation-plan-review-guide_09_30_2011.pdf
FEMA	Tribal Mitigation Plan Review Guide	https://www.fema.gov/sites/default/files/2020-06/fema-tribal-mitigation-plan-review-guide_12-05-2017.pdf
FEMA	Mitigation Ideas	fema-mitigation-ideas_02-13-2013.pdf
FEMA	Independent Study 318: Mitigation Planning for Local and Tribal Communities	https://training.fema.gov/is/courseoverview.aspx?code=IS-318&lang=en
FEMA	Integrating Disaster Data into Hazard Mitigation Planning: A State and Local Mitigation Planning How-to Guide	HSDL - Integrating Disaster Data into Hazard Mitigation Planning: State and Local Mitigation Planning How-to-Guide
FEMA	FEMA Training Modules G-318 Preparing and Reviewing Local Plans G-393 Mitigation for Emergency Managers	https://www.fema.gov/emergency-managers/risk-management/hazard-mitigation-planning
Office of the Federal Register	Emergency Management and Assistance (44 Code of Federal Regulations [CFR] 201)	https://www.ecfr.gov/current/title-44/part-201
California Native American Heritage Commission (NAHC)	NAHC website	https://nahc.ca.gov/codes/

Agency	Guidance/Tool	Resource Website
Cal OES	California State Hazard Mitigation Plan	https://www.caloes.ca.gov/wp-content/uploads/002-2018-SHMP_FINAL_ENTIRE-PLAN.pdf
Cal OES	Local Hazard Mitigation Planning Program	https://www.caloes.ca.gov/office-of-the-director/operations/recovery-directorate/hazard-mitigation/state-hazard-mitigation-planning/
Cal OES	Region 9 LHMP Review Tool	https://www.caloes.ca.gov/office-of-the-director/operations/recovery-directorate/hazard-mitigation/state-hazard-mitigation-planning/
Cal OES	State of California Emergency Plan and Emergency Support Functions	https://www.caloes.ca.gov/office-of-the-director/operations/planning-preparedness-prevention/planning-preparedness/state-of-california-emergency-plan-emergency-support-functions/
Cal OES	California Adaptation Planning Guide	https://resources.ca.gov/CNRALegacyFiles/docs/climate/01APG_Planning_for_Adaptive_Communities.pdf
OPR	Integrated Climate Adaptation and Resilience Program (ICARP)	https://resilientca.org/
OPR	General Plan Guidelines (including Safety Element Completeness Checklist)	https://opr.ca.gov/planning/general-plan/guidelines.html
American Planning Association/FEMA	Planning Information Exchange	https://www.planning.org/nationalcenters/hazards/planninginformationexchange/
Element A—Planning Process; Element C—Mitigation Strategy; Element E—Plan Adoption		
FEMA	Plan Integration: Linking Local Planning Efforts	https://www.fema.gov/sites/default/files/2020-06/fema-plan-integration_7-1-2015.pdf
FEMA	Workshop: Planning for a Resilient Community	https://www.fema.gov/sites/default/files/documents/fema_planning-resilient-communities_fact-sheet.pdf
FEMA	Training Module IS-393 Introduction to Hazard Mitigation	https://training.fema.gov/is/courseoverview.aspx?code=IS-393.b&lang=en
FEMA	Integrating Historic Property and Cultural Resource Considerations into Hazard Mitigation Planning	https://www.fema.gov/pdf/fima/386-6_Book.pdf

Agency	Guidance/Tool	Resource Website
National Oceanic and Atmospheric Administration (NOAA)	Local Plan Alignment Compass	https://resilientca.org/topics/plan-alignment/
Cal OES	Cal OES Hazard Mitigation Planning Website	https://www.caloes.ca.gov/office-of-the-director/operations/recovery-directorate/hazard-mitigation/state-hazard-mitigation-planning/
National Institute of Standards and Technology	Community Resilience Planning Guide	https://www.nist.gov/community-resilience/planning-guide
OPR	Community Engagement Best Practices	https://opr.ca.gov/docs/20190717-Community_Engagement_Best_Practices.pdf
Alliance of Regional Collaboratives for Climate Adaptation (ARCCA)	Adaptation Capability Advancement Toolkit (Adapt CA)	https://arccacalifornia.org/adapt-ca/
FEMA/U.S. Environmental Protection Agency (EPA)/OPR Association of Bay Area Governments	Vulnerability Assessment Toolkit: A Toolkit for Project Teams	http://www.centralcoastclimate.org/resources/
FEMA/U.S. EPA/OPR	Framework for Building Regional Resilience in California: Workbook for Local and Regional Governments	http://www.centralcoastclimate.org/resources/
California Natural Resources Agency (CNRA) Climate-Safe Infrastructure Working Group	Paying It Forward: A Path Toward Climate-Safe Infrastructure in California	https://resources.ca.gov/CNRALegacyFiles/docs/climate/ab2800/AB2800_ES_FINAL.pdf
State of California Department of Finance (DOF)	Population/Demography Information	https://dof.ca.gov/Forecasting/Demographics/
California Animal Response Emergency System	Website for local animal emergency planners	https://www.cdfa.ca.gov/AHFSS/Animal_Health/eprs/cares/

Agency	Guidance/Tool	Resource Website
American Planning Association	Hazard Mitigation: Integration Best Practices into Planning	https://www.planning.org/publications/report/9026884/
American Planning Association	Policy Guide on Hazard Mitigation	https://www.planning.org/publications/report/9026884/
American Planning Association	Planning for Post-Disaster Recovery: Next Generation	https://www.planning.org/research/postdisaster/
Plan Review, Evaluation, and Implementation		
FEMA	2015 Hazard Mitigation Assistance Guidance	https://www.fema.gov/sites/default/files/2020-04/HMA_Guidance_FY15.pdf
FEMA	Grants Visualization Tool	https://www.fema.gov/about/reports-and-data/data-visualizations
FEMA	Mitigating Flood and Drought Conditions Under Hazard Mitigation Assistance	https://www.fema.gov/grants/mitigation/hazard-mitigation-assistance-guidance
FEMA	Training Module IS-277 Benefit-Cost Analysis Entry Level	https://training.fema.gov/is/courseoverview.aspx?code=IS-277.a&lang=en
FEMA	Training Module Hazard Mitigation Assistance Grant Programs IS-212.b Introduction to Unified HMA	https://www.fema.gov/grants/mitigation/applying/hazard-mitigation-assistance-training#:~:text=Trainings%20are%20available%20designed%20to,specifically%20tailored%20to%20each%20audience.
FEMA	Training Module E-212 HMA: Developing Quality Application Elements	https://training.fema.gov/emi.aspx
FEMA	Training Module E-213 HMA: Application Review and Evaluation	https://training.fema.gov/emi.aspx
FEMA	Training Module E-276 Benefit-Cost Analysis Entry Level	https://training.fema.gov/emi.aspx
Cal OES	Hazard Mitigation Grant Program (HMGP) web page	https://www.caloes.ca.gov/office-of-the-director/operations/recovery-directorate/hazard-mitigation/hazard-mitigation-grant-program/
OPR	ICARP—Investing in Adaptation Topic	https://resilientca.org/topics/investing-in-adaptation/

Agency	Guidance/Tool	Resource Website
Additional State Requirements		
California Environmental Justice Alliance	SB 1000 Toolkit: Planning for Healthy Communities	https://caleja.org/2017/09/sb-1000-toolkit-release/
Public Health Institute	Climate Change, Health, and Equity: A Guide for Local Health Departments	https://www.phi.org/resources/?resource=climatechange-health-and-equity-a-guide-for-local-healthdepartments
OPR	SB 1000: General Plan Guidelines: Chapter 4 (Environmental Justice Section) and Chapter 5	https://opr.ca.gov/planning/general-plan/guidelines.html
OPR	Defining Vulnerable Communities in the Context of Climate Adaptation	https://opr.ca.gov/docs/20180723-Vulnerable_Communities.pdf https://opr.ca.gov/planning/icarp/tac/
OPR	Resilience Guidebook Equity Checklist	https://opr.ca.gov/docs/20180312-Equity_Checklist.pdf
OPR	SB 379: General Plan Guidelines: Chapter 4	https://opr.ca.gov/planning/general-plan/guidelines.html
CAL FIRE	SB 1241: Fire Prevention Program	https://www.calcities.org/docs/default-source/planning-commissioners-academy---session-materials/wildfire-planning-in-the-general-plan.pdf?sfvrsn=ed1a0a7_3

43.2. RESOURCES FOR HAZARD INFORMATION AND ASSESSMENT

43.2.1. Federal Hazard Resources

FEMA, USGS, NOAA, and other federal agencies have developed many powerful tools that can be used to identify and assess hazards. These resources can be used independently or in coordination with State resources to assist local jurisdictions in identifying hazards that may affect their communities and to develop the basis for assessing the vulnerability of their communities. Many of these tools use Geographic Information Systems (GIS) to determine physical extents of hazards or estimate potential impacts.

43.2.2. State Hazard Resources

A local jurisdiction's initial hazard assessment should begin with a review of California's SHMP Risk Assessment chapters to determine which hazards are considered a priority for the State. The SHMP offers detailed descriptions of hazards unique to California, as well as information on actions being taken by State agencies to address the identified hazards and additional planning and GIS resources available to assist local jurisdictions in strengthening their hazard mitigation efforts.

California continues to develop tools to support risk and vulnerability assessment and hazard mitigation planning using the most current technology and best available data. These tools include guidance for climate adaptation, toolkits to guide local vulnerability assessments, and hazard mapping tools. These resources allow users to easily begin to understand hazards in their community. They are designed to be user-friendly and do not require specialized training to use. Jurisdictions are encouraged to review the resources available and spend time exploring those that may assist their LHMP preparation efforts.

43.2.3. Summary of Hazard Information and Assessment Resources

Table 43-2 lists federal, State, and regional resources that may be useful to jurisdictions in their risk assessments. Not all resources listed are applicable to all jurisdictions. New resources continue to be developed, so local planning teams should review FEMA, Cal OES, OPR, and other agency websites for additional resources during the hazard mitigation planning process.

Table 43-2. Resources Supporting Hazard Information and Assessment

Agency	Guidance/Tool	Resource Website
General		
FEMA	Hazus	https://www.fema.gov/flood-maps/products-tools/hazus
FEMA	Risk Mapping, Assessment, and Planning Program (Risk MAP) Region 9	https://www.fema.gov/about/organization/region-9
FEMA	How-To Guide; FEMA 433—Using Hazus-MH for Risk Assessment	https://www.fema.gov/pdf/plan/prevent/hazus/fema433.pdf

Agency	Guidance/Tool	Resource Website
FEMA	Training Modules IS-922 Application of GIS for Emergency Management E-190 ArcGIS for Emergency Managers E-296 Application of Hazus-MH for Risk Assessment E-313 Basic Hazus-MH	https://training.fema.gov/is/courseoverview.aspx?code=IS-922.a&lang=en https://training.fema.gov/emicourses/emicatalog.aspx?cid=E313&ctype=R
Cal OES	MyPlan	https://myplan.caloes.ca.gov/
Cal OES	MyHazards	https://myhazards.caloes.ca.gov/
Resources for Seismic Hazards		
SCEC	Uniform California Earthquake Rupture Forecast (UCERF)3	https://www.scec.org/ucerf
CGS	Alquist-Priolo Earthquake Fault Zoning Maps	https://www.conservation.ca.gov/cgs/alquist-priolo
CGS	Seismic Zonation Maps	https://www.conservation.ca.gov/cgs/shp
CGS	California Earthquake Hazard Zone Application (EQZapp)	https://www.conservation.ca.gov/cgs/geohazards/eq-zapp
CGS	CGS Information Warehouse (maps and reports and GIS data)	https://maps.conservation.ca.gov/cgs/EQZApp/app/
CGS	Geologic Hazards Data Viewer	https://maps.conservation.ca.gov/geologichazards/#dataviewer
CGS	Geologic Hazards Data List	https://maps.conservation.ca.gov/geologichazards/#datalist
Cal OES	Earthquake Warning California	https://earthquake.ca.gov/
California Seismic Safety Commission (SSC)	Earthquake Loss Reduction Plan	https://ssc.ca.gov/wp-content/uploads/sites/9/2020/08/cssc_13-03_loss_reduction_plan.pdf
USGS/ Science Application for Risk Reduction	HayWired Scenario	https://www.usgs.gov/programs/science-application-for-risk-reduction/science/haywired-scenario?qt-science_center_objects=0#qt-science_center_objects
CAL FIRE	Watershed Emergency Response Team (WERT) Report	Recent Landslide Hazard Assessments (ca.gov)
Resources for Flood Hazards		
FEMA	NFIP	https://www.fema.gov/flood-insurance
FEMA	CRS User Manual	https://www.fema.gov/sites/default/files/documents/fema_community-rating-system_coordinators-manual_2017.pdf
FEMA	Using National Flood Hazard Layer Web Map Service	https://hazards.fema.gov/femaportal/wps/portal/NFHLWMSkmzdownload

Agency	Guidance/Tool	Resource Website
FEMA	NFIP Technical Bulletins	https://www.fema.gov/emergency-managers/risk-management/building-science/national-flood-insurance-technical-bulletins
FEMA	Flood Risk Products: Using Flood Risk Products in Hazard Mitigation Plans	https://www.fema.gov/sites/default/files/2020-07/fema_using-flood-risk-products_guide.pdf https://www.fema.gov/floodplain-management/manage-risk
FEMA	Resources for American Society of Civil Engineers 24 Hazard Mitigation Assistance Flood Retrofitting	https://www.fema.gov/sites/default/files/2020-04/HMA_Guidance_FY15.pdf
FEMA P-312	Homeowners Guide to Retrofitting (2014)	https://www.fema.gov/sites/default/files/2020-08/FEMA_P-312.pdf
FEMA P-259	Engineering Principles and Practices of Retrofitting Floodprone Residential Structures, 3rd Edition (2012)	https://www.fema.gov/sites/default/files/2020-08/fema259_complete_rev.pdf
FEMA P-936	Floodproofing Non-Residential Buildings	https://www.fema.gov/sites/default/files/2020-07/fema_p-936_floodproofing_non-residential_buiildings_110618pdf.pdf
FEMA P-55	Coastal Construction Manual, 4th Edition (2011)	https://www.fema.gov/sites/default/files/2020-08/fema55_voli_combined.pdf
FEMA	Training Modules	https://www.fema.gov/pdf/floodplain/is_9_complete.pdf https://www.fema.gov/floodplain-management/community-rating-system
American Society of Floodplain Managers	Website	https://www.floods.org/
DWR	Model Floodplain Management Ordinances	5A-Attachment_1.pdf (granicus.com)
CGS	Tsunami Inundation Mapping	https://www.conservation.ca.gov/cgs/tsunami/maps
Resources for Fire Hazards		
FEMA	Wildfire Mitigation Resources	https://www.ready.gov/wildfires
National Fire Protection Association	Codes and Standards	https://www.nfpa.org/Codes-and-Standards
CAL FIRE	Fire and Resource Assessment Program	https://frap.fire.ca.gov/

Agency	Guidance/Tool	Resource Website
CAL FIRE	Fire and Resource Assessment Program Very High Fire Hazard Severity Zones	https://frap.fire.ca.gov/mapping/pdf-maps/
CAL FIRE	Strategic Fire Plan for California	https://osfm.fire.ca.gov/divisions/community-wildfire-preparedness-and-mitigation/fire-plan/
CAL FIRE	California's Forests and Rangelands: 2017 Assessment	https://frap.fire.ca.gov/media/4babn5pw/assessment2017.pdf
OSFM	California Communities at Risk List	https://osfm.fire.ca.gov/divisions/community-wildfire-preparedness-and-mitigation/fire-plan/communities-at-risk/
OPR	Fire Hazard Planning: General Plan Technical Advice Series	https://opr.ca.gov/docs/20201109-Draft_Wildfire_TA.pdf
California Fire Safe Council (CFSC)	Grants Clearinghouse	https://cafiresafecouncil.org/grants-and-funding/apply-for-a-grant/
California Fire Science Consortium	Statewide Coordination through University of California (UC) Berkeley	https://www.cafiresci.org/
Joint Fire Science Program	Fire Science Program Website	https://www.firescience.gov/index.cfm
Climate-Related Hazards		
U.S. Federal Government	U.S. Climate Resilience Toolkit	https://toolkit.climate.gov/
U.S. Global Change Research	2018 National Climate Assessment	https://science2017.globalchange.gov/
Intergovernmental Panel on Climate Change	Managing the Risk of Extreme Events and Disasters to Advance Climate Change Adaptation: Summary for Policy Makers	https://www.ipcc.ch/report/managing-the-risks-of-extreme-events-and-disasters-to-advance-climate-change-adaptation/
FEMA	Climate Resilient Mitigation Activities for Hazard Mitigation Assistance	https://www.fema.gov/sites/default/files/documents/fema_resources-climate-resilience.pdf
FEMA	Green Infrastructure Methods Fact Sheet	https://www.mass.gov/doc/green-infrastructure-methods-fact-sheet/download
Scripps Institution of Oceanography	California-Nevada Climate Applications Program	https://cnap.ucsd.edu/climate-tools/
NOAA	Coastal Plan Alignment Compass	https://resilientca.org/topics/plan-alignment/

Agency	Guidance/Tool	Resource Website
OPR	ICARP Adaptation Clearinghouse	https://opr.ca.gov/climate/icarp/services.html#:~:text=The%20Adaptation%20Clearinghouse%20(ResilientCA.gov,and%20adapting%20to%20climate%20change https://resilientca.org/
OPR	General Plan Guidelines—Chapters 7 and 8	https://opr.ca.gov/planning/general-plan/guidelines.html
CNRA/ OPR/ California Energy Commission (CEC)	California's Fourth Climate Change Assessment, and the upcoming Fifth Assessment	https://climateassessment.ca.gov/ https://opr.ca.gov/climate/icarp/climate-assessment/
Various	Cal-Adapt Climate Resources	https://cal-adapt.org/
California Department of Public Health (CDPH) Office of Health Equity	Cal BRACE	https://www.cdph.ca.gov/Programs/OHE/Pages/CalBRACE.aspx https://www.cdph.ca.gov/Programs/OHE/Pages/ClimateHealthProfileReports.aspx
CDPH	Climate Change & Health Vulnerability Indicators for California	https://skylab.cdph.ca.gov/CCHVIz/
California Office of Environmental Health Hazard Assessment (OEHHA)	CalEnviroScreen	https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-40
OEHHA	2018 Office of Environmental Health and Hazard Assessment Indicators of Climate Change in California	https://oehha.ca.gov/climate-change/document/indicators-climate-change-california
California Coastal Conservancy	Climate Ready Program	https://scc.ca.gov/climate-change/
California Air Resources Board (CARB)	Cool California	https://coolcalifornia.arb.ca.gov/
ARCCA	ARCCA website	https://arccacalifornia.org/
ARCCA	Adaptation Capability Advancement Toolkit	https://arccacalifornia.org/adapt-ca/
ARCCA	Regional Adaptation Collaborative Toolkit	https://arccacalifornia.org/toolkit/
Georgetown Climate Center	Georgetown Adaptation Clearinghouse	https://www.adaptationclearinghouse.org/

Agency	Guidance/Tool	Resource Website
American Planning Association	Climate Change Resources	https://www.planning.org/resources/climatechange/
Cal OES	California Adaptation Planning Guide	https://resources.ca.gov/CNRALegacyFiles/docs/climate/01APG_Planning_for_Adaptive_Communities.pdf
California Air Pollution Control Officers Association	California Emissions Estimator Model	http://www.aqmd.gov/caleemod/home
California Air Pollution Control Officers Association	The Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity	https://www.caleemod.com/handbook/index.html)
Extreme Heat Resources		
CalEPA	Urban Heat Island Index for California	https://calepa.ca.gov/urban-heat-island-interactive-maps-2/
National Weather Service (NWS)	Heat Risk Forecast	https://www.weather.gov/safety/heat-index
CDPH Office of Health Equity	Cal BRACE Program	https://www.cdph.ca.gov/Programs/OHE/Pages/calbrace.aspx
CNRA	California Heat Assessment Tool	https://www.cal-heat.org/
Climate Action Team Public Health Workgroup	Preparing California for Extreme Heat: Guidance and Recommendations	https://ww2.arb.ca.gov/sites/default/files/2020-08/sommerfeldt_1.pdf
CRNA	Protecting Californians from Extreme Heat: A State Action Plan to Build Community Resilience	https://resources.ca.gov/-/media/CNRA-Website/Files/Initiatives/Climate-Resilience/2022-Final-Extreme-Heat-Action-Plan.pdf
CNRA	California Heat Adaptation Tool	https://www.cal-heat.org/
Sea-Level Rise Resources		
California Ocean Protection Council (OPC)	Sea-level Rise Guidance Document	https://www.opc.ca.gov/updating-californias-sea-level-rise-guidance/
OPC	Rising Seas in California: An Update on Sea-Level Rise Science	http://www.opc.ca.gov/webmaster/ftp/pdf/docs/rising-seas-in-california-an-update-on-sea-level-rise-science.pdf
California Coastal Commission	Sea-Level Rise Policy Guidance	https://www.coastal.ca.gov/climate/slrguidance.html
California Coastal Commission	Residential Adaptation Policy Guidance	https://www.coastal.ca.gov/climate/slr/vulnerability-adaptation/residential/
NOAA	Digital Coast	https://coast.noaa.gov/digitalcoast/

Agency	Guidance/Tool	Resource Website
NOAA	Coastal Services Center website	https://coast.noaa.gov/
NOAA	Sea the Future: Sea Level Rise and Coastal Flood Web Tools Comparison Matrix	https://sealevel.climatecentral.org/matrix/
USGS	Coastal Storm Modeling System: CoSMoS	https://www.usgs.gov/centers/pcmsc/science/coastal-storm-modeling-system-cosmos
USGS	Hazard Exposure Reporting and Analytics	https://www.usgs.gov/apps/hera/
Our Coast Our Future	Tools for Planning for Sea-level Rise and Storm Hazards along the California Coast	https://ourcoastourfuture.org/
OPR	ICARP Adaptation Clearinghouse: Ocean and Coast Topic Area	https://resilientca.org/topics/ocean-and-coast/
California Coastal Conservancy	Sea-Level Rise Adaptation Resources	https://scc.ca.gov/climate-change/climate-change-projects/#slr-adaptation
State Lands Commission	Sea-Level Rise Resources	https://www.slc.ca.gov/sea-level-rise/additional-resources-for-addressing-sea-level-rise/
DWR	Quick Guide Coastal Appendix: Planning for Sea-Level Rise	https://www.oceansciencetrust.org/wp-content/uploads/2016/11/QGCoastalAppendix_FINALDRAFT_2016oct14.pdf
The Nature Conservancy	Coastal Resilience California	https://coastalresilience.org/
The Nature Conservancy	Coastal Resilience California Mapping Tool	https://maps.coastalresilience.org/california/
Climate Central	Surging Seas Risk Finder	https://sealevel.climatecentral.org/
San Francisco Bay Conservation and Development Commission (BCDC)	Adapting to Rising Tides	https://www.adaptingtorisingtides.org/
CNRA	Case Studies in Natural Shoreline Infrastructure in Coastal California	https://coastalresilience.org/case-studies-of-natural-shoreline-infrastructure-in-coastal-california/
Drought Resources		
Centers for Disease Control and Prevention (CDC)	Preparing for the Health Effects of Drought	https://www.cdc.gov/nceh/hsb/cwh/docs/CDC_Drought_Resource_Guide-508.pdf

Agency	Guidance/Tool	Resource Website
California Department of Food and Agriculture (CDFA)	State Water Efficiency and Enhancement Program	https://www.cdfa.ca.gov/oefi/sweep/
DWR State Water Resources Control Board	California Drought Portal	https://drought.ca.gov/
DWR	California Water Plan	https://water.ca.gov/Programs/California-Water-Plan
DWR	Water Use and Efficiency Resources	https://water.ca.gov/Programs/Water-Use-And-Efficiency
Sociotechnical/Technological Hazard Resources		
FEMA	Integrating Manmade Hazards into Mitigation Planning	HSDL – Resource Materials: Integrating Manmade Hazards into Mitigation Planning: Risk Management in a Multi-Hazard World: 2003 All-Hazards Mitigation Workshop
Cal OES	State Threat Assessment Center	https://www.caloes.ca.gov/office-of-the-director/operations/homeland-security/state-threat-assessment-center/
Cal OES	California Cyber Security Taskforce	https://www.caloes.ca.gov/office-of-the-director/operations/homeland-security/cybersecurity-task-force/

43.2.4. Cal OES LHMP Technical Assistance and Training Program

The goal of the LHMP Technical Assistance and Training Program is for all local jurisdictions in California (including special districts and Tribal Nations) to have FEMA-approved, locally adopted LHMPs that provide each community with a path toward increased resiliency. Eligible jurisdictions must have an approved plan to be considered for funding through mitigation programs authorized under the federal Stafford Act.

Program Objectives

The objectives of the LHMP Technical Assistance and Training Program are to:

- Integrate hazard mitigation activities into all pertinent local government programs.
- Maximize the use of hazard mitigation resources, grants, and funds to reduce the impact of future disasters at the local level.

- Maintain collaborative and cooperative relationships with local emergency managers, land use planners, and the scientific and technical communities involved in hazard mitigation.
- Provide technical assistance guidance and training to local governments to improve hazard risk assessments, mitigation project identification and analysis, and the development of LHMPs.
- Improve communications with stakeholders, legislators, and special interest groups involved in hazard mitigation.
- Continue to enhance Cal OES Regional and Operational Area capability and coordination.
- Develop a statewide program of support for hazard identification and analysis and a risk-based approach to project identification, prioritization, and support for local governments.
- Maintain transparent and continuous communication with FEMA Hazard Mitigation Planning program staff and stakeholders.

Program Components

The State is committed to supporting a robust hazard mitigation program. Cal OES administers FEMA's HMA program by providing support to local jurisdictions through training workshops, consultation and LHMP review, jurisdiction-specific technical assistance, and maintenance of an LHMP resource web page. The program components together are intended to result in a successful LHMP submittal by jurisdictions.

Program components include the following:

- Formal LHMP training offered by Cal OES Hazard Mitigation Planning Division staff:
  - FEMA-approved training classes delivered in partnership with the California Specialized Training Institute (CSTI) and FEMA
  - LHMP and grant meetings and workshops for local jurisdictions: jurisdiction-specific, held upon request from jurisdictions (i.e., kickoff meetings)
  - LHMP workshops for other professional associations, groups, or agencies
  - Presentations at public meetings and panel discussion participation
- LHMP review and informal technical assistance offered by Cal OES Hazard Mitigation Planning Division staff:

- LHMP and grant meetings and phone calls with local jurisdiction staff, professional associations, and agency staff
- Informational emails with local jurisdiction staff, professional associations, and agency staff
- Letters and emails on plan status to jurisdictions from Cal OES
- Other personal communications

Cal OES Hazard Mitigation Planning Division staff also works with Cal OES Hazard Mitigation Assistance (HMA) Branch staff to provide high-level grant information to local jurisdictions. Detailed grant sub-application training is offered directly from Cal OES HMA Branch staff.

43.3. RESOURCES FOR LOCAL PLAN ALIGNMENT

The State of California has facilitated hazard mitigation at the local level by passing legislation that strengthens the linkage of mitigation and adaptation efforts with land use planning. This linkage is referred to as "plan alignment."

A Plan Alignment Toolkit created by OPR provides local jurisdictions with an interactive web-based application to get tips, best practices, and guidance specific to climate hazards and plans most relevant to a community. Users can enter plan-specific information, including identified hazards from the LHMP, and get customized plan alignment roadmaps and guidance. The Toolkit also provides guidance on community and stakeholder engagement and how to incorporate these sectors into the planning process. The Toolkit is currently online at ResilientCA.org.

The State Adaptation Clearinghouse of OPR's Integrated Climate Adaptation and Resilience Program (ICARP) also addresses plan alignment. Its website notes that the many plans that help communities manage assets and resources can be leveraged to help the community achieve climate mitigation and adaptation goals. Aligning goals and actions across LHMPs, adaptation plans, general plans, and other planning documents allows mitigation and adaptation efforts to be built into local jurisdictions' comprehensive planning efforts.

The Coastal Plan Alignment Compass, released in 2018, assists local governments in coordinating local plans to ensure a cohesive approach that strengthens hazard mitigation and climate adaptation. Details about the Coastal Plan Alignment Compass are provided on the Clearinghouse plan alignment topic page as well as a listing of other resources supporting plan alignment and the incorporation of climate considerations into the planning process (ResilientCA.org 2022).

43.4. LINKING STATE AND LOCAL MITIGATION PLANS

S16 – 44 CFR 201.3(c)(6), 201.4(c)(2)(ii), 201.4(c)(3)(iii), and 201.4(c)(4)(ii): Does the plan describe the process and time frame to review, coordinate, and link local and Tribal Nation mitigation plans with the state mitigation plan?
Several subsections address various elements of LHMPs and how they are integrated and assessed, including how LHMPs are reviewed and technical assistance provided by Cal OES. Notably, Cal OES examined all 2,256 individual mitigation actions identified in the 58 county LHMPs to understand in what ways plans are prioritizing and addressing hazards. Section 43.4 is one that provides context on linking state and local planning efforts.

An LHMP is required to describe the planning process, the assessment of hazards and risk, the involvement of participating entities, action items, and a maintenance strategy. Local jurisdictions must use FEMA's Plan Review Tool to navigate the required components for submitting their LHMPs. FEMA and the State review the plans in accordance with the required elements and provide necessary technical assistance that will lead to an approved plan. For a local plan to receive approval by the State, it needs to be consistent with the State's mitigation priorities and efforts.

The required LHMP elements related to hazard identification and vulnerability offer an opportunity for integration of State and local planning. The SHMP provides information on natural and technological hazards that are known to exist within the State, and the general location and vulnerability aspects of each hazard. Local jurisdictions can easily incorporate this general information into the hazard identification and vulnerability portion of their LHMP, and supplement with local knowledge and data, including use of the MyPlan interactive mapping tool developed by Cal OES.

43.4.1. Integrating Local Risk Assessments

As noted in Section 2.5 of this SHMP, the State has incorporated local risk assessment data into this Plan through a comprehensive look at how each county ranked local risk associated with hazards of concern based on the net impact of each hazard on each county. This process identified hazards that had high impacts in each county, ultimately informing the identification of actions at the local level. These impacts by county are summarized in each hazard profiled in the SHMP. Cal OES intends to continue to monitor these hazard impact evaluations over the performance period of the SHMP through the plan review and technical assistance programs. This information will then be used to inform future SHMP updates and updates to the guide for local hazard mitigation planning.

To achieve this, Cal OES will be creating a database to track trends in prioritization of hazards, baseline equity data, and local mitigation action measures and strategies to reduce risk and vulnerability in California communities. The Cal OES LMP Unit will use this database to implement the 2023 FEMA Local Hazard Mitigation Planning Policy Guide. As the LMP Unit continues to conduct technical assistance and training sessions on the new guidance, Cal OES staff will highlight best practices in reporting hazard vulnerability data in local risk assessments so that Cal OES may more easily monitor vulnerability and roll up data into future SHMP updates.

43.4.2. Integrating Goals and Capability Assessments

Using a consistent set of goals and objectives reinforces the plan integration process. The 2023 SHMP contains an updated set of goals, objectives, and actions that can easily be adopted or adapted by local jurisdictions to guide their LHMP development. In its future reviews of local plans, Cal OES will continue to check for consistency between the goals of the local plans and those in the SHMP. These reviews also will confirm that each local plan has clearly identified actions for each hazard assessed that has been identified as having high impact on the defined planning area. In turn, when reviewing and evaluating LHMPs, State reviewers can ensure that local concerns are reflected in overall State goals, objectives, and strategies.

The State of California has a broad array of hazard mitigation legislation, plans, and programs that require, encourage, and support mitigation capabilities at the local level. These resource capabilities—including statewide codes and general plan requirements—can be integrated into the capabilities section of LHMPs.

43.4.3. Integrating Local Mitigation Actions

FEMA’s Standard State Mitigation Planning Requirement S16-b requires Standard state hazard mitigation plans to describe the state’s process and timeframe to share risk assessment data and mitigation priorities with local governments for their plan updates, as well as integrate local risk assessment and mitigation actions into the state mitigation plan updates. To meet this requirement, the Cal OES LMP Unit performed an analysis across all 58 county LHMPs, using plans approved by April 18, 2023. This date was selected as the cutoff date based on when new FEMA LHMP guidance became effective (on April 19, 2023).

For multi-jurisdictional plans, Cal OES reviewed only the county base plan—not every individual municipal or special district annex—to keep comparisons more similar and to simplify the analysis. Some multi-jurisdictional LHMPs have over 80 annexes for participants, accounting for over 1,000 mitigation actions; while others have only one or two special district annexes that include only an additional five to 10 actions. Additionally, many of the annexes have mitigation actions similar to or modeled from those included in the county base plan.

Cal OES staff counted every individual mitigation action found in the mitigation strategy section of the plans related to natural hazards aligning with the SHMP. Cal OES separated out mitigation actions that are all-hazard or multi-hazard in nature (e.g., purchasing and distributing NOAA weather radios) from mitigation actions that address a single natural hazard. Every action was counted by hazard. The results of this analysis are shown in Table 43-3.

Findings

Overall, the county plans included 2,256 individual mitigation actions addressing natural hazards. 921 of those actions were all-hazard or multi-hazard actions; such actions appeared in 55 of 58 county plans. Across the county mitigation strategies, 48 counties include wildfire-specific mitigation actions, 43 counties include earthquake-specific mitigation actions, and 41 counties include flood hazard-specific mitigation actions. This aligns with the 2023 SHMP Risk Assessment, highlighting that California communities have the highest vulnerability to these three hazards and have a need to address them with specific mitigation actions. After the “Big Three” hazards, drought, dam failure, severe weather, climate change, extreme temperatures, and landslide hazards appear in the mitigation strategies of 21 percent to 52 percent of the county plans.

Overall, 921 of 2,256 mitigation actions, accounting for 41 percent of all individual mitigation actions in county LHMPs, are all-hazard or multi-hazard in nature. This is consistent with hazard mitigation best practices because cost-effective measures that reduce risk to one hazard often reduce risk across several natural hazards. Wildfire and flood hazards each have 367 mitigation actions.

Table 43-3. Mitigation Actions by Hazard in LHMPs

Hazard	Actions Addressing the Hazard		Counties with Actions Addressing the Hazard	
	Number of Actions	% of All Actions Across LHMPs	Number of Counties	% of All Counties
All Hazards/Multi-Hazard	921	40.82%	55	94.83%
Wildfire	367	16.27%	48	82.76%
Earthquake	166	7.36%	43	74.14%
Flood	367	16.27%	41	70.69%
Drought	96	4.26%	30	51.72%
Dam Failure	49	2.17%	26	44.83%
Severe Weather	60	2.66%	23	39.66%
Climate Change	54	2.39%	17	29.31%
Extreme Temperatures	22	0.98%	14	24.14%
Landslide	35	1.55%	12	20.69%
Tsunami	11	0.49%	7	12.07%
Avalanche	13	0.58%	6	10.34%
Agricultural Hazards	9	0.40%	6	10.34%
Slope Failure	8	0.35%	4	6.90%
Levee Failure	32	1.42%	3	5.17%
Soil Hazards	9	0.40%	3	5.17%
Volcano	5	0.22%	3	5.17%
Severe Wind	7	0.31%	3	5.17%
Erosion	4	0.18%	2	3.45%
Subsidence	2	0.09%	2	3.45%
Sea-Level Rise	14	0.62%	2	3.45%
Debris Flow	2	0.09%	1	1.72%
Seiche	1	0.04%	1	1.72%
Fog	1	0.04%	1	1.72%
Tree Mortality	1	0.04%	1	1.72%

This means that each of these hazards accounts for 16 percent of all county local mitigation actions. These three hazard categories—multiple-hazard, wildfire, and flooding—include 1,655 individual county actions, accounting for 73 percent of all mitigation actions across the county base plans. This aligns with the hazard landscape and hazard mitigation trends in California.

FEMA, Cal OES and other organizations have studied many of the mitigation strategies and produced ample data about cost-effectiveness of building codes, defensible space and home hardening, and acquisition of repetitively flooded structures, making them favorable from a political and economic standpoint at the local level.

Going Forward

This analysis represents a single point in time. Cal OES constantly reviews and submits LHMPs for approval by FEMA. Going forward, Cal OES will update the data as it continues to review new drafts of LHMPs. This analysis will be updated on an annual basis to help inform the priority of mitigation actions and tie them to grant funding decisions with the Cal OES Hazard Mitigation Grants Division. Moreover, Cal OES aims to expand an analysis of individual mitigation actions to include municipalities and special districts.

43.5. LOCAL HAZARD MITIGATION SUBMITTAL AND REVIEW PROCESS

Cal OES supports local jurisdictions in the development of LHMPs. It provides local jurisdictions with information on integrating hazard identification, risk assessment, risk management, and mitigation actions into a comprehensive approach to hazard mitigation.

In addition to providing technical assistance, training, and outreach to local jurisdictions, Cal OES reviews all LHMPs in accordance with the 2023 FEMA Local Mitigation Planning Policy Guide and the Local Mitigation Planning Handbook (May 2023), FEMA's Mitigation Ideas Book, and the FEMA Plan Review Checklist (revised 2023). In the past five years the LMP Unit has participated as panel members at events such as the California Emergency Services Association (CESA) conferences, the Cal OES Mitigation Summit, CAL FIRE Land Use Planning webinars, the Association of Environmental Planners conferences, the quarterly Mutual Aid Regional Advisory Committee (MARAC) meetings, and the FEMA Region 9 Annual Tribal Conference. Cal OES continues to partner with FEMA to update and provide both G318 Local Mitigation Planning training via recorded webinar and in person as a consistent and accessible resource for local jurisdictions and Tribal Nations. The LMP Unit continues to provide in depth technical assistance on plan development and implementation through one-on-one virtual and in-person meetings with local jurisdictions. Both outreach and technical assistance efforts are documented and provided to the FEMA Region 9 Community Planning Unit through weekly reports, with in-depth discussion of these efforts being provided during bi-monthly planning calls. Cal OES staff review each plan and work with jurisdictions to ensure compliance and consistency with the following SHMP components:

- Plan goals, objectives, and strategy
- Hazard Risk Assessments

All jurisdictions must submit their plans to Cal OES for initial review and subsequent forwarding to FEMA for review and approval. The following sections describe the review process.

The SHMP is the leading document to share risk assessment data and mitigation priorities with local governments. When it is first made publicly available, the Risk Assessments and mitigation priorities are the most up to date with the goals of the State. To ensure that current data is available for local governments, the State has created multiple platforms to access current risk assessment data after the Plan is made public. This data is currently available via the MyPlan and MyHazards web pages at http://myplan.calema.ca.gov/ and http://myhazards.calema.ca.gov/. Additional local planning resources are available at Cal OES Hazard Mitigation Planning.

Cal OES is developing an online resource platform that will provide county and municipal staff and the public with the ability to visualize, explore, and access the datasets evaluated in the 2023 SHMP. This online resource will include the following:

- A searchable catalog of all the data sources used in the 2023 SHMP Risk Assessments, including a description of each dataset and links to the authoritative source data
- An interactive web application that will enable the user to explore the hazard datasets and the Risk Assessment results
- Downloadable summaries of the hazard risk assessments for each California county
- Documents and additional resources to help support the hazard mitigation planning process

The online platform will be a central location for data and resources to support the development of LHMPs throughout California.

43.5.1. Jurisdiction LHMP Submittal Steps

Step 1—Finalize LHMP and Complete Review Tool

The jurisdiction finalizes its LHMP and uses the final LHMP to complete the FEMA Plan Review Checklist, commonly referred to as "the review tool" (revised 2023). A downloadable version of the FEMA Plan Review Checklist, along with related local mitigation planning resources, can be found on the Cal OES website (Cal OES 2023d).

The first page of the review tool must be filled out completely by the jurisdiction, including adding the jurisdiction name and title, and the contact information for the person who will be responsible for LHMP communications throughout the review process.

If a consultant has been used for preparation of the LHMP, a jurisdiction contact, rather than a consultant contact, must still be provided on the first page of the review tool. A jurisdiction must provide written confirmation via email to the Cal OES LMP Unit at MitigationPlanning@CalOES.ca.gov if it wishes for a consultant to communicate with Cal OES and FEMA on its behalf.

Step 2—Submit to Cal OES

The jurisdiction submits the following:

- Final draft of the LHMP document ready for Cal OES review to the LMP Unit at MitigationPlanning@CalOES.ca.gov

  Please note: If the files are too large to email via this address, the jurisdiction should send an email to explain the situation so that other arrangements for the electronic submission of the LHMP can be made
- A completed electronic copy of the FEMA Plan Review Checklist (revised 2023) in a Word document file (or other editable format) with the "Location in Plan" field completed for each element

Cal OES and FEMA no longer accept hard copy submittals of the LHMP and review tool. All submissions must be completed electronically.

43.5.2. State LHMP Receipt Steps

Step 1—Assign Reviewer

Once Cal OES receives the submittal, the submittal package will be logged into the mitigation planning tracking database and assigned to a Cal OES LHMP reviewer.

Step 2—Assess the Submittal for Completeness

The Cal OES LHMP reviewer assesses the LHMP submittal package to confirm that all required items have been submitted and that the FEMA Plan Review Checklist has been completed and includes all necessary contact information and the location of the information required for each element. If any items are missing, the reviewer will contact the jurisdiction via email to request missing information and will move the status of the LHMP to the Request for Information (RFI) category of the LHMP tracking report.

Step 3—Issue Determination of Completion

When the submittal package is determined to be complete, the Cal OES LHMP reviewer will email the jurisdiction to confirm receipt of the LHMP and ensure the jurisdiction has the plan reviewer's contact information. The Cal OES LHMP reviewer will also inform the jurisdiction of the start of their 45-day review period to complete the first review of the plan.

43.5.3. State LHMP Review and Guidance Steps

A 45-day review period begins upon Cal OES receipt of all required documentation from the jurisdiction and determination of application completeness by the LHMP reviewer.

Step 1—Review LHMP

Within 45 days of receipt of a complete LHMP submittal package, the assigned Cal OES LHMP reviewer conducts a review of the LHMP. If the review cannot be completed by Cal OES within 45 days, the LHMP reviewer will send an email to the jurisdiction with notification of the delay and indicating a new estimated review completion date.

The review uses the FEMA Plan Review Checklist (revised 2023) to determine if each required element and sub-element is "met "or "not met." The reviewer will add a description of required revisions in the tool, as applicable, for any elements or sub-elements that are determined to be "not met," as well as the regulatory citation and the location of information in the FEMA guidance publications and/or 44 CFR, Section 201.6 that will assist the jurisdiction in successfully completing the required element.

Step 2—Request Revisions

If the Cal OES reviewer finds that any elements have not been met, review comments and suggestions for improvement are provided in the FEMA Plan Review Checklist and returned to the jurisdiction. The jurisdiction is then responsible for making the required revisions and resubmitting to Cal OES for re-review within one year. If a revised LHMP is not submitted within one year of receiving the required revision notification, the jurisdiction will be asked to start its LHMP planning process over again because the original information may be outdated.

Step 3—Submit to FEMA

Once the Cal OES reviewer agrees that the jurisdiction's LHMP has met all required elements, Cal OES formally submits the latest version of the LHMP electronically to FEMA Region 9 for review along with a formal transmittal letter and a completed copy of the FEMA Plan Review Checklist.

43.5.4. FEMA Review and Approval Steps

Step 1—Acknowledge Receipt

The FEMA LHMP reviewer issues an acknowledgment of receipt letter to the jurisdiction, and copies Cal OES, providing confirmation that the LHMP has been received and will be reviewed within 45 days, when possible.

Step 2—Complete Review Tool

FEMA conducts its review and completes the FEMA Plan Review Checklist.

Step 3—Request Revisions

If FEMA determines that revisions are required, requested revisions will be added to the FEMA Plan Review Checklist, emailed directly to the jurisdiction, and copied to Cal OES, with instructions to complete revisions as soon as possible.

Step 4—Issue Approval Pending Adoption

Once the jurisdiction completes the requested revisions and FEMA accepts the revisions, FEMA will either issue a formal "Approval" letter or "Approved Pending

Adoption" letter via email correspondence. Pursuant to the 2023 FEMA Local Mitigation Planning Policy Guide, if a jurisdiction adopts the LHMP prior to FEMA approval and has provided an electronic copy of the adoption resolution to FEMA, the jurisdiction will receive a final approval letter from FEMA. If the jurisdiction did not adopt the plan prior to FEMA approval, FEMA will issue an "Approved Pending Adoption" letter and the jurisdiction must follow Step 5 to receive a final "Approval" letter.

Step 5—Formally Adopt LHMP and Provide Adoption Documents to FEMA

The jurisdiction is responsible for formally adopting its plan within one year of the approval pending adoption and notifying FEMA and Cal OES when adoption is completed. The adoption resolution should be scanned and emailed to the FEMA reviewer who issued the initial "Approved Pending Adoption" letter, and copied to the FEMA Region 9 Community Planning email at fema-r9-mitigation-planning@fema.dhs.gov and the LMP Unit at MitigationPlanning@CalOES.ca.gov.

Step 6—Issue Formal FEMA Approval Letter

Upon final approval, FEMA will issue a formal approval letter and a final FEMA Plan Review Checklist. The approval letter will include an expiration date five years from the date of the final approval letter.

43.5.5. How to Check the Status of an LHMP Review

To find out the status of an LHMP, send an email either to the assigned Cal OES LHMP reviewer or to the LMP Unit at MitigationPlanning@CalOES.ca.gov. For status of plan reviews by FEMA, contact the assigned FEMA plan reviewer or email the FEMA Region 9 Community Planning email at mitigationplanning@caloes.ca.gov.

Additionally, jurisdictions will receive notification from Cal OES if their LHMP is approaching expiration. In addition to the outreach provided following a declared disaster event, Cal OES is developing a formal process for conducting outreach and technical assistance for county, municipal, and Tribal Nation governments when LHMPs are near expiration. The outreach process will begin approximately 36 months prior to expiration and will highlight funding opportunities, the importance of planning and plan integration, and best practices for engaging communities throughout the planning update process.

43.6. GRANT COORDINATION

Multiple funding opportunities are available to local governments to aid in building resilience and developing and updating LHMPs. Programs administered by Cal OES include the following:

- FEMA funding programs
  - PA Hazard Mitigation (406 Mitigation)
  - HMA grant programs, which include the Hazard Mitigation Grant Program (HMGP), BRIC program, and Flood Mitigation Assistance (FMA)
  - HHPD Program: provide technical, planning, design, and construction assistance in the form of grants for rehabilitation of eligible dams
- State-funded initiatives—some are ongoing, and others are one-time opportunities:
  - Prepare California, which provides assistance to equity priority communities
  - California Wildfire Mitigation Program, administered in collaboration with CAL FIRE

Cal OES issues a notice of funding opportunity (NOFO) to spread awareness about the availability of funding. Interested entities are required to submit a proposal application or a notice of interest (NOI). Cal OES reviews NOIs for eligibility and then invites applicants with eligible projects to submit full grant applications.

Cal OES reviews all applications and submits applications for FEMA-funded projects to FEMA in accordance with the State's priorities. FEMA reviews the submitted applications for programmatic and environmental and historic preservation (EHP) compliance prior to awarding funds. Cal OES retains eligible applications that are not initially selected for submission to FEMA for future consideration when funding becomes available.

Mitigation action prioritization is described in Section 45.2, which includes 15 questions that determine the priority of each mitigation action. Additionally, Section 47.2 provides criteria for reviewing and ranking activities and projects developed by State agencies, local jurisdictions, Tribal Nations, and other eligible entities.

43.7. GUIDE TO COMMUNITY PLANNING AND HAZARD MITIGATION

There are numerous components of community planning that help protect communities from hazards and mitigate their impacts. Community planning tools include the California Adaptation Planning Guide, general plans, building codes, development project reviews, and infrastructure development. In California, community planning is required and offers opportunities for managing hazards at the local level. The planning process offers opportunities for input from the public and members of the emergency management community such as fire departments. Through active engagement in community planning, hazard mitigation planners can further promote hazard mitigation and resilience.

43.7.1. What is Community Planning?

Community planning is a process by which local governments and citizens determine the long-term development pattern of a community in terms of land use, housing, infrastructure, open space, and protection of natural and cultural resources. Decision makers determine what will be built, where it will be located, and what function it will serve. In California, general plans are the vehicle used to outline the policies and regulations for land use decisions at the local level.

Five interdependent components provide the foundation for the community planning process:

- Design
- Laws and regulations
- Environmental analysis
- Socioeconomic analysis
- Political approval

Community planning is a complex system of processes and regulations that assist local governments in meeting challenges in their communities. These processes and regulations include components that help protect communities from hazards. Among the most important of these components are the general plan law, the Subdivision

Map Act, environmental review, and building codes. These tools can be used to create safer and more resilient communities.

43.7.2. Role of Community Planning in Hazard Mitigation

The political, social, economic, and physical environment surrounding communities is continually changing. Changes in population, demographics, transportation systems, regional economy, political climate, and landscapes all create burdens and challenges for land use. Community planning is the way to manage these challenges.

As the population of California continues to grow, communities need to provide space to accommodate this growth, even as land availability for outward expansion has dramatically decreased. The challenge of limited land availability is further complicated by natural hazards. Communities may be pressured into developing areas that are more hazardous, including areas vulnerable to wildfires, earthquakes, landslides, and floods. Placing new development in these areas can increase the dangers to people and property while placing more burdens on public safety officials to protect them. These are the concerns that community leaders need to consider when determining the future of their communities.

Community planning can have a profound impact on how cities and counties use the land within their jurisdictions. One of the most effective ways to reduce or minimize the impacts of hazards is to responsibly develop land in hazardous areas. Designing communities so that most new development is located in non-hazardous areas can significantly reduce future costs of disasters. Improving building codes and adopting these codes as the standards for new and existing construction can also increase the resilience of built structures within the community. Determining what can be built and at what intensity can increase or decrease risks.

Part 5—Mitigation Strategy

Standard 4.2.1: The Emergency Management Program has a plan to implement mitigation projects and sets priorities based on loss reduction. The plan:

- **Is based on the natural and human-caused hazards identified in Standard 4.1.1 and the risk and consequences of those hazards**
- **Is developed through formal planning processes involving Emergency Management Program stakeholders**
- **Establishes short and long-term strategies, actions, goals, and objectives**

Part 5 outlines California's efforts to prioritize and implement hazard mitigation projects to reduce losses to natural hazards. California takes risks and consequences identified in the SHMP's risk assessment and uses that to inform long-term strategies, actions, goals and objectives to enhance natural hazard resiliency across the State. All of Part 5 of the 2023 State Hazard Mitigation Plan can be applied to meeting this requirement.

44. Hazard Mitigation Goals

S9 – 44 CFR 201.4(c)(3)(i): Does the mitigation strategy include goals to reduce long-term vulnerabilities from the identified hazards?

The six goals outlined in Chapter 44 reflect priorities of the State and its continued commitment to comprehensive, statewide mitigation program, not just those relating to FEMA funding. The goals are consistent with the hazards and vulnerabilities identified in the California Risk Assessment and explain what will be achieved by implementing the California Mitigation Strategy.

Developing a course of action to address vulnerabilities is a vital part of mitigation planning. Parts 2 and 3 of the 2023 State Hazard Mitigation Plan (SHMP or Plan) present hazard profiles and Risk Assessments in order of hazard impact scores. This arrangement of the hazards indicates the connection between the impact of assessed hazards and the goals and objectives developed to mitigate them. Mitigation goals and objectives permit the State to focus efforts on reducing or eliminating the vulnerabilities identified in the Risk Assessment.

For this planning effort, a goal setting process was applied in which each planning component, namely each goal and objective, stands on its own merit and is not considered a subset of any other component. Goals were identified that meet a vision for the plan. Objectives were identified that meet multiple goals. Objectives were used to prioritize actions.

Goals are broad, long-term policy and vision statements that explain what will be achieved by implementing the mitigation strategy. Objectives are defined, short-term measurable actions that lead to achieving an overall goal.

The Goals and Objectives Working Group reevaluated the goals from the 2018 SHMP to determine their current applicability, effectiveness, and relevance. Stakeholders refined the goals to reflect the priorities of the State of California for the2023 SHMP update. The refined goals provide greater detail to identity what the State aims to achieve in the next five years.

HHPD3: Did Element S9 (mitigation goals) include mitigation goals to reduce long-term vulnerabilities from high hazard potential dams?
This requirement is addressed by SHMP Goals 1, 4, and 6.

The goals for the 2023 SHMP are:

- **Goal 1**—Significantly reduce risk to life, community lifelines, the environment, property, and infrastructure by planning and implementing whole-community risk reduction and resilience strategies.
- **Goal 2**—Build capacity and capabilities to increase disaster resilience among historically underserved populations, individuals with access and functional needs, and communities disproportionately impacted by disasters and climate change.
- **Goal 3**—Incorporate equity metrics, tools, and strategies into all mitigation planning, policy, funding, outreach, and implementation efforts.
- **Goal 4**—Apply the best available science and authoritative data to design, implement, and prioritize projects that enhance resilience to natural hazards and climate change impacts.
- **Goal 5**—Integrate mitigation principles into laws, regulations, policies, and guidance to support equitable outcomes to benefit the whole community.

- **Goal 6—** Significantly reduce barriers to timely, efficient, and effective hazard mitigation planning and action.

The goals reflect the priorities of resilience, climate change adaptation and mitigation, and equity. Based on feedback and insight from stakeholders and local governments, the goals were updated to better support resilience efforts at the State and local levels and to establish recommended data sources for consistency across efforts.

The SHMP Goals and Objectives Working Group developed objectives that identify how to achieve the updated goals. The objectives were developed such that each applies to multiple goals. This provides an opportunity to broaden success measures for the SHMP and allows for increased versatility and flexibility. Table 44-1 identifies the 2023 SHMP objectives and the goals with which they align.

Table 44-1. SHMP Objectives and Associated Goals

Objective	Goals					
	1	2	3	4	5	6
1—Promote cross-sector collaboration by fostering partnerships across all sectors and levels of government and non-governmental organizations (NGOs) involved in the State's risk reduction and resilience strategies. Encourage two-way communication to empower stakeholders while ensuring that stakeholders representing underserved and historically marginalized communities are actively integrated into decision-making processes.	X	X	X			X
2—Improve climate literacy using best available data and science to increase public awareness and understanding of the potential impacts of future and emerging hazards brought on or exacerbated by climate change.	X	X		X		
3—Improve the understanding of the locations, potential and cascading impacts, and linkages among the threats, hazards, vulnerabilities, and measures needed to protect life, community lifelines, the environment, property, and infrastructure.	X		X	X	X	
4—Promote, coordinate, and implement hazard mitigation plans and projects to be consistent with and supportive of climate action and adaptation goals, policies, and programs, and community needs at all governmental levels.	X	X	X		X	X
5—Actively promote and work collaboratively with local jurisdictions, Tribal Nations, and community organizations on coordinated hazard mitigation planning efforts to foster and reinforce resilient communities while addressing risk at a scale consistent with hazard areas.	X	X	X		X	X

Objective	Goals					
	1	2	3	4	5	6
6—Promote integration of regional, local, and Tribal Nation hazard mitigation plans, which strengthens linkages between these plans and other related planning and land use initiatives.	X			X	X	
7—Reduce complexities, remove barriers, and streamline programs to support procedural equity and increase access to resources. This may be by strengthening outreach methods, producing materials in multiple languages, utilizing plain language, or reducing the effort required to access resources.	X	X	X	X		X
8—Develop criteria and metrics to prioritize and measure progress toward increasing resources for communities and populations subjected to systematic, institutional, and procedural oppression, including Tribal Nation communities, to achieve equitable outcomes in risk reduction and resilience efforts.	X	X	X	X		X
9—Reduce mitigation-related disparities impacting underserved populations and historically marginalized communities by developing equitable and inclusive plans, investments, and engagements. Develop plans, programs, and policies that are adaptive and recognize the historic economic, social, and demographic influences of the community in a manner to expand resources to benefit the community.	X	X	X		X	X
10—Encourage and promote leveraging existing federal and non-federal (State, local, and non-governmental) resources and investments to foster a comprehensive statewide, whole-community approach to mitigation. Develop a coordinated suite of assistance that improves the current condition of the community and supports the needs and desires of the community while encouraging multi-jurisdictional, regional collaboration.	X	X			X	X
11—Actively promote climate-focused programs, policies, projects, and initiatives developed by federal, State, and academic entities, including by encouraging multi-benefit projects that reduce risk using nature-based solutions.	X	X		X	X	
12—Identify and encourage the use of statewide recommended criteria to develop and inform a shared data repository to integrate into State, local, Tribal Nation, and non-governmental plans, strategies, and actions.				X		
13—Develop and implement mitigation policies, protocols, programs, and procedures to address the State's changing environment and climate.	X			X	X	

Objective	Goals					
	1	2	3	4	5	6
14—Encourage the incorporation of mitigation measures into changes in the built environment, focusing on areas at substantial risk, and strengthening community resilience in present and future conditions to support risk-informed development.	X	X		X	X	
15—Create financial and regulatory incentives to encourage avoiding hazardous areas, reducing risk, and using hazard-resistant building materials and methods.		X	X	X	X	X
16—Encourage multi-objective mitigation and resilience strategies and efforts with diverse stakeholders through coordination and collaboration by employing innovative approaches to risk reduction.		X	X	X	X	X

44.1. LINKAGE OF STATE GOALS AND STRATEGIES WITH LOCAL PLANS

Using a consistent set of goals and objectives reinforces the plan integration process. The 2023 SHMP contains an updated set of goals, objectives, and strategies that can easily be adopted or adapted by local jurisdictions to guide their local hazard mitigation plan (LHMP) development. In turn, when reviewing and evaluating LHMPs, State reviewers can ensure that local goals, objectives, and strategies are consistent with those of the State, and that local concerns are reflected in the overall State goals, objectives, and strategies. Consistent goals and objectives can lead to consistent mitigation strategies at both the State and local level.

45. Progress on Previous Plan

S12 – 44 CFR 201.4(d): Was the plan updated to reflect progress in statewide mitigation efforts and changes in priorities?
Chapter 45 has been dedicated to the reconciliation of past actions and the change of priorities based on a new protocol applied for the 2023 SHMP.

45.1. STATUS OF ACTIONS FROM PREVIOUS SHMP

The 2018 SHMP update identified 114 mitigation actions for implementation. These actions were reviewed for the current update, and for each action it was determined whether the action had been completed, was in progress, or had not been started. Incomplete actions were reviewed to determine if they should be carried over to the 2023 SHMP update or removed due to changes in priorities, capabilities, or feasibility. Of the 114 actions from the 2018 SHMP, 14 have reported progress toward completion, 1 reported no action, 26 were completed, 68 indicated work is conducted as an ongoing capability, and 5 have been removed.

Appendix J summarizes the status of actions from the 2018 SHMP.

45.2. UPDATED PRIORITY OF ACTIONS FROM PREVIOUS SHMP

The 2018 SHMP broadly prioritized actions that addressed the three main hazards, flood, earthquake, and wildfire. A more focused, consistent approach is used to prioritize actions in this updated Plan. For each action in the SHMP, the State must assign a priority that, at a minimum, takes into account the benefits of the project versus the cost. The following questions represent the prioritization scheme for action implementation. The answers to the questions are weighted and scored. Then, based on the scoring of each action, they are categorized as high, medium, or low priorities.

- Will the action result in life safety?
- Will the action result in property protection?
- Will the action be cost-effective (future benefits exceed cost)?
- Is the action technically feasible?
- Does the State have the legal authority to implement the action?
- Is funding available for the action?
- Will the action have a positive impact on the natural environment?
- Will the action mitigate impacts from climate change?
- Does the action benefit equity priority communities?
- Does the State have the administrative capability to execute the action?
- Will the action reduce risk to more than one hazard?
- Can the action be completed in less than five years?
- Is there a local champion in an agency or department for the action?
- Will the action meet other local objectives (such as capital improvements, economic development, environmental quality, or open space preservation)?
- Does the action support the policies of other plans and programs?

The answers to each of these questions are weighted as follows:

- Yes = 3 points
- Not sure, could be either yes or no, or question is difficult to quantify = 1 point
- No = 0 points

Following scoring of each action, priorities are assigned based on the following metrics:

- 31 or more = High Priority
- 15 to 30 = Medium Priority
- 0 to 14 = Low Priority

This prioritization process was applied to a revised action plan that addresses the high-impact and medium-impact hazards identified by the Risk Assessment for this SHMP. It also was applied based on new findings from the capabilities and capacities assessed by this Plan, as evidenced in the prioritization questions above. Chapter 47 indicates the implementation priority for each action in this SHMP.

46. Assessment of State Capabilities to Mitigate Risk

S8 – 44 CFR 201.4(c)(3)(ii): Does the plan discuss the evaluation of the state's hazard management policies, programs, capabilities, and funding sources to mitigate the hazards identified in the risk assessment?

Chapter 46 describes and evaluates California's existing pre- and post-disaster capabilities to manage risk to natural hazards identified in the SHMP. We include state laws, plans, documents, building codes, and funding mechanisms and other programs used to overcome challenges, leverage existing opportunities, and implement a statewide program.

The State of California has a history of successfully implementing hazard mitigation through legislation, planning, program development, and project implementation. This history demonstrates California's capability to implement State-level hazard mitigation programs that are effective and innovative.

46.1. LAWS, REGULATIONS, POLICIES AND PROGRAMS

Table 46-1 summarizes State-mandated legislation that affects State and local hazard mitigation planning efforts in California as well as agencies and programs with responsibilities related to hazard mitigation. See Appendix L for a more detailed discussion on each piece of legislation.

Table 46-1. Summary of Relevant State Agencies, Programs and Regulations

Agency, Program, or Regulation	Hazard Mitigation Area Affected	Relevance
Assembly Bill (AB) 9: Fire safety: Wildfires: Fire Adapted Communities	Wildfire Hazard	Establishes the Regional Forest and Fire Capacity Program to support regional leadership to build local and regional capacity and develop, prioritize, and implement strategies and projects that create fire-adapted communities and landscapes by improving watershed health, forest health, community wildfire preparedness, and fire resilience.
AB 32: The California Global Warming Solutions Act of 2006	Action Plan Development	Establishes a State goal of reducing greenhouse gas (GHG) emissions.
AB 38: Fire safety: Low-Cost Retrofits: Regional Capacity Review: Wildfire Mitigation	Wildfire Hazard	Directs the California Natural Resources Agency (CNRA) to review the regional capacity of each county that contains a very high fire hazard severity zone and establishes a comprehensive wildfire mitigation and assistance program.
AB 52: Native Americans; California Environmental Quality Act (CEQA)	Stakeholder Coordination	California Tribal Nations have the ability to establish, through a formal notice letter, a standing request to consult with a lead agency regarding any proposed project subject to CEQA in the geographic area with which the Tribal Nation is traditionally and culturally affiliated.
AB 70: Flood Liability	Flood Hazard	A city or county may be required to partially compensate for property damage caused by a flood if it unreasonably approves new development in areas protected by a State flood control project.
AB 162: Flood Planning	Flood Hazard	Cities and counties must address flood-related matters in the land use, conservation, safety, and housing elements of their general plans.
AB 267: CEQA: Exemption: Prescribed Fire, Thinning, and Fuel Reduction Projects	Wildfire Hazard	Extends to January 1, 2026, the exemption from requirements of CEQA for prescribed fire, thinning, or fuel reduction projects on federal lands to reduce the risk of high-severity wildfire that had been reviewed under the National Environmental Policy Act of 1969.
AB 380: Forestry: Priority Fuel Reduction Projects	Wildfire Hazard	Requires the California Department of Forestry and Fire Protection (CAL FIRE) to identify priority fuel reduction projects annually and exempts the identified priority fuel reduction projects from certain legal requirements.

Agency, Program, or Regulation	Hazard Mitigation Area Affected	Relevance
AB 431: Forestry: Timber Harvesting Plans: Defensible Space: Exemptions	Wildfire Hazard	Extends to January 1, 2026, the exemption from a requirement to complete a timber harvest plan for maintaining defensible space between 150 feet and 300 feet from a habitable structure.
AB 497: Forestry and Fire Protection: Local Assistance Grant Program: Fire Prevention Activities: Street and Road Vegetation Management	Wildfire Hazard	Appropriates funds for local assistance grants for fire prevention activities with priority for projects that manage vegetation along streets and roads to prevent the ignition of wildfire.
AB 575: Civil Liability: Prescribed Burning Activities: Gross Negligence	Wildfire Hazard	Provides that a private entity engaging in a prescribed burning activity that is supervised by a person certified as burn boss is liable for damages to a third party only if the prescribed burning activity was carried out in a grossly negligent manner.
AB 642: Wildfires	Wildfire Hazard	Makes changes to support cultural and prescribed fire, including the creation of a Cultural Burning Liaison at CAL FIRE, and requires a proposal for creating a prescribed fire training center.
AB 747: General Plans—Safety Element	Hazard Mitigation Planning	The safety elements of cities and counties' general plans must address evacuation routes and include any new information on flood and fire hazards and climate adaptation and resilience strategies.
AB 2140: General Plans—Safety Element	Hazard Mitigation Planning	Enables enhanced State and federal disaster assistance and mitigation funding to communities with compliant hazard mitigation plans.
AB 2800: Climate Change—Infrastructure Planning	Action Plan Development	Requires State agencies to consider the impacts of climate change when developing State infrastructure.
Alquist-Priolo Earthquake Fault Zoning Act	Earthquake Hazard	Restricts construction of buildings used for human occupancy on the surface trace of active faults.
Board of Forestry and Fire Protection (BOF) State Responsibility Area Fire Safe Regulations	Wildfire Hazard	Sets the floor for fire safety standards for perimeters and access to residential, commercial, and industrial building construction.

Agency, Program, or Regulation	Hazard Mitigation Area Affected	Relevance
California Coastal Management Program	Flood, Landslide, Tsunami, and Wildfire Hazards	Requires coastal communities to prepare coastal plans and requires that new development minimize risks to life and property in areas of high geologic, flood, and fire hazard.
CAL FIRE	Wildfire Hazard	CAL FIRE has responsibility for wildfires in areas that are not under the jurisdiction of the Forest Service or a local fire organization.
California Department of Parks and Recreation (State Parks)	Wildfire Hazard	State Parks Resources Management Division has wildfire protection resources available to suppress fires on State Park lands.
California Department of Water Resources (DWR)	Flood Hazard	This department is the State coordinating agency for floodplain management.
California Division of Safety of Dams (DSOD)	Dam Failure Hazard	This division of DWR monitors the dam safety program at the State level and maintains a working list of dams in California.
CEQA	Action Plan Implementation	Establishes a protocol of analysis and public disclosure of the potential environmental impacts of development projects. Any project action identified in this plan will seek full CEQA compliance upon implementation.
California Fire Alliance	Wildfire Hazard	The alliance works with communities at risk from wildfires to facilitate the development of community fire loss mitigation plans.
California Fire Plan	Wildfire Hazard	This plan's goal is to reduce costs and losses from wildfire through pre-fire management and through successful initial response.
California Fire Safe Council (CFSC)	Wildfire Hazard	This council facilitates the distribution of National Fire Plan grants for wildfire risk reduction and education.
California Fire Service and Rescue Emergency Mutual Aid Plan	Wildfire Hazard	This plan provides guidance and procedures for agencies developing emergency operations plans, as well as training and technical support.
California General Planning Law	Hazard Mitigation Planning	Requires every county and city to adopt a comprehensive long-range plan for community development, and related laws call for integration of hazard mitigation plans with general plans.
California State Hazard Mitigation Plan	Hazard Mitigation Planning	Local hazard mitigation plans must be consistent with the State's hazard mitigation plan.

Agency, Program, or Regulation	Hazard Mitigation Area Affected	Relevance
California Residential Mitigation Program	Earthquake Hazard	This program helps homeowners implement seismic retrofits to lessen the potential for damage to their houses during an earthquake.
California State Building Code	Action Plan Implementation	Local communities must adopt and enforce building codes, which include measures to improve buildings' ability to withstand hazard events.
Senate Bill (SB) 535: Disadvantaged and Low-Income Communities Investments	Action Plan Funding	This is a potential source of funding for actions located in disadvantaged or low-income communities.
Division of the State Architect's AB 300 List of Seismically At-Risk Schools	Earthquake Hazard, Action Plan Development	The Division of the State Architect recommends that local school districts conduct detailed seismic evaluations of seismically at-risk schools identified in the inventory that was required by AB 300.
Government Code Section 65302.5	Wildfire	Any county that has State Responsibility Areas or a very high fire hazard severity zone within its boundaries must submit a copy of the proposed safety element of a general plan to any agency with responsibility for fire protection in the county prior to adoption or amendment.
Governor's Executive Order S-13-08 (Climate Impacts)	Action Plan Implementation	This order includes guidance on planning for sea-level rise in designated coastal and floodplain areas for new projects.
Office of the State Fire Marshal (OSFM)	Wildfire Hazard	This office has a wide variety of fire safety and training responsibilities.
Public Resources Code, Section 4290	Wildfire	Provides authority to BOF to develop and implement fire safety standards for defensible space on State Responsibility Area lands. All residential, commercial, and industrial construction on these lands approved after January 1, 1991, must follow the regulations established by this board.
Public Resources Code, Section 4291	Wildfire	Any person with ownership or control of buildings on lands that have flammable vegetation must abide by these regulations.
Public Resources Code, Sections 4201 to 4204	Wildfire	Directs CAL FIRE to map areas of significant fire hazards based on fuels, terrain, weather, and other relevant factors.

Agency, Program, or Regulation	Hazard Mitigation Area Affected	Relevance
Seismic Safety Commission (SSC)	Earthquake	SSC investigates earthquakes, researches earthquake-related issues and reports and recommends to the Governor and Legislature policies and programs needed to reduce earthquake risk.
SB 5: Flood Control Regulations	Flood protection and Land use	Cities and counties within the Sacramento-San Joaquin Valley are required to include information from the CVFPP to be adopted by the Central Valley Flood Protection Board (CVFPB).
SB 27: Sacramento-San Joaquin Delta Emergency Preparedness Act of 2008	Emergency Response and Preparedness	Provides direction for the creation of a report outlining specific recommendations to be made to the legislature and Governor to support the following items: a Delta interagency unified command system, an emergency preparedness and response strategy, and a supporting exercise/training plan.
SB 92: Public Resources Portion of Biennial Budget Bill	Dam Failure Hazard	Requires dams (except for low-risk dams) to have emergency action plans (EAPs) that are updated every 10 years and inundation maps updated every 10 years, or sooner if specific circumstances change.
SB 97: Guidelines for Greenhouse Gas Emissions	Action Plan Implementation	Establishes that GHG emissions and the effects of GHG emissions are appropriate subjects for CEQA analysis.
SB 99: General Plans: Safety Element: Emergency Evacuation Routes	Action Plan Implementation	Requires safety elements to include information to identify residential developments in hazard areas that do not have at least two emergency evacuation routes.
SB 244: Land Use; General Plan, Disadvantaged Unincorporated Communities	Equity	Requires Local Agency Formation Commissions to 1) deny any application by a city to annex a territory that is contiguous to a "disadvantaged unincorporated community" unless a second application is submitted to annex the disadvantaged community as well, and 2) evaluate disadvantaged unincorporated communities in a municipal services review upon the next update of a sphere of influence after June 30, 2012.
SB 375: The Sustainable Communities and Climate Protection Act of 2008	Climate Change	Requires California's urban regions to achieve mandated GHG reductions through coordinated transportation, housing, and land use planning.
SB 379: General Plans: Safety Element—Climate Adaptation	Action Plan Implementation	Requires cities and counties to include climate adaptation and resilience strategies in the safety element of their general plans.

Agency, Program, or Regulation	Hazard Mitigation Area Affected	Relevance
SB 743: Environmental Quality: Transit-Oriented Infill Projects, Judicial Review Streamlining for Environmental Leadership Development Projects	Climate Change	Changes the transportation impact analysis required as part of CEQA compliance. Changes include elimination of auto delay, level of service, and other similar measures of vehicular capacity or traffic congestion as a basis for determining significant impacts for land use projects and plans in California.
SB 1000: General Plan Amendments—Safety and Environmental Justice Elements	Action Plan Implementation	Requires review and revision of general plan safety elements to address only flooding and fires (not climate adaptation and resilience) and requires environmental justice to be included in general plans.
SB 1035: Fire, Flood, and Adaptation Safety Element Updates	Action Plan Implementation	Clarifies that revisions to the safety element to address fire hazards, flood hazards, and climate adaptation and resilience strategies all must occur upon each revision to a housing element or local hazard mitigation program.
SB 1241: Land use: general plan: safety element: fire hazard impacts	Wildfire	Mandates wildfire planning responsibilities of local governments that have jurisdiction in State Responsibility Areas and Very High Fire Hazard Severity Zones
SB 5 (2007), as amended by SB 1278 (2012) and AB 1965 (2012)	Flood protection and Land use	Extends the time originally provided by SB 5 (2007) for localities to make their general plans consistent with the CVFPP.
Standardized Emergency Management System (SEMS)	Action Plan Implementation	Local governments must use this system to be eligible for State funding of response-related personnel costs.
Western Governors Association Ten-Year Comprehensive Strategy	Wildfire Hazard	This strategy implementation plan prepared by federal and Western state agencies outlines measures to restore fire-adapted ecosystems and reduce hazardous fuels.

Agency, Program, or Regulation	Hazard Mitigation Area Affected	Relevance
State Threat Assessment Center	Human Caused Hazards	The State Threat Assessment Center serves as California's information-sharing clearinghouse of strategic threat analysis and situational awareness reporting to statewide leadership and the public safety community in support of efforts to prevent, prepare for, mitigate, and respond to all crimes and all hazards impacting California citizens and critical infrastructure, while preserving civil liberties, individual privacy, and constitutional rights.

46.1.1. Planning and Zoning

Development in California is subject to a variety of planning and zoning laws and regulations. These policies determine where new construction can take place, what types of development are allowable in areas that are already developed, and the processes by which communities make development decisions. Planning and zoning policies strongly influence mitigation outcomes by determining whether development will continue or expand in high-risk areas.

Mitigation practices for facilities improve safety from natural hazards associated with the location and form of new development. These practices include local development planning and development oversight responsibilities delegated to cities and counties. Principal among these practices is compliance with the Planning and Zoning Law (Government Code, Sections 65000-66499.58), Subdivision Map Act (Government Code, Sections 66410-66499.40), and the California Environmental Quality Act (CEQA) (Public Resources Code, Sections 21000-21189.70.10).

Planning and Zoning Law General Plan Safety Element

The Planning and Zoning Law requires all cities and counties to develop and adopt a comprehensive general plan including land use, circulation, housing, safety, open space, conservation, and noise elements. It also mandates consistency among all general plan elements and between the general plan and implementation measures such as zoning and subdivision review.

California is one of approximately 10 states mandating that natural hazards be addressed as a required element of local general plans. The general plan safety element establishes policies and programs to protect the community from risks associated with earthquakes, floods, wildfire, and other natural and human-caused hazards.

As outlined by the California Governor's Office of Planning and Research (OPR), general plan safety element guidelines include the following (OPR 2020):

- The aim of the safety element is to reduce the potential risk of death, injuries, property damage, and economic and social dislocation resulting from fires, floods, earthquakes, landslides, and other hazards. Other locally relevant safety issues, such as airport land use, emergency response, hazardous materials spills, and crime reduction, may also be included.
- The safety element overlaps topics also mandated in the land use, conservation, and open-space elements. When preparing a new general plan or undertaking a comprehensive revision of an existing general plan, OPR suggests addressing these common topics in a single place rather than scattering them among four separate elements. The key concern should be to integrate effectively these common issues into the decision-making process.
- The safety element must identify hazards and hazard abatement provisions to guide local decisions related to zoning, subdivisions, and entitlement permits. The element should contain general hazard and risk reduction strategies and policies supporting hazard mitigation measures. Policies should address the identification of hazards and emergency response, as well as mitigation through avoidance of hazards by new projects and reduction of risk in developed areas.

As a required element of the general plan, the safety element provides the foundational information and policy direction regarding hazards, vulnerability, and risk upon which proactive mitigation strategies and actions can be based over time. California encourages all jurisdictions to adopt their LHMPs directly into the safety element to ensure alignment of mitigation efforts and efforts to support long-term community safety. All other general plan elements must be consistent with the safety element, and vice versa. Likewise, all zoning, subdivisions, and capital improvements must be consistent with the safety element.

Subdivision Map Act Subdivision Review

Under the Subdivision Map Act, no subdivision map can be approved unless the city or county finds that the subdivision, including its design and improvements, is consistent with the general plan. This requirement for direct implementation of the general plan through subdivision review appears to be unique to California. This allows the opportunity for cities and counties to make sound land use decisions on the subdivision of lands within known hazard areas.

California Environmental Quality Act Environmental Review

CEQA is an important California law reinforcing hazard mitigation. It requires an environmental review of any "discretionary" project, such as a general plan amendment, zone change, specific plan, subdivision, or development plan review. If significant impacts are found, an environmental impact report must be prepared.

Hazard Mitigation Through Local Land Use Planning

To maximize the value of pre-disaster mitigation, many jurisdictions have written hazard mitigation provisions into local zoning, development subdivision, and environmental review codes and ordinances for reference in routine project review. Such ordinances address hazards identified in federal and State hazards mapping, such as Flood Insurance Rate Maps (FIRMs) for 100-year floodplains, as well as any identified in the general plan or in an LHMP prepared by the jurisdiction.

Ordinance language provides direction for further investigation where scientific evidence regarding hazard presence, return periods, or potential magnitude of impact is not clear. Such ordinances also identify standard hazard mitigation measures that can be attached to a project or subdivision as conditions to be met prior to subsequent stages of development.

The following are examples of commonly applied zoning and subdivision regulatory approaches to new development in naturally hazardous areas:

- Transfer of allowable density or intensity from hazardous parts of a site to safer areas during development plan review
- Restriction of allowable residential densities, thereby reducing the potential number of structures at risk
- Enforcement of suitable building setbacks from flood, landslide, and fault zones
- Adoption of slope-density formulas to limit the number of dwellings on hillsides
- Modification of proposed parcel boundaries and street locations to avoid hazardous areas
- Requirement of multiple ingress and egress points for emergency access and evacuation
- Provision of adequate street widths for two-directional movement in an emergency
- Assurance of sufficient water storage and pressure for adequate fire flows

- Assurance of sufficient water supply during drought conditions

Also common is an array of complementary techniques for avoiding private property development in hazard-prone areas, such as the following:

- Application of agricultural and conservation easements by private land trusts
- Establishment of open space easements or donation of property for tax relief purposes
- Acquisition of land or development rights using developer fees or public park bonds
- Limitations on infrastructure provision and extensions

Together, these regulations and practices represent a powerful combination of tools to strengthen natural hazard mitigation in the course of day-to-day development planning review. Among these land use processes are three critical points at which communities make important risk reduction decisions related to new development in hazard-prone areas (each is described earlier in this chapter):

- Mandatory environmental review under CEQA
- General plan and zoning decisions
- Subdivision map approvals

Decisions at these critical points all have far-reaching consequences in areas where natural hazards can create the potential for damage to development. If flooding, geological, and other hazards are not sufficiently recognized at these key decision points, a multiplier effect can be created in which the existing hazards are distributed among many new land parcels authorized under the decision. Environmental review provides an opportunity to identify and evaluate risk-reducing natural hazard mitigation measures as a prelude to the land use planning process.

Central Valley Flood Protection Plan

The Central Valley Flood Protection Plan (CVFPP) is California's strategic blueprint to improve flood risk management in the Central Valley. It was prepared by Department of Water Resources (DWR) in accordance with the Central Valley Flood Protection Act of 2008 and adopted by the CVFPB in June 2012. The CVFPP guides the State's participation in managing flood risk in areas protected by the State Plan of Flood Control (SPFC). The CVFPP is updated every 5 years in accordance with the Central Valley Flood Protection Act.

The 2022 CVFPP update evaluates progress made since passage of major State bonds in 2007 and recommends future management actions led by State, federal, and local partners to continue implementation of the CVFPP. The update focuses on three themes:

- Climate resilience
- Performance tracking
- Alignment with other State efforts

Policy Recommendations

The 2022 CVFPP includes 15 high priority policy Issue recommendations:

1. Establish basin-specific task forces of high-level decision makers and staff from State, federal, and local agencies, Tribal Nations, and other partners to further advance implementation of projects and programmatic implementation of the CVFPP by State/federal/local/Tribal Nations.
2. Work with appropriate resource agencies to create and implement regional scale and long-term permitting mechanisms, where appropriate, for implementation and operation and maintenance of flood management activities, including multi-benefit projects.
3. Continue State leadership in the wise use of floodplains and promote floodplain best management guidance, supported by the California Strategic Floodplain Management Plan.
4. Collaborate with State, federal, and local partners to develop recommendations to improve existing processes to facilitate modification of federal authorizations for SPFC facilities.
5. Complete watershed-based climate change vulnerability and adaptation assessments building to a system scale for the Sacramento River and San Joaquin River Basins, to understand the anticipated changes in the flood system and investment needs supported by State/federal/Tribal Nation agencies.
6. Obtain increased State and federal stable funding for flood management, including ongoing investments and multi-benefit capital projects in the Central Valley by State, federal, and local agencies.
7. Continue to periodically update the best available science, tools, and data to improve understanding of the condition, performance, and response of the

flood system for CVFPP updates, conservation strategy updates, and related performance tracking systems in collaboration with partners.

8. Continue to enhance emergency preparedness plans, ability to respond in flood emergencies, and decreased notification and decision-making times.
9. Increase data collection and enhancement of forecasting tools and expand use of forecast-based operations to increase reservoir management flexibility and increase forecast lead times.
10. Secure annual dedicated funding to continue and expand the successful Regional Flood Management Plan (RFMP) Program, which will support the six regional flood management planning areas throughout the Central Valley's SPFC: Mid and Upper Sacramento River, Feather River, Lower Sacramento River/Delta North, Lower San Joaquin River/Delta South, Mid San Joaquin River, and Upper San Joaquin River.
11. Continue to prioritize actions that repair and rehabilitate existing flood system features.
12. Use action plans developed through collaborative planning efforts to inform planning, design, funding, and implementation of priority near-term and long-term projects to progress regional flood management strategies for the San Joaquin River Basin.
13. Progress equity and environmental justice in flood management planning decision-making, implementation, and monitoring.
14. Explore, create, and implement regional-scale and long-term multi-benefit programs for planning, implementation, and long-term management that include single purpose projects as needed consistent with, and supportive of, broader regional actions to leverage funding sources and align program priorities.
15. Continue to align the SHMP with other State plans such as the California Water Resilience Portfolio, the CVFPP, the California Water Plan Update, and the Delta Stewardship Council's Delta Plan.

Management Actions

The 2022 CVFPP describes how the State is continuing to refine and implement Management Actions. These actions include larger-scale, multi-benefit actions that generally provide cross-regional benefits in the Central Valley and enhance climate resilience. Management actions support intended outcomes under public safety, ecosystem vitality, economic stability, and enriching experiences. These large-scale actions greatly bolster overall system resiliency in a way that complements smaller-scale urban, rural, and small community actions. Figure 46-1 defines the different types of management actions.

Figure 46-1. Ongoing Management Action Categories for the 2022 State Systemwide Investment Approach Portfolio

Management Action Category	Management Actions
Systemwide	• State operations, planning, and performance tracking. • Systemwide risk assessments. • Emergency management. • Reservoir operations. • Annual operation and maintenance. • Flood management policy actions.
Urban	• Risk awareness, floodproofing, and local land use planning. • Studies and analysis.
Rural	• Risk awareness, floodproofing, and local land use planning. • Studies and analysis.
Small Community	• Risk awareness, floodproofing, and local land use planning. • Studies and analysis.

Source: (CVFPB 2022)

Building on the 2017 CVFPP update, refinements to the State Systemwide Investment Approach for 2022 reflect updated risk and management actions, performance tracking, climate change analysis and resilience, alignment with other State efforts, and new information, tools, and data, including components from the conservation strategy.

The management actions outlined in the 2022 CVFPP include but are not limited to:

- Continued support and implementation of systemwide improvements to the SPFC.
- Continued support and implementation of urban actions leading to the achievement of 200-year urban level of protection for urban communities protected by SPFC levees. Urban actions help achieve protection from the 200-year (0.5% annual chance) flood, significantly improve flood risk

management, and support intended outcomes related to public safety and economic stability.

- Continue to assist and advocate for rural actions. Rural areas may receive flood risk reduction benefits through upstream or adjacent systemwide, urban, and small community actions. Rural areas also receive greater benefit from:
  - Flood system operation and maintenance
  - Systemwide, floodplain expansion and reconnection
  - Flood preparedness and emergency response
  - Nonstructural floodplain risk management actions that provide cost-effective means of achieving desired outcomes and enhancing climate resilience in rural areas
- Continued support and implementation of the Small Communities Flood Risk Reduction Program to help communities with fewer than 10,000 residents protected by the SPFC achieve 100-year level of protection, where feasible. Since 2017, this program has achieved the following:
  - 35 small communities (including 14 disadvantaged communities) received State funding for feasibility studies in their communities.
  - Knights Landing (Lower Sacramento River/Delta North RFMP), Grimes (Mid and Upper Sacramento River RFMP), and Franklin-Beachwood (Mid-San Joaquin River RFMP) received additional State funding to advance their projects into the design and construction phases.
- Continued support and implementation of the CVFPP Conservation Strategy. The CVFPP Conservation Strategy provided data and information to support the development of the 2022 CVFPP by guiding the integration and improvement of ecosystem functions associated with flood risk reduction actions and providing the basis for recommending conservation actions for five conservation planning areas, included in the Systemwide Planning Area for the CVFPP.

Regional Flood Management Planning

Regional flood management planning groups support 5-year updates to the CVFPP by identifying and describing region-specific challenges, priorities, and accomplishments. They provide insight into various flood management projects, needs, and objectives. The RFMPs are separated into six planning areas throughout the Central Valley: Mid and Upper Sacramento River, Feather River, Lower Sacramento River/Delta North, Lower San Joaquin River/Delta South, Mid San Joaquin River, and Upper San Joaquin River. The RFMPs align with the CVFPP and its investment strategy. They highlight potential funding needs, identify areas for improvement, and provide a foundation for regional engagement.

Each RFPM includes a high-level overview for each planning area. The region-specific flood management challenges highlight areas for growth, future needs, and implementation obstructions. The priorities focus on future projects, goals, and objectives that are desired or essential to improving flood management capacity in the region. Finally, the accomplishments describe projects and achievements that have helped improve flood management capabilities in the region.

46.1.2. Building Codes

State regulations that affect the ability of buildings to withstand hazard events are included in the codes summarized in Table 46-2.

Table 46-2. State Codes Relevant to Buildings and Hazards

Code	Code Description	Hazard-Resistant Provisions
California Building Standards Code (California Code of Regulations [CCR] Title 24)	Establishes the regulations applied to building and construction within the State of California	Flood provisions, soil provisions
Chapter A3, California Building Code	Prescriptive provisions for seismic strengthening of cripple walls and sill plate anchorage of light, wood-frame residential buildings	Provides code for the voluntary retrofit of single-family residences that are wood-framed and have a raised foundation
California Water Code	Establishes regulations applied to water resources and water service providers within the State of California.	Division 5—flood control; Division 14—California Water Storage District Law
California Health and Safety Code	Establishes regulations applied to public health and safety resources and services within the State of California	Division 32—Seismic Safety Building Rehabilitation Loans

Source: (California Legislature n.d.)

Hazard Mitigation Through Building Codes

According to the Federal Emergency Management Agency (FEMA), one of the most cost-effective ways to safeguard communities against natural disasters is to adopt and follow hazard-resistant building codes. During a natural disaster, such codes can reduce casualties as well as building damage. Building codes also help communities get back on their feet faster by minimizing indirect costs such as business interruptions and lost income.

With hazard-resistant codes, buildings are constructed to withstand high winds, flooding, and earthquakes. The additional cost of the building features (roof tie-downs, window protection, strengthened walls and roof coverings, etc.) is on average less than 2 percent of total construction costs. Based on forecasted growth, FEMA estimates $132 billion in reduced property losses associated with use of modern building codes from 2000-2040.

Modern building codes address many concerns, including public health and safety, resiliency, and affordability. Some states have broken the chain of destruction by adopting modern building codes that protect property and people during natural disasters. Florida and California, pioneers in this field, have had modern hazard-resistant building codes in place since the 1990s. Other states, such as Virginia, New York, and Montana, have followed suit, putting in place statewide building codes that local jurisdictions are required to adopt.

46.1.3. NFIP Administration

Technical Assistance

DWR, on behalf of FEMA, provides individual technical assistance to California communities participating in the National Flood Insurance Program (NFIP) by conducting Community Assistance Visits and Community Assistance Contacts. The Community Status Book Report database lists participating communities, the date of their current flood map and entry into the program (FEMA 2022v). See Appendix P for the complete list of NFIP communities. Approximately 99 percent of California communities participate in the NFIP (DWR 2022i).

DWR provides statewide NFIP workshops that are designed to interpret and explain the NFIP regulations and to give an overview of the need for community-based floodplain management.

DWR and FEMA conduct workshops for floodplain management agencies, including State and local officials. The workshops allow floodplain management officials to have a greater understanding of FEMA's minimum regulation requirements and how to meet them.

Based on data provided by FEMA, the State of California had 192,404 flood insurance policies in force with $58.4 million,100 in total coverage as of October 31, 2022 (FEMA n.d.). The total annual premium for these policies was $158 million—an average cost per policy of $823.73. Also as of October 31, 2022, 50,344 flood insurance claims have been paid, totaling $626 million—an average of $12,446 per claim (FEMA n.d.).

Community Rating System Involvement

The Community Rating System (CRS) is an extension of the NFIP that provides insurance premium discounts based on a community's enforcement of higher regulatory standards. DWR's strategy toward CRS participation in the State has two main goals:

- Bring more communities into the CRS program
- For communities already in the program, improve their CRS classification

The strategy has four main elements and a series of projects associated with them:

- **Encourage Participation**—State staff promote the CRS and help communities join the program. DWR explains the benefits of the CRS to elected officials and other local decision makers so they will encourage their staff to devote the resources needed to join the CRS or improve their classification.
- **Facilitate Credits**—DWR and other State agencies help communities receive credit for State programs.
- **Improve Local Programs**—Training, templates, models, and examples help communities improve their floodplain management activities and receive CRS credit for them.
- **Track Progress**—DWR can see where improvements are made, adjust, and measure the worth of its efforts.

Currently, California has 89 communities participating in the CRS program. This accounts for 66 percent of the NFIP policy base statewide, representing a majority of flood problem areas in the State. The CRS benefits more than 167,000 policyholders and saves property owners and businesses over $14.5 million each year. See Appendix P for the complete list of CRS communities.

46.1.4. Hazard Mapping

The California Governor's Office of Emergency Services (Cal OES) hosts a site called *MyHazards,* which facilitates the identification of hazards by individuals, businesses, and local government. *MyHazards* is a tool for members of the general public to discover hazards in their area (earthquakes, floods, fires, and tsunamis) and learn steps to reduce personal risk (Cal OES 2022c).

Using the *MyHazards* tool, users may enter an address, city, and zip code, or select a location from a map. The map targets the location and allows users to zoom and scroll to their desired view. The screen then presents information on the risks identified within the search radius and recommended actions. Hazard data is approximate and data layer visibility is subject to the extent of the map. The MyHazards tool incorporates state and federal data on tsunami, liquefaction, earthquake, wildfire, and flood hazards (Cal OES 2022c).

46.2. FUNDING

Cal OES administers federal Hazard Mitigation Assistance (HMA) programs in California. Detailed discussions about Cal OES's program management capabilities in administering each of the FEMA HMA programs are included in Chapter 50.

When a federal disaster is declared, FEMA Hazard Mitigation Grant Program (HMGP) funds become available to support planning and project efforts to mitigate the effects of future disasters. Following Fire Management Assistance Declarations, HMGP Post Fire funds are made available for short- and long-term wildfire mitigation. In California, these funds are administered by Cal OES's Hazard Mitigation Section. Annual HMA programs such as the Building Resilient Infrastructure and Communities (BRIC) Program, and Flood Mitigation Assistance (FMA) funds are also administered by the Cal OES Hazard Mitigation Section.

Eligible applicants include State agencies, local governments, special districts, federally recognized Tribal Nations, and private non-profit organizations, consistent with 44 CFR 206.221(e). Eligible mitigation projects and planning activities can be funded through the HMGP, BRIC, and FMA programs.

See Sections 51.4 and 53.2 and Appendix O for additional funding opportunities identified by this SHMP.

46.3. OBSTACLES, CHALLENGES, AND PROPOSED SOLUTIONS

This section meets FEMA's requirement that state hazard mitigation plans describe "obstacles, challenges and proposed solutions related to any state capabilities, including a brief discussion of potential strategies for overcoming any challenges related to implementing and enforcing hazard-resistant building codes statewide, as applicable, and changes since the previous plan approval" (FEMA 2022r).

Throughout the stakeholder engagement process for the 2023 SHMP update, stakeholders noted gaps and challenges in existing State capabilities to implement hazard mitigation actions and build resilience. Prominent among those concerns was limited statewide data to assess the presence of equity priority communities, as well as a lack of a singular State standard for climate change and sea-level rise data.

Ensuring that these data sources are readily available will equip decision makers with the knowledge they need to integrate mitigation into their practices. For example, providing elected officials and land use planners with data regarding equity priority communities and the barriers within these communities can inform future investments to address issues such as limited public transportation and housing. Cal OES convened a group of equity stakeholders to form the Equity Working Group to identify the most appropriate datasets for use in the Plan update. Cal OES also recently established an Office of Diversity, Equity, and Inclusion (ODEI) that will regularly engage with the Hazard Mitigation Section to aid in identifying the best available data on equity during the SHMP maintenance phase. ODEI will be engaged with statewide equity initiatives. The Hazard Mitigation Section will provide information from these engagements to local jurisdictions via tools and resources for use in their planning processes.

Identifying a State-supported and recommended data source for climate change and sea-level rise data will ensure consistency across planning efforts and initiatives throughout the State. It also will facilitate the prioritized allocation of resources to ensure that data stays up-to-date and readily available to State agencies and local jurisdictions. California is preparing its Fifth Climate Assessment, which will leverage diverse expertise throughout the State to contribute to the scientific foundation for understanding climate-related vulnerability in California. It will support on-the-ground implementation and decision-making at the local, regional, Tribal Nation, and State levels, focusing on the needs of communities most vulnerable to climate change impacts. The assessment will consider California-specific research needs and questions related to climate change impacts, including down-scaled data related to risk for wildfire, heavy precipitation, flooding, extreme heat, drought, sea-level rise, and other hazards. The assessment will result in a suite of regional, topical, and statewide reports that prioritize equity in the translation of this cutting-edge research to meet the needs and context of regions across the State. Data and conclusions from this effort will inform the next update of the SHMP, as well as future LHMPs. This effort will reduce the challenge of identifying State-supported data sources for climate change.

Other challenges identified through the SHMP update process include obtaining the implementation status of mitigation actions. This issue most often arose when there had been turnover at the lead agency, resulting in the loss of institutional knowledge. Cal OES plans to enhance its existing monitoring tools and increase engagement with partner agencies on SHMP actions during the SHMP maintenance phase to improve situational awareness of implementation efforts and allow for better tracking.

This SHMP builds upon State efforts to establish a framework for ongoing maintenance and monitoring of SHMP activities. Chapter 48 includes the addition of a mitigation action status report as part of monitoring efforts. The status report will provide a dedicated opportunity to obtain the status of a mitigation action at least annually. The form will serve as an ongoing documentation tool to maintain situational awareness from year-to-year on what steps have been taken toward implementation. The addition of this tracking mechanism will eliminate the challenge of losing visibility on the status of mitigation actions as a result of staff turnover and other issues. Relatedly, Action # 2018-002 seeks to strengthen inter-agency coordination actions, including State, regional, and local linkages, and to establish and track the progress of inter-agency advisory groups, task forces, and work groups to ensure vertical and horizontal integration and coordination of mitigation planning and implementation.

47. MITIGATION ACTIONS

Mitigation actions for this SHMP were identified through the following sources:

- Actions were identified with an emphasis on addressing hazards with the highest impacts, as measured by the hazard impact scoring presented in Section 4.1.3. The action plan focuses on hazards with either high or medium impact scores. Actions to address hazards with low impact scores were considered optional.
- 2018 SHMP Mitigation Strategy—All actions that are not yet completed were updated and included as described in Section 45.1.
- SHMP Hazard and Working Groups convened to develop new action items to address hazards in the Risk Assessment and gaps in agency capabilities.
- SHMP Hazard and Working Group members submitted recommended actions in an action item follow-up form. Cal OES reviewed and approved each action for inclusion in the SHMP.

47.1. IDENTIFIED ACTIONS

Table 47-1 presents the recommended SHMP Mitigation Action Plan, providing the following information:

- Mitigation action title and description
- Agencies responsible for implementation
- Hazards mitigated and their associated impact ratings
- Mitigation objectives met
- Community lifelines addressed
- Whether new or existing assets are benefitted
- Estimated cost to implement the action
- Potential funding sources (see Appendix O for a complete list)
- Anticipated timeline during which the action can be completed

The following are descriptions of action attributes included in the action plan:

- **Action Numbering**—The action plan assigns a numeric identifier to each action for tracking and progress reporting. Actions with a "2023" prefix are new actions identified for this SHMP update. Actions with a "2018" prefix are actions carried over from the 2018 SHMP.
- **Hazards Mitigated**—The action plan lists which hazards of concern each action will mitigate "All hazards" indicates that the action has potential to mitigate all 34 hazards of concern assessed in this SHMP.
- **Objectives Met**—The action plan lists which objectives identified in Chapter 44 each action will help to meet.
- **Community Lifelines Addressed**—The action plan lists which of the seven FEMA categories for lifelines each action will protect.
- **New or Existing Assets**—The action plan identifies whether each action will reduce risk to new assets as they are built, existing assets (i.e., retrofits), or both.
- **Estimated Costs**—The action plan provides general cost information as follows:
  - **High**—The State would require funding from an outside source (i.e., grant) to implement the action.
  - **Medium**—The action could be funded under an existing State program budget, but funds for the action have not currently been obligated.
  - **Low**—Funding for the action has already been obligated and the action is considered to be an ongoing action.
- **Potential Funding Sources**—The action plan lists options for funding the action, including any match requirements for actions targeted for grant funding.
- **Timeline**—The action plan provides general project implementation timing as follows:
  - **Short-Term**—The action can be completed within the five-year performance period for the SHMP.
  - **Long-Term**—The action is likely to take longer than five years to complete.
  - **Ongoing**—The action is already funded and being implemented by the State.

47.2. PRIORITIZATION

S10 – 44 CFR 201.4(c)(3)(i), 201.4(c)(3)(ii) and 201.4(c)(3)(iii): Does the plan prioritize mitigation actions to reduce vulnerabilities identified in the risk assessment?
Section 47.2 defines a prioritization schema that was applied for this plan update process.

Standard 4.2.2:
The Emergency Management Program documents project ranking based upon the greatest opportunity for loss reduction and documents how specific mitigation actions contribute to overall risk reduction. The process for prioritizing mitigation actions for inclusion in the 2023 SHMP is documented in Section 47.2.

As described in Section 45.2, Cal OES prioritized actions for this SHMP by answering 15 questions, weighing the responses, and assigning a priority ranking from 0 to 3. Total scores from 0 to 14 defined a low priority, 15 to 30 were medium priority, and actions with scores between 31 and 45 ranked high priority. Most of the actions were ranked with a medium priority (69), and the remainder (23) were ranked high. Table 47-2 indicates the priority for each action in the SHMP Mitigation Action Plan.

Responsible Agencies

In the mitigation action plan table that follows, responsible agencies are identified by the following acronyms or short forms:

- BOF—California Board of Forestry and Fire Protection
- CAL FIRE—California Department of Forestry and Fire Protection
- Cal OES—California Governor's Office of Emergency Services
- Cal/OSHA—California Department of Industrial Relations Division of Occupational Safety and Health
- CalGEM—California Department of Conservation Geologic Energy Management
- Caltrans—California Department of Transportation
- CARB—California Air Resources Board
- CBSC—California Building Standards Commission
- CDFA—California Department of Food and Agriculture
- CDPH —California Department of Public Health
- CDT—California Department of Technology
- CEA—California Earthquake Authority
- CEC—California Energy Commission
- CGS—California Geological Survey
- CNRA—California Natural Resources Agency
- Coastal Commission—California Coastal Commission
- CPUC—California Public Utilities Commission
- CSU—California State University
- CVFPB—Central Valley Flood Protection Board
- DOC— California Department of Conservation
- DSOD—California Division of Safety of Dams
- DWR—California Department of Water Resources
- HCD—California Department of Housing and Community Development
- NOAA—National Oceanic and Atmospheric Administration
- OEHHA—California Office of Environmental Health Hazard Assessment
- OPC— California Ocean Protection Council
- OPR—California Governor's Office of Planning and Research
- OSFM— California Office of the State Fire Marshal
- OSPR—California Department of Fish and Wildlife Office of Spill Prevention and Response
- SGC—California Strategic Growth Council
- SLC—California State Lands Commission
- SSC—California Seismic Safety Commission
- USGS—U.S. Geological Survey
- Water Boards—California State Water Resources Control Board

HHPD4: Did Element S10 (mitigation actions) prioritize mitigation actions and activities to reduce vulnerabilities from high hazard potential dams?
The Plan identifies and prioritizes nine mitigation actions that would reduce vulnerabilities from high hazard potential dams as shown in Table 47-1.

S11 – 44 CFR 201.4(c)(3)(iv): Does the plan identify current and potential sources of funding to implement mitigation actions and activities?
For every action identified below in Table 47-1, a current or potential funding source(s) has been identified.

HHPD5: Did Element S11 (funding sources) identify current and potential sources of funding to implement mitigation actions and activities for high hazard potential dams?
For every action relating to high hazard potential dams identified below in Table 47-1, a current or potential funding source(s) has been identified.

Table 47-1. SHMP Hazard Mitigation Action Plan

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2023-001 [HIGH Priority]: Encourage integration of community wildfire protection plans into LHMPs by adding the requirements that are unique to community wildfire protection plans to the LHMP review tool as an "optional" component. Then promote this concept through targeted outreach to areas of the State that this integration would benefit.					
Responsible Agencies: Cal OES					
Hazards Mitigated: Wildfire *(High Impact Hazard)*					
1, 3, 4, 5, 6, 12	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (HMGP Post Fire)	Ongoing
Action 2023-002 [MEDIUM Priority]: Conduct both structural and non-structural assessments of State-owned facilities that identify vulnerabilities and feasible alternatives to retrofit those vulnerabilities.					
Responsible Agencies: Cal OES					
Hazards Mitigated: Earthquake *(High Impact Hazard)*					
3, 4, 14	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	Existing	High	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing
Action 2023-003 [MEDIUM Priority]: Develop a Hazus repository for earthquake and flood hazards where local planning efforts that create these models can share this information with the State once the models have been developed.					
Responsible Agencies: SSC, DWR					
Hazards Mitigated: Earthquake *(High Impact Hazard)*; Riverine, Stream and Alluvial Flood *(High Impact Hazard)*; Sea-Level Rise, Coastal Flooding and Erosion *(High Impact Hazard)*					
1, 3, 12, 13, 16	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2023-004 [MEDIUM Priority]: Leverage existing State programs to develop and support programs for the assessment and retrofit of structures identified with soft-story construction.					
Responsible Agencies: SSC					
Hazards Mitigated: Earthquake *(High Impact Hazard)*					
1, 3, 5, 10, 14, 16	Food, Water, Shelter	Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing
Action 2023-005 [MEDIUM Priority]: Coordinate planning efforts for aquifer storage and recharge actions within areas of known liquefaction risk so that the liquefaction risk is not increased by the storage basin mitigation action.					
Responsible Agencies: DWR					
Hazards Mitigated: Drought, Earthquake *(High Impact Hazard)*					
1, 3, 5, 16	Food, Water, Shelter	New and Existing	Low	State Budget	Ongoing
Action 2023-006 [HIGH Priority]: Promote the HCD "Prohousing Designation Program". Encourage cities and counties to apply for this designation to receive points or preference in competitive housing, community development, and infrastructure programs. ▪ Strengthen protections for people who are experiencing homelessness and are extremely vulnerable to climate risks through funding programs for permanent and interim housing. ▪ Invest Community Development Block Grant (CDBG) funds in long-term disaster recovery and resilience building that targets the unmet housing recovery needs of low and moderate-income households in a way that mitigates disaster risk and reduces future losses among vulnerable communities. ▪ Implement climate resilience and sustainable building strategies in addition to enforcing "CALGreen," California's green building code. ▪ Encourage greater diversity of housing types in all neighborhoods and encourage new housing development in existing communities to reduce vehicle miles traveled and mitigate climate change while simultaneously addressing housing need.					
Responsible Agencies: HCD					
Hazards Mitigated: Air Pollution; Drought; Extreme Cold or Freeze; Extreme Heat; Wildfire					
1, 3, 5, 7, 8, 9, 15, 16	Food, Water, Shelter	New and Existing	Low	State Budget, CDBG	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2023-007 [HIGH Priority]: CEA Grants—Provide financial support to homeowners to retrofit single-family soft-story residences. The Earthquake Soft-Story Program is under development and is expected to open for registration in early 2023. The program provides up to $13,000 per residential unit for seismic residential retrofitting.					
Responsible Agencies: CEA					
Hazards Mitigated: Earthquake *(High Impact Hazard)*					
3, 5, 10, 14, 15	Food, Water, Shelter	Existing	High	CEA Loss Mitigation Fund, State Budget, FEMA HMA (BRIC, HMGP, Public Assistance [PA] Mitigation)	Ongoing
Action 2023-008 [HIGH Priority]: CEA Grants ▪ Provide financial support to building owners to retrofit multi-family, soft-story residences. The Multi-Family, Soft-Story Retrofit Program was recently notified of Round 1 approval for a BRIC grant, with tentative development to begin upon FEMA approval. The program will provide grants for seismic residential retrofitting of multi-family housing units in areas with high seismicity and social vulnerability index (SVI) scores. ▪ Provide financial support to homeowners to retrofit single-family residences. The Earthquake Brace + Bolt Program (EBB) was initiated in 2013. As of 2023, the program has retrofitted more than 19,000 single-family residences throughout the State. The EBB provides up to $3,000 per residential unit for seismic residential upgrading. Funding has been collectively provided through the CEA Loss Mitigation Fund, the State of California, and through FEMA HMGP grants.					
Responsible Agencies: CEA					
Hazards Mitigated: Earthquake *(High Impact Hazard)*					
3, 5, 10, 14, 15	Food, Water, Shelter	Existing	High	CEA Loss Mitigation Fund, State Budget, FEMA HMA (BRIC, HMGP, PA Mitigation)	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2023-009 [HIGH Priority]: Implement the 2022 Central Valley Flood Protection Plan (CVFPP). Complete urban level of flood protection projects for the City of West Sacramento, the City of Stockton, the City of Manteca, and the City of Lathrop to achieve the 200-year level of flood protection for levee-protected urban areas (greater than 10,000 residents) in the Central Valley.					
Responsible Agencies: DWR					
Hazards Mitigated: Levee Failure *(Medium Impact Hazard)*; Riverine, Stream and Alluvial Flood *(High Impact Hazard)*					
1, 3, 5, 6, 14	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	High	State Budget, FEMA HMA (BRIC, HMGP, FMA)	Long-term
Action 2023-010 [HIGH Priority]: Implement the 2022 CVFPP. Complete Central Valley Small Community Flood Risk Reduction Program (communities between 200 and 10,000 residents) to achieve the 100-year level of flood protection for levee-protected small communities.					
Responsible Agencies: DWR					
Hazards Mitigated: Levee Failure *(Medium Impact Hazard)*; Riverine, Stream and Alluvial Flood *(High Impact Hazard)*					
1, 3, 5, 6, 14	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	High	State Budget, FEMA HMA (BRIC, HMGP, FMA)	Long-term

<table>
<tr><th>Objectives Met</th><th>Community Lifelines</th><th>Benefits New or Existing Assets</th><th>Estimated Cost</th><th>Potential Sources of Funding</th><th>Timeline</th></tr>
<tr><td colspan="6">Action 2023-011 [HIGH Priority]: Pre-Wildfire Geologic Hazard Mitigation Planning & Post-Wildfire Hazard Identification Program—Build capacity by increasing current staffing and resources to fully implement each task of the program:
▪ Pre-fire mud and debris flow and flooding hazard awareness and planning
▪ Post-fire watershed emergency assessment focused on life/safety hazards from debris flows, flooding, rockfall, etc.
▪ Post Watershed Emergency Response Team (WERT) mud and debris flow and flood hazard emergency planning
▪ Burn area monitoring and process refinement
▪ Outreach and education
▪ Necessary ongoing support materials</td></tr>
<tr><td colspan="6">Responsible Agencies: CGS</td></tr>
<tr><td colspan="6">Hazards Mitigated: Landslide, Debris Flow, and other Mass Movements (High Impact Hazard); Riverine, Stream and Alluvial Flood (High Impact Hazard); Wildfire (High Impact Hazard)</td></tr>
<tr><td>1, 2, 3, 5, 13, 16</td><td>Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material</td><td>New and Existing</td><td>High</td><td>State Budget, FEMA HMA (BRIC, HMGP, HMGP Post Fire)</td><td>Ongoing</td></tr>
</table>

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2023-012 [HIGH Priority]: Continue to support programs that promote the mitigation of FEMA-identified repetitive loss (RL) and severe repetitive loss (SRL) properties. This will include but is not limited to: ▪ Create a pathway for access to RL/SRL data in support of local hazard mitigation planning ▪ Encourage the mitigation of RL/SRL properties through the State's outreach efforts for the suite of HMA grant programs ▪ Encourage participation in FEMA's CRS program that targets the mitigation of RL properties ▪ Prioritize the understanding of where RL/SRL properties are within the State and why they are experiencing repetitive flood loss					
Responsible Agencies: DWR					
Hazards Mitigated: Riverine, Stream and Alluvial Flood *(High Impact Hazard)*; Sea-Level Rise, Coastal Flooding and Erosion *(High Impact Hazard)*					
1, 3, 4, 5, 6, 10, 12, 14, 15, 16	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, FMA)	Ongoing
Action 2023-013 [HIGH Priority]: Federal High Hazard Potential Dam (HHPD) Inundation Mapping—Continue to develop inundation models for federal high hazard potential dams in the State.					
Responsible Agencies: Cal OES, DSOD					
Hazards Mitigated: Dam Failure *(Medium Impact Hazard)*					
2, 3, 4, 10	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget; HHPD grants	Short-term

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2023-014 [HIGH Priority]: California Wildfire Mitigation Program – Provide a framework, tools, and support that will allow communities to establish locally led programs to harden, retrofit, and establish defensible space around residences, prioritizing equity priority communities and individuals. Implement the demonstration projects and develop a scaling-up strategy.					
Responsible Agencies: Cal OES, CAL FIRE					
Hazards Mitigated: Wildfire *(High Impact Hazard)*					
1, 4, 5, 6, 13	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing
Action 2023-015 [MEDIUM Priority]: Coordinate with State-led programs that support mitigation goals to align timelines and funding sources to achieve mitigation planning, local capacity building, project scoping, and project implementation.					
Responsible Agencies: Cal OES, OPR, CAL FIRE, CNRA, SGC, DWR, CGS/DOC					
Hazards Mitigated: Avalanche *(Medium Impact Hazard)*, Dam Failure *(Medium Impact Hazard)*, Drought *(Medium Impact Hazard)*, Earthquake *(High Impact Hazard)*, Flood *(High Impact Hazard)*, Landslide/debris flows/other mass movements *(High Impact Hazard)*, extreme heat, extreme cold *(High Impact Hazard)*, severe wind/weather/storms *(High Impact Hazard)*, Sea-Level Rise, Coastal Flooding and Erosion *(High Impact Hazard)*, Tsunami *(Medium Impact Hazard)*, Wildfire *(High Impact Hazard)*, Volcano *(Low Impact Hazard)*					
1, 4, 5, 6, 13	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2023-016 [HIGH Priority]: Provide technical assistance, tools, and support for communities to undertake a mitigation-informed recovery process, including through accessing Public Assistance (PA) (406) Mitigation Funds to harden damaged infrastructure after disasters.					
Responsible Agencies: Cal OES, CGS					
Hazards Mitigated: Avalanche *(Medium Impact Hazard)*, Dam Failure *(Medium Impact Hazard)*, Drought *(Medium Impact Hazard)*, Earthquake *(High Impact Hazard)*, Flood *(High Impact Hazard)*, Landslide/debris flows/other mass movements *(High Impact Hazard)*, extreme heat, extreme cold *(High Impact Hazard)*, severe wind/weather/storms *(High Impact Hazard)*, Sea-Level Rise, Coastal Flooding and Erosion *(High Impact Hazard)*, Tsunami *(Medium Impact Hazard)*, Wildfire *(High Impact Hazard)*, Volcano *(Low Impact Hazard)*					
1,5,7,10,16	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA section 406 (PA)	Ongoing
Action 2023-017 [HIGH Priority]: Update and maintain Fire Hazard Severity Zone maps to help local agencies and Californians determine high wildfire hazard areas to inform preparedness efforts.					
Responsible Agencies: CAL FIRE					
Hazards Mitigated: Wildfire (High Impact Hazard)					
1, 4, 5, 6, 13	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget	Ongoing
Action 2023-018 [High Priority]: Continue to develop, update, and maintain liquefaction mapping in the State utilizing best available data and science.					
Responsible Agencies: CGS					
Hazards Mitigated: Earthquake (High Impact Hazard)					
1, 4, 5, 6, 13	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Medium	State Budget, NEHRP grant Funding	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2023-019 [High Priority]: Development of Statewide Extreme Heat Ranking System – provide subject matter expertise and technical assistance to create the nation's first extreme heat advanced warning and ranking system to better prepare communities for heat waves by: ▪ Support development of outreach plans for reaching diverse and vulnerable populations and recommendations for tailored communications by local governments that include the use of culturally appropriate materials translated into different languages based on common languages spoken in the community. ▪ Support in developing recommendations to local governments regarding relevant heat prevention, preparedness, and resilience measures.					
Responsible Agencies: CalEPA, OPR, CDPH					
Hazards Mitigated: Extreme Heat (High Impact Hazard)					
1, 2, 3, 5, 9, 11, 13	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Medium	General Fund	Ongoing
Action 2023-020 [High Priority]: Perinatal Extreme-Heat Health Effects and Pregnant Individual Safety Guidance – CDPH will review existing research on the perinatal health effects of extreme heat and develop guidance for pregnant individuals and infant children on safe conditions and health considerations during extreme heat, including guidance on safe outdoor conditions for pregnant workers. Develop a report with recommendations on best practices for linking pregnant individuals to health and well-being information on extreme heat.					
Responsible Agencies: CDPH					
Hazards Mitigated: Extreme Heat (High Impact Hazard)					
1, 2, 3, 5, 9, 11, 13	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Medium	Self-funded by CDPH on a limited-term basis	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2023-021 [High Priority]: Climate Syndromic Surveillance Program – Develop and implement a statewide syndromic surveillance system, which will provide near real-time notification from emergency departments of climate-related conditions, complaints, and discharge diagnoses, allowing for early warnings of heat-related illness cases.					
Responsible Agencies: CDPH					
Hazards Mitigated: Extreme Heat (High Impact Hazard)					
1, 2, 3, 5, 9, 11, 13	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Medium	General Fund	Ongoing
Action 2018-001 [HIGH Priority]: Mitigation legislation and implementation—Support legislative efforts that formalize California's comprehensive mitigation program including: ▪ Support ongoing funding for mitigation planning and action for all communities ▪ Support funding, training, and technical assistance for local capacity building ▪ Eliminate or significantly reduce barriers to entry for equity priorities to undertake mitigation ▪ Streamline the implementation of mitigation projects ▪ Promote innovative mitigation solutions					
Responsible Agencies: Cal OES, Delta Stewardship Council, CAL FIRE, OSFM, CARB, CNRA, OPR					
Hazards Mitigated: All hazards					
1, 4, 5, 6, 13	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-002 [HIGH Priority]: Strengthen inter-agency coordination actions including State, regional, and local linkages. Establish and track the progress of inter-agency advisory groups, task forces, and work groups to ensure vertical and horizontal integration and coordination of mitigation planning and implementation.					
Responsible Agencies: OPR, Cal OES, OPC, CNRA					
Hazards Mitigated: All hazards					
1, 4, 5, 6, 13	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget; HHPD grants	Ongoing
Action 2018-003 [HIGH Priority]: Broaden public and private sector mitigation linkages through the following programs: ▪ Great California Shake Out ▪ Fire Safe Councils ▪ State Water Efficiency and Enhancement Program ▪ California Solar Initiative ▪ California Cybersecurity Task Force					
Responsible Agencies: OPR, Cal OES, OPC, CNRA					
Hazards Mitigated: All hazards					
1, 4, 5, 6	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget	Ongoing
Action 2018-005 [HIGH Priority]: Incorporate climate change into local, regional, and statewide hazard profiles, risk assessments, and mitigation plans.					
Responsible Agencies: OPR, Local Jurisdictions, Cal OES, State Hazard Mitigation Team					
Hazards Mitigated: Climate Change *(High Impact Hazard)*					
1, 2, 4, 5, 10, 11, 13	Food, Water, Shelter; Health & Medical; Energy; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP), applicable local jurisdictions	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-006 [MEDIUM Priority]: Enhance collaboration on the development and sharing of data systems and geographic information system (GIS) modeling for the SHMP's Risk Assessment analysis to develop an ArcGIS Online Hub site that will facilitate the sharing of relevant information to State and local partners.					
Responsible Agencies: Cal OES, CDT, OPR, CARB, OEHHA, CDPH, CGS, DWR, SLC, CAL FIRE					
Hazards Mitigated: Air Pollution *(High Impact Hazard)*; Dam Failure *(Medium Impact Hazard)*; Drought *(Medium Impact Hazard)*; Earthquake *(High Impact Hazard)*; Epidemic/Pandemic/Vector-Borne Disease *(Medium Impact Hazard)*; Extreme Cold or Freeze *(High Impact Hazard)*; Extreme Heat *(High Impact Hazard)*; Geomagnetic Storm *(Low Impact Hazard)*; Invasive and Nuisance Species *(Medium Impact Hazard)*; Landslide, Debris Flow, and other Mass Movements *(High Impact Hazard)*; Levee Failure *(Medium Impact Hazard)*; Riverine, Stream and Alluvial Flood *(Medium Impact Hazard)*; Sea-Level Rise, Coastal Flooding and Erosion *(High Impact Hazard)*; Severe Wind, Weather and Storms *(High Impact Hazard)*; Snow Avalanche *(Medium Impact Hazard)*; Subsidence *(Medium Impact Hazard)*; Tree Mortality; Tsunami and Seiche *(Medium Impact Hazard)*; Volcano *(Low Impact Hazard)*; Well Stimulation and Hydraulic Fracturing *(Low Impact Hazard)*; Wildfire *(High Impact Hazard)*					
1, 2, 5, 10, 12, 13	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, HMGP Post Fire, FMA); HHPD grants	Ongoing
Action 2018-007 [MEDIUM Priority]: Support and coordinate monitoring of progress on State goals and objectives. Set systematic near- and long-term mitigation targets and priorities. Develop a robust mitigation action tracking system.					
Responsible Agencies: Cal OES, State Departments and Agencies, CARB, DWR, CEC					
Hazards Mitigated: All hazards					
4, 5, 6, 8, 9, 10, 16	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget; HHPD grants	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-008 [MEDIUM Priority]: Develop a database describing the specific natural hazard event that each project in the SHMP and LHMPs is designed to mitigate. These detailed "trigger events" describe the situation that will test the completed projects and include specific metrics. This database will enhance capabilities to conduct robust loss avoidance studies.					
Responsible Agencies: Cal OES, State Departments and Agencies					
Hazards Mitigated: Dam Failure *(Medium Impact Hazard)*; Drought *(Medium Impact Hazard)*; Earthquake *(High Impact Hazard)*; Extreme Cold or Freeze *(High Impact Hazard)*; Extreme Heat *(High Impact Hazard)*; Geomagnetic Storm *(Low Impact Hazard)*; Invasive and Nuisance Species *(Medium Impact Hazard)*; Landslide, Debris Flow, and other Mass Movements *(High Impact Hazard)*; Levee Failure*(Medium Impact Hazard)*; Riverine, Stream and Alluvial Flood *(High Impact Hazard)*; Sea-Level Rise, Coastal Flooding and Erosion *(High Impact Hazard)*; Severe Wind, Weather and Storms *(High Impact Hazard)*; Snow Avalanche *(Medium Impact Hazard)*; Subsidence *(Medium Impact Hazard)*; Tree Mortality *(Medium Impact Hazard)*; Tsunami and Seiche *(Medium Impact Hazard)*; Wildfire *(High Impact Hazard)*					
1, 2, 5, 10, 12, 13	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, HMGP Post Fire, FMA; HHPD grants	Ongoing
Action 2018-009 [HIGH Priority]: California Global Warming Solutions Act (AB 32)—Reduce Greenhouse Gas (GHG) emissions to 40 percent below 1990 levels by 2030. Implement the proposed CARB Scoping Plan, building on key programs to reduce GHG emission in the energy-producing, transportation, agriculture, and forestry sectors.					
Responsible Agencies: CARB					
Hazards Mitigated: Climate Change					
2, 3, 4, 11, 13, 15	Food, Water, Shelter; Health & Medical; Energy; Transportation; Hazardous Material	New and Existing	Low	State Budget, U.S. Environmental Protection Agency (EPA)	Short-term

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-010 [MEDIUM Priority]: Interagency Coordination—Coordinate the activities of State agencies to improve air and water quality; protect natural resources and agricultural lands; increase the availability of affordable housing; improve infrastructure systems; promote public health; and assist State and local entities in the planning of sustainable communities and meeting AB 32 goals. ▪ Provide technical support and feedback on climate change issues to be addressed in the California Water Plan Update. ▪ Review and develop policy and operational recommendations associated with the effects of climate change on fire preparedness and response planning. ▪ Provide guidance for agencies to incorporate and integrate climate change into all planning and investment decisions. ▪ Ensure the State's ability to adapt to climate change impacts on ocean and coastal resources. ▪ Facilitate coordination among State, regional, and local agency efforts to adapt to the impacts of climate change. ▪ Provide a venue for cross-sector collaboration and information sharing on development of the Safeguarding California plan.					
Responsible Agencies: Strategic Growth Council, DWR, Cal OES, OPR					
Hazards Mitigated: Climate Change *(High Impact Hazard)*					
1, 5, 6, 10, 12, 16	Food, Water, Shelter; Health & Medical; Energy; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing

<table>
<tr><th>Objectives Met</th><th>Community Lifelines</th><th>Benefits New or Existing Assets</th><th>Estimated Cost</th><th>Potential Sources of Funding</th><th>Timeline</th></tr>
<tr><td colspan="6">Action 2018-011 [MEDIUM Priority]: California Adaptation Strategy—Communicate current and needed actions State government should take to build climate change resilience through the California Climate Adaptation Strategy update including:
Organizing the State’s climate adaptation efforts around six outcome-based priorities for building resilience and increasing the State’s ability to measure progress
Breaking down siloes and unifying collective climate adaptation efforts across all sectors and regions
Making it easier for Californians to understand and contribute to California’s climate resilience agenda</td></tr>
<tr><td colspan="6">Responsible Agencies: CNRA, Cal OES</td></tr>
<tr><td colspan="6">Hazards Mitigated: Climate Change (High Impact Hazard)</td></tr>
<tr><td>2, 3, 4, 11, 13, 15</td><td>Food, Water, Shelter; Health & Medical; Energy; Transportation; Hazardous Material</td><td>New and Existing</td><td>Low</td><td>State Budget</td><td>Ongoing</td></tr>
<tr><td colspan="6">Action 2018-012 [HIGH Priority]: California Building Resilience Against Climate Change Effects (Cal BRACE) Project—Enhance CDPH’s capability to plan for and reduce health risks associated with climate change by:
Working with stakeholders to address health inequities
Providing resources and technical assistance for public health departments to build climate adaptation capacity and enhance resiliency at local and regional levels
Working with local, State, and national partners to assure climate change mitigation and adaptation activities do not exacerbate health inequities</td></tr>
<tr><td colspan="6">Responsible Agencies: CDPH, Cal OES</td></tr>
<tr><td colspan="6">Hazards Mitigated: Climate Change (High Impact Hazard)</td></tr>
<tr><td>2, 3, 4, 11, 13, 15</td><td>Food, Water, Shelter; Health & Medical; Energy; Transportation; Hazardous Material</td><td>New and Existing</td><td>Low</td><td>State Budget, FEMA HMA (BRIC, HMGP)</td><td>Short-term</td></tr>
</table>

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-013 [MEDIUM Priority]: Climate Change Assessment—Produce periodic scientific assessments on the potential impacts of climate change in California.					
Responsible Agencies: OPR, CNRA, CEC, Strategic Growth Council					
Hazards Mitigated: Climate Change					
2, 3, 4, 11, 13, 15	Food, Water, Shelter; Health & Medical; Energy; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing
Action 2018-014 [MEDIUM Priority]: Local Planning for Climate Change— Support the incorporation of climate change adaptation and GHG emission reductions into local planning processes.					
Responsible Agencies: OPR, HCD					
Hazards Mitigated: Climate Change *(High Impact Hazard)*					
2, 3, 4, 11, 13, 15	Food, Water, Shelter; Health & Medical; Energy; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing
Action 2018-015 [MEDIUM Priority]: Web Based Climate Change Tools—Provide a centralized source of climate change information and resources.					
Responsible Agencies: OPR, CARB					
Hazards Mitigated: Climate Change *(High Impact Hazard)*					
2, 3, 4, 11, 12, 13, 15	Food, Water, Shelter; Health & Medical; Energy; Transportation; Hazardous Material	New and Existing	Low	State Budget	Ongoing
Action 2018-017 [MEDIUM Priority]: Earthquake Zones of Required Investigation—Ensure efficient, accurate, and reliable completion of the statewide Seismic Hazard Mapping Program.					
Responsible Agencies: CGS					
Hazards Mitigated: Earthquake *(High Impact Hazard)*					
1, 3, 5, 6, 14	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-019 [MEDIUM Priority]: Uniform California Earthquake Rupture Forecast (UCERF)—Revise California earthquake probabilities. Prepare updated shaking hazard map of California.					
Responsible Agencies: USGS, CGS					
Hazards Mitigated: Earthquake *(High Impact Hazard)*					
1, 3, 5, 6, 14	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Short-term
Action 2018-020 [MEDIUM Priority]: Hazus Earthquake Loss Estimates—Update statewide annualized losses if the need becomes apparent during the next five years.					
Responsible Agencies: Cal OES, CGS					
Hazards Mitigated: Earthquake *(High Impact Hazard)*					
1, 3, 9, 10, 12	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing
Action 2018-021 [MEDIUM Priority]: California Earthquake Early Warning System (see Napa Earthquake Case Study)—Support the development and installation of robust early warning systems to rapidly detect the occurrence of an earthquake, estimate the level of ground shaking, and issue a warning before significant ground shaking begins.					
Responsible Agencies: Cal OES					
Hazards Mitigated: Earthquake *(High Impact Hazard)*					
3, 7	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-023 [MEDIUM Priority]: Light Detection and Ranging (LiDAR) Fault Mapping—Examine the utility of high-resolution LiDAR topographic data for mapping active faults.					
Responsible Agencies: CGS					
Hazards Mitigated: Earthquake *(High Impact Hazard)*					
3, 10	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Short-term
Action 2018-027 [MEDIUM Priority]: CSU Retrofits—Reduce unacceptable seismic risk of existing buildings and manage current construction programs to limit future seismic risk.					
Responsible Agencies: CSU					
Hazards Mitigated: Earthquake *(High Impact Hazard)*					
1, 5, 14	Food, Water, Shelter	Existing	High	State Budget, FEMA HMA (BRIC, HMGP, PA Mitigation)	Ongoing
Action 2018-029 [MEDIUM Priority]: Seismic Evaluation of Single-Family Dwellings—Develop comprehensive guidelines for evaluating and seismically retrofitting single- family dwellings.					
Responsible Agencies: CEA, CBSC, HCD					
Hazards Mitigated: Earthquake *(High Impact Hazard)*					
1, 5, 14	Food, Water, Shelter	Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing
Action 2018-030 [HIGH Priority]: CEA Grants—Provide financial support to homeowners to retrofit single-family residences.					
Responsible Agencies: CEA					
Hazards Mitigated: Earthquake *(High Impact Hazard)*					
1, 5, 14, 15	Food, Water, Shelter	Existing	Low	State Budget, CEA Grants, FEMA HMA (BRIC, HMGP)	Long-term

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-033 [MEDIUM Priority]: Mobile Homes—Adopt regulations to improve the structural and lateral stability of manufactured housing.					
Responsible Agencies: HCD, Cal OES					
Hazards Mitigated: Earthquake *(High Impact Hazard)*					
5, 14	Food, Water, Shelter	New	Low	State Budget	Ongoing
Action 2018-036 [MEDIUM Priority]: The Great California Shake Out Earthquake Drill and Public Readiness Initiative—Conduct statewide emergency preparedness, mitigation, and response activities to include multiple levels of government, the private sector, and the public.					
Responsible Agencies: Cal OES					
Hazards Mitigated: Earthquake *(High Impact Hazard)*					
1, 5, 7	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget	Ongoing
Action 2018-037 [MEDIUM Priority]: Landslide Inventory Maps—Continue to map earthquake-induced landslides through the Seismic Hazards Mapping Program.					
Responsible Agencies: CGS					
Hazards Mitigated: Earthquake *(High Impact Hazard)*					
1, 2, 3, 5, 6, 14	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-038 [MEDIUM Priority]: Post-Fire Runoff & Debris Flows—Develop regional modeling to assess potential effects of post-fire runoff. Develop an early warning system for post-fire flash floods and debris flows.					
Responsible Agencies: DOC, USGS, NOAA, Cal OES					
Hazards Mitigated: Landslide, Debris Flow, and other Mass Movements *(High Impact Hazard)*; Riverine, Stream and Alluvial Flood *(High Impact Hazard)*; Wildfire *(High Impact Hazard)*					
1, 2, 3, 5, 6, 14	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Medium	State Budget, FEMA HMA (BRIC, HMGP, HMGP Post Fire, FMA)	Long-term
Action 2018-039 [MEDIUM Priority]: Update the Volcano Hazard Vulnerability Assessment as needed to address future changes in geospatial data on: ▪ At-risk populations ▪ Infrastructure ▪ Resources					
Responsible Agencies: USGS, CGS, Cal OES					
Hazards Mitigated: Earthquake *(High Impact Hazard)*; Volcano *(Low Impact Hazard)*					
1, 3, 5, 6, 14	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Medium	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing
Action 2018-040 [MEDIUM Priority]: Flood Control System Deficiencies in Central Valley—Produce a descriptive document to inventory the facilities and operations associated with State and federal flood control works, and a flood control system status report to assess the status of that inventory.					
Responsible Agencies: DWR					
Hazards Mitigated: Riverine, Stream and Alluvial Flood *(High Impact Hazard)*					
1, 2, 3, 5, 6, 14	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Medium	State Budget, FEMA HMA (BRIC, HMGP, FMA)	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-041 [MEDIUM Priority]: Flood Risk Mapping—Adopt a schedule for mapping flood risk areas in the Central Valley and prepare/approve levee flood protection zone maps. Provide yearly notices to owners of property in a levee flood protection zone.					
Responsible Agencies: DWR					
Hazards Mitigated: Riverine, Stream and Alluvial Flood *(High Impact Hazard)*					
2, 3, 5	Food, Water, Shelter	New and Existing	Medium	State Budget, FEMA HMA (BRIC, HMGP, FMA)	Ongoing
Action 2018-042 [MEDIUM Priority]: Land Use Planning and Management—Control future development in floodplains and flood-prone areas, in conformance with the CVFPP.					
Responsible Agencies: CVFPB, DWR					
Hazards Mitigated: Riverine, Stream and Alluvial Flood *(High Impact Hazard)*					
2, 3, 5	Food, Water, Shelter	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, FMA)	Ongoing
Action 2018-045 [MEDIUM Priority]: California's Flood Future—Continue to assess statewide exposure to flood risk; identify and address the barriers to improved flood management with the development of a companion report: Investing in California's Flood Future: An Outcome-Driven Approach to Flood Management.					
Responsible Agencies: DWR					
Hazards Mitigated: Riverine, Stream and Alluvial Flood *(High Impact Hazard)*; Sea-Level Rise, Coastal Flooding and Erosion *(High Impact Hazard)*					
2, 3, 5	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Medium	State Budget, FEMA HMA (BRIC, HMGP, FMA)	Short-term

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-046 [MEDIUM Priority]: Flood Management System Planning and Programs—Improve flood management across the State through five integrated program areas: ▪ Flood Management Planning ▪ Floodplain Risk Management ▪ Flood Reduction Projects ▪ Flood System Operations and Maintenance ▪ Flood Emergency Response					
Responsible Agencies: DWR					
Hazards Mitigated: Riverine, Stream and Alluvial Flood *(High Impact Hazard)*; Sea-Level Rise, Coastal Flooding and Erosion *(High Impact Hazard)*					
2, 3, 5	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, FMA)	Ongoing
Action 2018-047 [MEDIUM Priority]: CVFPP —Update and implement recommendations and planning requirements outlined in the plan.					
Responsible Agencies: DWR					
Hazards Mitigated: Riverine, Stream and Alluvial Flood *(High Impact Hazard)*					
2, 3, 4, 5, 6	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, FMA)	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-048 [MEDIUM Priority]: California Water Plans—Ensure reliable water supplies and foundational actions for sustainable water use in California by: ▪ Identifying specific outcomes and metrics to track performance ▪ Prioritizing near-term State actions and investments ▪ Recommending financing methods having more stable revenues ▪ Informing water deliberations and decisions as they unfold					
Responsible Agencies: DWR					
Hazards Mitigated: Riverine, Stream and Alluvial Flood *(High Impact Hazard)*; Drought *(Medium Impact Hazard)*					
2, 3, 4, 5, 6	Food, Water, Shelter; Energy	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, FMA)	Ongoing
Action 2018-049 [HIGH Priority]: NFIP Compliance—Work with local floodplain managers to promote participation in and ensure compliance with the NFIP to update communities' FIRMs.					
Responsible Agencies: DWR, Local Building Departments					
Hazards Mitigated: Riverine, Stream and Alluvial Flood *(High Impact Hazard)*; Sea-Level Rise, Coastal Flooding and Erosion *(High Impact Hazard)*					
1, 2, 3, 6, 11, 13, 14, 15	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, FMA)	Ongoing
Action 2018-050 [MEDIUM Priority]: Sea-Level Rise Guidance—Provide guidance on factors to consider in projecting sea-level rise, potential impacts, and adaptation strategies.					
Responsible Agencies: OPC, CNRA, OPR, CEC, Coastal Commission					
Hazards Mitigated: Sea-Level Rise, Coastal Flooding and Erosion *(High Impact Hazard)*					
1, 2, 3, 4, 6, 11, 13, 14, 15	Food, Water, Shelter; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-051 [MEDIUM Priority]: State Agency Adaptation Planning—Assess vulnerability of State assets to sea-level rise and develop adaptation strategies to address potential impacts by updating the 2019 vulnerability assessment.					
Responsible Agencies: Caltrans					
Hazards Mitigated: Sea-Level Rise, Coastal Flooding and Erosion *(High Impact Hazard)*					
1, 2, 3, 4, 6, 11, 13, 14, 15	Food, Water, Shelter; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing
Action 2018-052 [MEDIUM Priority]: San Francisco Bay Conservation and Development Commission (BCDC) Climate Change Planning Program—Provide scientific information and planning resources to Bay Area local jurisdictions to support robust mitigation plans and actions.					
Responsible Agencies: Bay Conservation and Development District, Coastal Commission					
Hazards Mitigated: Sea-Level Rise, Coastal Flooding and Erosion *(High Impact Hazard)*					
1, 2, 3, 4, 6, 11, 13, 14, 15	Food, Water, Shelter; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing
Action 2018-054 [MEDIUM Priority]: Reducing Tsunami Hazards and Risks—Support and provide matching funds for development of improved technologies and methodologies to assess, mitigate, and recover from tsunami risk including the following improved models and products for tsunami mitigation: ▪ Tsunami Hazard Zone maps ▪ Tsunami Hazard Engineering Subzone maps ▪ Guidance documents for implementing the Seismic Hazards Mapping Act ▪ Guidance to mitigate and recover from hazards in harbors and communities					
Responsible Agencies: CGS, Cal OES					
Hazards Mitigated: Tsunami and Seiche *(Medium Impact Hazard)*					
1, 3, 14, 15	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Medium	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-055 [MEDIUM Priority]: Understanding and Utilizing Tsunami Probability—Improve the understanding of tsunami hazards in California through coordinated research and apply these products to land-use and construction mitigation practices.					
Responsible Agencies: CGS, Cal OES					
Hazards Mitigated: Tsunami and Seiche *(Medium Impact Hazard)*					
1, 3, 14	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Medium	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing
Action 2018-056 [MEDIUM Priority]: Tsunami Mitigation and Preparedness Planning—Continue tsunami preparedness activities and develop loss estimation models to compute potential impacts from tsunamis with a partnership between the Cal OES Tsunami Program and the California Geological Survey Tsunami Program as modeling and technology capabilities improve. ▪ Provide site-specific harbor and pier improvements, engineering recommendations, and cost-benefit assessments. ▪ Develop planning and technical assistance resources to support tsunami evacuation planning. ▪ Continue ongoing outreach and preparedness efforts.					
Responsible Agencies: CGS, Cal OES, State and Local Jurisdictions, SLC					
Hazards Mitigated: Tsunami and Seiche *(Medium Impact Hazard)*					
1, 3, 14, 15	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Medium	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing
Action 2018-059 [HIGH Priority]: Delta Levees Program—Provide funding to local agencies in the Sacramento-San Joaquin region for levee maintenance and improvement and for habitat mitigation and enhancement.					
Responsible Agencies: DWR					
Hazards Mitigated: Levee Failure *(Medium Impact Hazard)*					
1, 3, 4, 5, 15	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	High	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-062 [HIGH Priority]: Ensure dam safety by: ▪ Reviewing and approving dam enlargements, repairs, alterations, and removals to ensure that the dam's appurtenant structures are designed to meet minimum requirements. ▪ Performing independent analyses to understand dam and appurtenant structure performance. ▪ Overseeing construction to ensure work is done in accordance with approved plans and specifications. ▪ Inspecting dams that are significant hazard or higher every year and low hazard dams every two years to ensure they are safe, performing as intended, and not developing issues. ▪ Reviewing and approving inundation maps for dams and their appurtenances that are incorporated into Emergency Action Plans (EAPs). ▪ Periodically reviewing the stability of dams and their major appurtenances considering improved design approaches and requirements, as well as new findings regarding earthquake hazards and hydrologic estimates in California.					
Responsible Agencies: DSOD					
Hazards Mitigated: Dam Failure *(Medium Impact Hazard)*					
1, 3, 5, 6, 10, 12, 13, 14	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP), HHPD grants	Ongoing
Action 2018-063 [MEDIUM Priority]: EAPs—Review and approve EAPs for State jurisdictional dams with a DSOD hazard classification of significant, high, or extremely high. Inundation maps and EAPs are created by dam owners and the inundation maps are reviewed and approved by DSOD.					
Responsible Agencies: Cal OES					
Hazards Mitigated: Dam Failure *(Medium Impact Hazard)*					
1, 3, 5, 6, 10, 12, 13, 14	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP), HHPD grants	Long-term

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-064 [HIGH Priority]: Legislation for Local Wildfire Hazard Planning—Incorporate wildfire hazards into development and land use planning as stated in California Government Code 65302(g)(3) 66474.02. and the California Environmental Quality Act (CEQA).					
Responsible Agencies: CAL FIRE, OPR, HCD					
Hazards Mitigated: Wildfire *(High Impact Hazard)*					
1, 2, 3, 4, 5, 6, 13, 14	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, HMGP Post Fire)	Ongoing
Action 2018-065 [HIGH Priority]: Fire Hazard Severity Zones—Map areas of significant fire hazards based on fuels, terrain, weather, and other relevant factors to define the application of various mitigation strategies for reducing risk, in accordance with Public Resource Code 4203(a) and Government Code 51178. ▪ Review and adopt 2023 State Responsibility Areas ▪ Transmit recommendations to local jurisdictions for local adoption in 2023					
Responsible Agencies: CAL FIRE					
Hazards Mitigated: Wildfire *(High Impact Hazard)*					
1, 2, 3, 4, 5, 6, 13, 14	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, HMGP Post Fire)	Short-term

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-068 [HIGH Priority]: Fire Safe Councils—increased awareness, knowledge, and actions implemented by individuals and communities to reduce human loss and property damage from wildland fires, such as defensible space, fire prevention and fire safe building standards by partnership between CAL FIRE and California Fire Safe Council to direct award funding for: ▪ Defensible space around individual homes ▪ County coordinators to ensure communication across stakeholders for funding opportunities and strategic work					
Responsible Agencies: CAL FIRE, California Fire Safe Council					
Hazards Mitigated: Wildfire *(High Impact Hazard)*					
1, 2, 3, 4, 5, 6, 7, 8, 13, 14	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, HMGP Post Fire)	Ongoing
Action 2018-069 [MEDIUM Priority]: Post-Event Assessment—Leverage existing capabilities to conduct post-event assessments to prioritize natural resource recovery, including watershed protection, reforestation, and ecosystem restoration.					
Responsible Agencies: Cal OES, State Departments and Agencies					
Hazards Mitigated: All hazards					
1, 2, 3, 4, 5, 6, 10, 13, 16	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, FMA)	Ongoing
Action 2018-070 [MEDIUM Priority]: Community Wildfire Protection Plans—Identify hazardous fuel reduction treatment priorities, recommend measures to reduce structural ignitability and address issues such as wildfire response, hazard mitigation, community preparedness and structure protection.					
Responsible Agencies: CAL FIRE, public fire agencies, community residents					
Hazards Mitigated: Wildfire *(High Impact Hazard)*					
1, 2, 3, 4, 5, 6, 10, 13, 14	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, HMGP Post Fire)	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-071 [MEDIUM Priority]: Initiatives and Technology—Mitigate the spread of invasive pests through education by the following outreach programs: ▪ "Buy It Where You Burn It—Don't Move Firewood" ▪ Invasive Species Council of California and related California Invasive Species Advisory Committee programs ▪ "Don't Pack a Pest"					
Responsible Agencies: CDFA					
Hazards Mitigated: Invasive and Nuisance Species *(Medium Impact Hazard)*					
1, 3, 5, 6, 10, 13, 16	Food, Water, Shelter	New and Existing	Low	State Budget	Ongoing
Action 2018-072 [MEDIUM Priority]: Air Quality/Pollution Monitoring—Maintain "CalEnviroScreen" mapping tool.					
Responsible Agencies: OEHHA, CDPH					
Hazards Mitigated: Air Pollution *(High Impact Hazard)*					
3, 5, 10, 12	None	New and Existing	Low	State Budget, EPA	Ongoing
Action 2018-073 [MEDIUM Priority]: Air Pollution Planning—Incorporate environmental justice into general plans.					
Responsible Agencies: OPR, Cities and Counties					
Hazards Mitigated: Air Pollution *(High Impact Hazard)*					
1, 5, 6, 7, 8, 9	None	New and Existing	Low	State Budget, EPA	Ongoing
Action 2018-074 [MEDIUM Priority]: Marine Invasive Species Act—Reduce the introduction of invasive species transported through vessel ballast water by continuing to enforce: ▪ Required Ballast Water Management Reports ▪ Regulations to manage biofouling					
Responsible Agencies: SLC					
Hazards Mitigated: Invasive and Nuisance Species *(Medium Impact Hazard)*					
3, 5	None	New and Existing	Low	State Budget	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-075 [MEDIUM Priority]: State Water Efficiency and Enhancement Program—Reduce agricultural water usage through installation of more efficient irrigation practices.					
Responsible Agencies: CDFA, DWR, Water Boards					
Hazards Mitigated: Drought *(Medium Impact Hazard)*					
11, 13	Food, Water, Shelter	New and Existing	Low	State Budget	Ongoing
Action 2018-077 [MEDIUM Priority]: Groundwater Management Plan—Strengthen local control and management of groundwater basins through implementation of the Sustainable Groundwater Management Act for local jurisdictions with medium and high priority basins to develop groundwater sustainability plans.					
Responsible Agencies: DWR					
Hazards Mitigated: Drought *(Medium Impact Hazard)*; Riverine, Stream and Alluvial Flood *(High Impact Hazard)*					
1, 2, 5, 6, 11, 13	Food, Water, Shelter	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, FMA)	Ongoing
Action 2018-078 [MEDIUM Priority]: Local Stormwater Management—Capture stormwater and redirect it for groundwater recharge, which will offset increased groundwater use during drought years.					
Responsible Agencies: County of Los Angeles					
Hazards Mitigated: Drought *(Medium Impact Hazard)*; Riverine, Stream and Alluvial Flood *(High Impact Hazard)*					
1, 2, 5, 6, 11, 13	Food, Water, Shelter	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, FMA)	Ongoing
Action 2018-079 [MEDIUM Priority]: California Drought Contingency Plan—Minimize drought impacts by improving agency coordination and enhancing monitoring and early warning capabilities.					
Responsible Agencies: DWR					
Hazards Mitigated: Drought *(Medium Impact Hazard)*					
1, 2, 5, 6, 11, 13	Food, Water, Shelter	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-081 [MEDIUM Priority]: Safe Drinking Water Plan for California—Assess the overall quality of the State's drinking water, identify problems, and recommend improvements.					
Responsible Agencies: Water Boards					
Hazards Mitigated: Drought *(Medium Impact Hazard)*					
1, 2, 5	Food, Water, Shelter	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing
Action 2018-082 [MEDIUM Priority]: Existing Buildings Energy Efficiency Action Plan—Double the energy efficiency savings of existing buildings by 2030 by: ▪ Harnessing emerging technologies ▪ Developing progressing program designs ▪ Promoting innovative market solutions ▪ Establishing efficiency policies, regulations, and financial opportunities					
Responsible Agencies: CEC					
Hazards Mitigated: Energy Shortage *(Medium Impact Hazard)*; Public Safety Power Shutoff (PSPS) *(High Impact Hazard)*					
1, 4, 11, 13, 14	Energy	New and Existing	Low	State Budget	Ongoing
Action 2018-083 [MEDIUM Priority]: Regional Energy-Savings Efforts—Implement effective energy saving programs on a regional basis to support climate mitigation efforts and energy resilience.					
Responsible Agencies: CPUC, Association of Bay Area Governments					
Hazards Mitigated: Energy Shortage *(Medium Impact Hazard)*					
1, 4, 11, 13, 14	Energy	New and Existing	Low	State Budget	Short-term

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-086 [MEDIUM Priority]: Clean Energy Progress Tracking—CEC's tracking progress reports provide a comprehensive assessment of California's progress toward a global clean energy future. The reports cover a range of sectors, providing information, metrics, and resources. Tracking is an ongoing capability that includes the following indicators: ▪ Energy efficiency ▪ Statewide energy demand ▪ Zero-emission vehicles ▪ Reliance on coal, renewable energy, and once-through cooling					
Responsible Agencies: CEC					
Hazards Mitigated: Energy Shortage *(Medium Impact Hazard)*					
1, 2, 4, 11, 13	Energy	New and Existing	Low	State Budget	Ongoing
Action 2018-088 [MEDIUM Priority]: Improve energy efficiency in K-12 schools by building on actions taken under the California Clean Energy Jobs Act as future programs and funding become available.					
Responsible Agencies: CEC, CPUC					
Hazards Mitigated: Energy Shortage *(Medium Impact Hazard)*					
1, 4, 11, 13, 14	Energy	New and Existing	Low	State Budget	Ongoing
Action 2018-090 [MEDIUM Priority]: Extreme Heat Vulnerability—Identify areas of the State most vulnerable to climate impacts by promoting the California Heat Assessment Tool. This tool allows planners, policymakers, public health practitioners, and community members to understand heat vulnerability driven by climate change and take action to mitigate the public health threat of extreme heat.					
Responsible Agencies: CNRA					
Hazards Mitigated: Extreme Heat *(High Impact Hazard)*					
1, 2, 3, 4, 11, 13	Health and Medical	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-091 [MEDIUM Priority]: Extreme Heat Vulnerability—Identify vulnerable populations (e.g., people experiencing homelessness, lower-income households, older adults) by continuing to engage stakeholders and provide updates in the Climate Change and Health Equity Program.					
Responsible Agencies: CDPH, HCD					
Hazards Mitigated: Extreme Heat *(High Impact Hazard)*					
1, 2, 3, 4, 7, 8, 9	Health and Medical	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Short
Action 2018-097 [MEDIUM Priority]: Refinery Safety—Improve public and worker safety through enhanced oversight of refineries and strengthen emergency preparedness					
Responsible Agencies: Cal OES, Cal/OSHA					
Hazards Mitigated: Hazardous Materials Release *(Low Impact Hazard)*					
3, 14	Hazardous Material	New and Existing	Low	State Budget	Ongoing
Action 2018-098 [MEDIUM Priority]: Oil Spill Planning—Prevent and mitigate the effects of oil spills impacting both land and water environments by: ▪ Enforcing requirements for SLC to develop regulatory requirements to identify systemic risks at marine oil terminals ▪ Enforcing industry oil spill contingency planning, drills, exercises, and updated staff qualification for incident command systems positions ▪ Performing vessel risk assessments, boardings, and participation in Harbor Safety Committees ▪ Pursuing oil spill prevention activities					
Responsible Agencies: OSPR, SLC, CalGEM, OSFM-Pipeline Safety Division					
Hazards Mitigated: Oil Spills *(Low Impact Hazard)*					
3, 14	Hazardous Material	New and Existing	Low	State Budget	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-100 [MEDIUM Priority]: Rail Safety—Examine and assess rail safety concerns related to the transport of crude oil.					
Responsible Agencies: Cal OES					
Hazards Mitigated: Transportation Accidents Resulting in Explosions or Toxic Releases					
3, 14	Hazardous Material	New and Existing	Low	State Budget	Ongoing
Action 2018-102 [MEDIUM Priority]: Homeland Security Strategy—Reduce the impact of human-made disaster events through a coordinated effort of capacity-building for State and local agencies.					
Responsible Agencies: Cal OES					
Hazards Mitigated: Terrorism *(High Impact Hazard)*					
3	Safety & Security	New and Existing	Low	State Budget, Homeland Security Grants	Ongoing
Action 2018-103 [MEDIUM Priority]: Homeland Security Grant Programs—Prioritize and allocate federal funding resources to support California's Homeland Security Strategy.					
Responsible Agencies: Cal OES					
Hazards Mitigated: Terrorism *(High Impact Hazard)*					
3	Safety & Security	New and Existing	Low	State Budget, Homeland Security Grants	Ongoing
Action 2018-105 [MEDIUM Priority]: Annual Vulnerability Assessments—Coordinate 35 vulnerability assessments each calendar year.					
Responsible Agencies: CDT					
Hazards Mitigated: Cyber Threats *(Medium Impact Hazard)*					
1, 3, 5	Safety & Security	New and Existing	Low	State Budget, Homeland Security Grants	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-106 [MEDIUM Priority]: Security Audit Program—Measure the effectiveness of security policies and guidelines.					
Responsible Agencies: CDT					
Hazards Mitigated: Cyber Threats *(Medium Impact Hazard)*					
1, 3, 5	Safety & Security	New and Existing	Low	State Budget, Homeland Security Grants	Ongoing
Action 2018-108 [MEDIUM Priority]: Cyber Security Integration Center & Task Force—Reduce the likelihood and severity of cyber incidents that could damage the economy, critical infrastructure, or public and private sector computer networks, through State agency coordination.					
Responsible Agencies: Cal OES					
Hazards Mitigated: Cyber Threats *(Medium Impact Hazard)*					
1, 3, 5	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, Homeland Security Grants	Ongoing
Action 2018-109 [MEDIUM Priority]: Protecting Critical Power Grid Infrastructure—Protect power grid integration from cyber threats through ongoing coordination with the California Cybersecurity Integration Center (Cal-CSIC) and the statewide cyber security task force.					
Responsible Agencies: CPUC					
Hazards Mitigated: Cyber Threats *(Medium Impact Hazard)*					
1, 3, 5	Safety & Security; Energy	New and Existing	Low	State Budget, Homeland Security Grants	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-110 [MEDIUM Priority]: Planning and Technical Assistance—Identify and communicate with local governments to promote local hazard evaluation and mitigation planning and to assist in developing and updating LHMPs. Increase the number of LHMPs in the State through enhanced planning and technical assistance.					
Responsible Agencies: Cal OES					
Hazards Mitigated: All hazards					
1, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 16	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, FMA); HHPD grants	Ongoing
Action 2018-111 [MEDIUM Priority]: Technical Assistance—Provide technical assistance, guidance, resources, and tools to local governments for all aspects of local hazard mitigation planning and action implementation.					
Responsible Agencies: Cal OES					
Hazards Mitigated: All hazards					
1, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 16	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, FMA); HHPD grants	Ongoing
Action 2018-113 [MEDIUM Priority]: Integration of Local and State Mitigation Efforts—Encourage local jurisdictions to take advantage of the financial benefits stated in Government Code Sections 8685.9 and 65302.6 either by creating an integrated LHMP/safety element or by adopting the LHMP as an annex to the Safety Element.					
Responsible Agencies: Cal OES, OPR					
Hazards Mitigated: All hazards					
1, 5, 6, 12, 15	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, FMA)	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-114 [HIGH Priority]: Integration of Local and State Mitigation Efforts—Prepare resource materials to assist local governments in achieving consistency with other hazard mitigation and land use plans and to comply with State legislative requirements.					
Responsible Agencies: Cal OES, OPR, DWR, CDPH, CARB, OPC, CNRA, CEC, Coastal Commission, OSFM, CAL FIRE, BOF					
Hazards Mitigated: All hazards					
1, 3, 5, 6, 12, 15	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, FMA)	Ongoing

Table 47-2. 2023 SHMP Mitigation Action Priority

Action	Criteria																Priority
	Life Safety	Property Protection	Cost-Effective	Technically Feasible	Legal Authority	Funding Available	Environmental	Climate Change	Equity Priority Community	Administrative Capacity	Multi-Hazard	Timeline	Local Champion	Other Local Objectives	Support Policies	Total Score	
2023-001	1	1	3	3	3	3	3	3	3	3	0	0	3	3	3	**35**	High
2023-002	1	1	3	3	3	1	0	0	1	1	0	0	3	3	3	**23**	Medium
2023-003	1	1	3	3	3	1	0	0	3	1	0	0	1	1	3	**21**	Medium
2023-004	1	1	3	3	3	1	0	0	3	1	0	0	1	3	3	**23**	Medium
2023-005	1	1	1	3	3	1	3	3	3	1	3	0	1	1	1	**26**	Medium
2023-006	3	3	1	3	3	3	0	3	3	3	3	0	3	3	3	**37**	High
2023-007	3	3	3	3	3	3	0	0	3	3	0	0	3	3	3	**33**	High
2023-008	3	3	3	3	3	3	0	0	3	3	0	0	3	3	3	**33**	High
2023-009	3	3	3	3	3	1	3	3	3	3	3	0	3	3	3	**40**	High
2023-010	3	3	3	3	3	1	3	3	3	3	3	0	3	3	3	**40**	High
2023-011	1	1	3	3	3	1	3	3	3	0	3	0	3	3	3	**33**	High
2023-012	3	3	3	3	3	3	3	3	3	1	3	0	3	3	3	**40**	High
2023-013	3	3	3	3	3	1	3	0	3	1	0	1	1	3	3	**31**	High
2023-014	1	3	3	3	3	3	1	1	3	3	0	3	3	1	3	**34**	High
2023-015	1	1	3	3	3	3	1	1	1	1	3	3	3	1	1	**29**	Medium
2023-016	1	3	3	3	3	3	1	1	1	1	3	3	3	1	1	**31**	High
2023-017	3	3	3	3	3	3	1	1	1	3	0	3	3	3	3	**36**	High
2023-018	3	3	3	3	3	3	1	1	1	3	0	3	3	3	3	**36**	High
2023-019	3	1	1	3	3	1	1	3	3	3	0	3	3	3	3	**34**	High
2023-020	3	1	3	3	3	3	1	3	3	3	0	3	3	3	3	**38**	High
2023-021	3	1	1	3	3	1	1	3	3	3	0	3	3	3	3	**34**	High

Action	Criteria																Priority
	Life Safety	Property Protection	Cost-Effective	Technically Feasible	Legal Authority	Funding Available	Environmental	Climate Change	Equity Priority Community	Administrative Capacity	Multi-Hazard	Timeline	Local Champion	Other Local Objectives	Support Policies	Total Score	
2018-001	1	1	3	3	3	3	3	3	3	3	3	0	3	1	3	**40**	High
2018-002	1	1	3	3	3	3	3	3	3	3	3	0	3	1	3	**36**	High
2018-003	1	1	3	3	3	3	3	3	3	3	3	0	3	3	3	**38**	High
2018-005	1	1	3	3	3	3	3	3	1	3	3	0	1	3	3	**34**	High
2018-006	0	0	1	3	3	1	1	1	1	1	3	0	3	3	3	**24**	Medium
2018-007	0	0	1	3	3	3	1	1	1	3	3	0	3	1	3	**26**	Medium
2018-008	0	0	1	3	3	1	1	1	1	1	3	0	3	3	3	**24**	Medium
2018-009	0	0	1	1	3	3	3	3	1	1	3	3	3	3	3	**31**	High
2018-010	0	0	1	1	3	1	3	3	3	1	3	0	3	3	3	**28**	Medium
2018-011	0	0	1	3	3	1	3	3	0	1	3	0	3	1	3	**25**	Medium
2018-012	3	1	1	3	3	1	0	3	3	1	3	3	3	3	3	**34**	High
2018-013	0	0	1	3	3	1	1	3	0	1	3	0	3	3	3	**25**	Medium
2018-014	0	0	1	3	3	1	1	3	0	1	3	0	3	3	3	**25**	Medium
2018-015	0	0	1	3	3	1	1	3	0	1	3	0	3	3	3	**25**	Medium
2018-017	1	1	3	3	3	1	0	0	3	1	0	0	3	3	3	**25**	Medium
2018-019	1	1	3	3	3	1	0	0	3	1	0	3	3	3	3	**28**	Medium
2018-020	1	1	3	3	3	1	0	0	3	1	0	0	3	3	3	**25**	Medium
2018-021	1	1	3	3	3	1	0	0	3	1	0	0	3	1	3	**23**	Medium
2018-023	1	1	3	3	3	1	0	0	3	1	0	3	3	3	3	**28**	Medium
2018-027	3	3	3	3	3	1	0	0	0	1	0	0	3	3	3	**26**	Medium
2018-029	3	3	3	3	3	1	0	0	3	1	0	0	3	3	3	**29**	Medium
2018-030	3	3	3	3	3	3	0	0	3	1	0	0	3	3	3	**31**	High

Action	Criteria															Priority
	Life Safety	Property Protection	Cost-Effective	Technically Feasible	Legal Authority	Funding Available	Environmental	Climate Change	Equity Priority Community	Administrative Capacity	Multi-Hazard	Timeline	Local Champion	Other Local Objectives	Support Policies	Total Score	
2018-033	3	3	3	3	3	1	0	0	3	1	0	0	3	3	3	**29**	Medium
2018-036	1	0	3	3	3	1	0	0	3	1	0	0	3	1	1	**20**	Medium
2018-037	1	1	3	3	3	1	0	0	1	1	0	0	3	1	3	**21**	Medium
2018-038	3	3	3	3	3	1	0	0	3	1	0	0	3	1	3	**27**	Medium
2018-039	3	3	3	3	3	1	0	0	3	1	0	0	3	1	3	**27**	Medium
2018-040	1	1	3	3	3	1	3	3	3	1	0	0	3	1	3	**29**	Medium
2018-041	1	1	3	3	3	1	3	3	3	1	0	0	3	1	3	**29**	Medium
2018-042	1	1	3	3	3	1	3	3	3	1	0	0	3	1	3	**29**	Medium
2018-045	1	1	3	3	3	1	3	3	3	1	0	0	3	1	3	**29**	Medium
2018-046	1	1	3	3	3	1	3	3	3	1	0	0	3	1	3	**29**	Medium
2018-047	1	1	3	3	3	1	3	3	3	1	0	0	3	1	3	**29**	Medium
2018-048	0	0	1	3	3	1	3	3	3	1	3	0	3	3	3	**30**	Medium
2018-049	3	3	3	3	3	3	3	3	3	1	3	0	1	3	3	**38**	High
2018-050	0	1	1	1	3	1	3	3	3	1	3	0	1	3	3	**27**	Medium
2018-051	0	1	1	1	3	1	3	3	3	1	3	0	1	3	3	**27**	Medium
2018-052	0	0	1	3	3	1	1	3	3	1	3	0	3	3	3	**28**	Medium
2018-054	1	1	1	3	3	1	1	3	3	1	3	0	3	3	3	**28**	Medium
2018-055	1	1	1	3	3	1	1	3	3	1	3	0	3	3	3	**28**	Medium
2018-056	1	1	1	3	3	1	1	3	3	1	3	0	3	3	3	**28**	Medium
2018-059	1	1	1	3	3	3	3	3	3	1	3	0	3	3	3	**32**	High
2018-062	3	3	3	3	3	3	3	3	3	1	0	0	3	3	3	**37**	High
2018-063	1	1	3	3	3	1	1	3	3	1	0	0	3	3	3	**29**	Medium

Action	Criteria															Priority
	Life Safety	Property Protection	Cost-Effective	Technically Feasible	Legal Authority	Funding Available	Environmental	Climate Change	Equity Priority Community	Administrative Capacity	Multi-Hazard	Timeline	Local Champion	Other Local Objectives	Support Policies	Total Score	
2018-064	1	3	3	3	3	1	3	3	3	1	0	0	3	3	3	**33**	High
2018-065	0	3	3	3	3	1	3	3	3	1	0	0	3	3	3	**32**	High
2018-068	0	3	3	3	3	1	3	3	3	1	0	0	3	3	3	**32**	High
2018-069	0	1	3	3	3	1	3	3	3	1	0	0	3	3	3	**30**	Medium
2018-070	0	1	3	3	3	1	3	3	3	1	0	0	3	3	3	**30**	Medium
2018-071	0	0	1	3	3	1	3	3	0	1	0	0	3	3	3	**24**	Medium
2018-072	0	0	1	3	3	1	3	1	3	1	0	0	3	3	3	**25**	Medium
2018-073	0	0	1	3	3	1	3	1	3	1	0	0	3	3	3	**25**	Medium
2018-074	0	0	1	3	3	1	3	3	0	1	0	0	3	3	3	**24**	Medium
2018-075	0	0	1	3	3	1	1	3	1	1	0	0	3	3	3	**23**	Medium
2018-077	0	0	1	3	3	1	1	3	1	1	3	0	3	3	3	**26**	Medium
2018-078	0	0	1	3	3	1	1	3	1	1	3	0	3	3	3	**26**	Medium
2018-079	0	0	1	3	3	1	1	3	1	1	0	0	3	3	3	**23**	Medium
2018-081	0	0	1	3	3	1	1	3	1	1	0	0	3	3	3	**23**	Medium
2018-082	0	0	1	3	3	1	1	3	1	1	0	0	3	3	3	**23**	Medium
2018-083	0	0	1	3	3	1	1	3	1	1	0	0	3	3	3	**23**	Medium
2018-086	0	0	1	3	3	1	1	3	1	1	0	0	3	3	3	**23**	Medium
2018-088	0	0	1	3	3	1	1	3	1	1	0	0	3	3	3	**23**	Medium
2018-090	0	0	1	3	3	1	1	3	1	1	0	0	3	3	3	**23**	Medium
2018-091	0	0	1	3	3	1	1	3	3	1	0	0	3	3	3	**25**	Medium
2018-097	3	0	1	3	3	1	0	0	0	1	0	3	3	1	3	**22**	Medium
2018-098	0	0	1	3	3	1	3	0	0	1	0	3	3	1	3	**22**	Medium

Action	Criteria															Priority
	Life Safety	Property Protection	Cost-Effective	Technically Feasible	Legal Authority	Funding Available	Environmental	Climate Change	Equity Priority Community	Administrative Capacity	Multi-Hazard	Timeline	Local Champion	Other Local Objectives	Support Policies	Total Score	
2018-100	0	0	3	3	3	1	1	0	0	1	0	0	3	3	3	**21**	Medium
2018-102	1	1	3	3	3	1	0	0	1	1	0	0	3	3	3	**23**	Medium
2018-103	1	1	3	3	3	1	0	0	1	1	0	0	3	3	3	**23**	Medium
2018-105	1	3	3	3	3	1	0	0	1	1	0	0	3	3	3	**25**	Medium
2018-106	1	1	3	3	3	1	0	0	1	1	0	0	3	3	3	**21**	Medium
2018-108	1	3	3	3	3	1	0	0	1	1	0	0	3	3	3	**25**	Medium
2018-109	1	3	3	3	3	1	0	0	3	1	0	0	3	3	3	**27**	Medium
2018-110	1	1	3	3	3	3	1	1	1	1	3	0	3	3	3	**30**	Medium
2018-111	1	1	3	3	3	3	1	1	1	1	3	0	3	3	3	**30**	Medium
2018-113	1	1	3	3	3	3	1	1	1	1	3	0	3	3	3	**30**	Medium
2018-114	1	1	3	3	3	3	1	3	1	1	3	0	3	3	3	**32**	High

Weighted responses:
Yes = 3 points; Not sure, could be either yes or no, or question is difficult to quantify = 1 point; No = 0 points
Total score:
31 or more = High Priority; 15-30 = Medium Priority; 0-14 = Low Priority

48. PUTTING THE PLAN INTO ACTION

The Cal OES Hazard Mitigation Planning Division oversees maintenance and updates of the SHMP. The process is a collaborative partnership with numerous stakeholders from local, Tribal Nation, regional, State, and federal government agencies, community-based organizations, academic institutions, and other non-governmental entities. The SHMP is a living document that must remain relevant to guide the implementation of mitigation actions, reduce risk from future hazard events, and build statewide resilience. A system for monitoring, evaluating, and updating the actions and content of the SHMP is critical to ensuring that the Plan remains on course. The following sections support and document the State's ongoing efforts to monitor, evaluate, and update the SHMP during its five-year life cycle.

48.1. ADOPTION

S19 – 44 CFR 201.4(c)(6): Did the state provide documentation that the plan has been formally adopted?
Cal OES formally adopted the plan on August 23, 2023. On September 7, 2023, FEMA Region 9 notified Cal OES that the SHMP was formally approved on August 30, 2023.

Adoption of the SHMP signifies the State's commitment to implementing a mitigation strategy that will guide hazard mitigation and resilience efforts over the next five years.

The Cal OES Director, acting as the Governor's designated official, formally adopts the SHMP as required by 44 CFR 201.4(c)(6). On August 23, 2023 the Cal OES Director adopted the SHMP after receiving "Approvable Pending Adoption" status from FEMA on July 24, 3034. The adoption resolution was submitted to FEMA, and FEMA provided full approval of the SHMP on September 7, 2023, making the SHMP effective as of August 30, 2023.

Copies of the adoption resolution and FEMA approval letter, documenting the successful completion of the update of the SHMP, are included after the executive summary at the front of this document.

48.2. IMPLEMENTING, MONITORING, AND REVIEWING MITIGATION ACTIONS

S17 – 44 CFR 201.4(c)(5)(i) and 201.4(d): Is there a description of the method and schedule for keeping the plan current?
Sections 48.2 and 48.3 outline the process Cal OES will use to monitor, evaluate, and update the plan, including the schedule for these activities.

Standard 4.1.3: The Emergency Management Program has a maintenance process for its Hazard Identification and Risk Assessment identified in Standard 4.1.1 and the Consequence Analysis identified in Standard 4.1.2, which includes a method and schedule for evaluation and revision.
The monitoring, maintenance, and update plan for the 2023 SHMP are detailed in Sections 48.2 and 48.3.

Standard 4.2.3: The Emergency Management Program has a process to monitor the overall progress of the mitigation activities and documents completed initiatives and their resulting reduction or limitation of hazard impact on the jurisdiction.
Sections 48.2.2 and 48.2.3 address opportunities for reviewing progress during the SHMP implementation process.

A mitigation action implementation plan establishes continuous tracking of recommended mitigation actions. This tracking enables the State to document the progress being made toward the SHMP's goals and objectives.

An implementation plan serves as a catalyst to implementing mitigation actions by ensuring that stakeholders and implementing agencies are engaged in the SHMP implementation process. The implementing agencies participated in the identification and development of mitigation actions to foster interagency support and accountability. Once actions were established, the planning process evaluated the potential implementation costs, timeframe, and funding sources. Completing these steps better ensures that mitigation actions will be implemented, making the SHMP an actionable plan.

48.2.1. Outreach to Agencies and Stakeholders

Monitoring the implementation of mitigation actions may include periodic reporting and site visits, regular contact and communication with responsible agencies, and stakeholder forums to discuss the status of actions, successes, and challenges.

48.2.2. Agency and Stakeholder Quarterly Reports

Monitoring also includes collecting quarterly reports from local, State, federal, and non-governmental partners. These reports document partners' mitigation activities relating to integrated planning, federal grant program project implementation, leadership initiatives, and laws, among other areas.

Quarterly reports on the implementation of mitigation actions document partners' activities as they relate to SHMP Enhanced Elements E6: Integrated Planning and E7: Mitigation Capabilities. These elements were E2 and E3, respectively, prior to April 2023.

48.2.3. System for Reviewing Progress

S18 – 44 CFR 201.4(c)(5)(ii) and 201.4(c)(5)(iii): Does the plan describe the systems for monitoring implementation and reviewing progress?
Section 48.2.3 describes the system California will use to track implementation and progress of the mitigation strategy.

To review progress on achieving the mitigation goals, objectives, and strategies for the SHMP, Cal OES will deploy a Mitigation Action Status Report. Mitigation actions will be tracked independently by the responsible implementing agency, who will share the status of actions with Cal OES to ensure that this information is included in annual reviews of the mitigation action plan. Responsible agencies will provide a mitigation action status report to Cal OES annually. The mitigation action status report will document the annual actions taken toward implementing a mitigation action. An example of the fields for the mitigation action status report is provided in Figure 48-1.

Figure 48-1. Example Content for Mitigation Action Status Report

Action Number:	
Mitigation Action Title:	
Timeframe/Deadline:	
Objectives:	
Responsible Agency:	
Agency Position Title:	
Action to be Taken:	
Year 1	
Year 2	
Year 3	
Year 4	
Year 5	
Status	
Summary of Completed Actions	

Under the approach to goal setting employed for this SHMP (see Chapter 0), objectives are the focal point for progress reporting since they help establish priorities for actions. Each objective has been mapped to the goals it will address. The progress reporting system established by Cal OES asks each agency with responsibility for mitigation actions to review the objectives identified for each action to determine a need for a change in priority.

This reporting system will build on the external partner reports that Cal OES collects quarterly. Whereas the quarterly reports document partner agencies' mitigation activities overall, this annual reporting mechanism will connect these activities to specific mitigation actions identified in the SHMP. This will enable Cal OES to better track the progress of achieving the recommended mitigation actions throughout the life cycle of the SHMP. This will also help partner agencies to identify mitigation actions for future SHMP updates to address gaps encountered in their mitigation activities.

48.3. MONITORING, EVALUATING, AND UPDATING THE PLAN

Standard 4.2.5: The Emergency Management Program has a maintenance process for the plan identified in Standard 4.2.1, which includes a method and schedule for evaluation and revision.
The process for monitoring, maintaining, and updating the SHMP is inclusive of the process for updating the Hazard Identification and Risk Assessment and Consequence Analysis, described previously in Section 48.2. The process to monitor, evaluate, and update the SHMP can be found in 48.3.

Updates provide the opportunity to ensure that the SHMP remains on course and current. Reviewing the SHMP regularly allows for it to be continuously informed by advances in hazard knowledge, changes in State and federal legislation, and performance of mitigation projects during hazard events. Actively monitoring, evaluating, and updating the SHMP maintains the relationships and partnerships established during the Plan update process and maintains stakeholder engagement in mitigation initiatives. In addition to the quarterly reports on mitigation activities, Cal OES will monitor, evaluate, and consider updates to the SHMP as appropriate on an annual basis using a mitigation action reporting form and review meeting schedule.

The SHMP planning team uses and updates a State agency responsibility matrix that identifies all relevant State agencies, the agencies' functions, and relevant legislation that contributes to each agency's responsibilities. This matrix can be used as a tool to assess agencies' capacity to support implementation of SHMP goals and objectives.

48.3.1. Quarterly Reviews

The planning process will continue in a cycle after the completion, adoption, and approval of the SHMP. To maintain internal coordination and integration, Cal OES Hazard Mitigation staff will meet on a quarterly basis to review progress of implementation and maintenance task status. Additionally, these meetings should include an evaluation of FEMA Review Guide element requirements and discussions to address any current feedback from FEMA.

48.3.2. Annual Meetings

An annual meeting will be held at which SHMP stakeholders will provide updates on mitigation actions and discuss changes in legislation, priorities, and other capabilities that should be incorporated into the plan update. During the annual review, Cal OES will identify any obstacles and opportunities to further strengthen identified mitigation actions. The focus of each year's meeting will depend on issues identified by the Cal OES team and raised by planning and implementation partners.

Potential focus areas could include the following:

- Overview and progress on the SHMP
- Mitigation actions and goals tracking
- Updates to data and policies
- Partner progress updates
- Stakeholder roles and responsibilities
- Identification of new partners to include

Annual meeting proceedings will document the following:

- Review of mitigation action status
- Confirm additional meetings, if necessary
- Update the milestone schedule as necessary

48.3.3. Maintenance Milestone Schedule

Table 48-1 provides an example five-year maintenance milestone schedule for activities that are a priority for documenting and updating data included in the SHMP to increase the efficacy of future updates. This schedule, based on the milestone schedule from the 2018 SHMP, is a general example that can be used when developing specific milestone schedules for future SHMP updates. Updates to the milestone schedule will be added as an appendix to the SHMP.

Table 48-1. SHMP Milestone Schedule Five-Year Cycle

Period	Action
Year 1: State Hazard Mitigation Plan is approved; new five-year update cycle begins	
1st Quarter (July – September)	Implementation and Progress Tracking ▪ Cal OES will engage stakeholders and request mitigation action status reports for each action from the respective lead agency ▪ Cal OES will review and compile the status reports to distribute to all stakeholders to maintain visibility on the progress of implementing the SHMP
2nd Quarter (October – December)	Annual SHMP Progress Meeting ▪ Cal OES will convene stakeholders to complete a review the SHMP
3rd Quarter (January – March)	Cal OES will distribute summary report of annual meeting
Year 2	
1st Quarter (July – September)	Implementation and Progress Tracking ▪ Cal OES will engage stakeholders and request mitigation action status reports for each action from the respective lead agency ▪ Cal OES will review and compile the status reports to distribute to all stakeholders to maintain visibility on the progress of implementing the SHMP
2nd Quarter (October – December)	Annual SHMP Progress Meeting ▪ Cal OES will convene stakeholders to complete a review the SHMP
3rd Quarter (January – March)	Cal OES will distribute summary report of annual meeting
Year 3	
1st Quarter (July – September)	Implementation and Progress Tracking ▪ Cal OES will engage stakeholders and request mitigation action status reports for each action from the respective lead agency ▪ Cal OES will review and compile the status reports to distribute to all stakeholders to maintain visibility on the progress of implementing the SHMP Begin process to identify funding and resources for SHMP update
2nd Quarter (October – December)	Annual SHMP Progress Meeting ▪ Cal OES will convene stakeholders to complete a review the SHMP
3rd Quarter (January – March)	Cal OES will distribute summary report of annual meeting

Period	Action
4th Quarter (April – June)	SHMP Project Kickoff Meeting ▪ Reassess SHMP goals/objectives and strategies ▪ Confirm mission/vision ▪ Review and confirm hazards to be addressed in SHMP, determine any additional hazards to be added (short discussion) ▪ Request each State agency to review their related info ▪ Review progress reports from approved SHMP Geographic Information Systems (GIS) Technical Assistance Working Committee (GIS-TAWC) Meeting ▪ Review previous vulnerability assessment: consider if it should be updated or replaced ▪ Review master list of maps and determine: 1) maps to add, 2) maps to delete, 3) existing map information/GIS layers that need to be updated ▪ Review and discuss potential updates/changes to MyPlan and MyHazards Additional Strategic Working Group Meetings ▪ Establish and reconvene additional working groups
Year 4	
1st Quarter (July – September)	Preparation of internal review draft
2nd Quarter (October – December)	Review and revisions for administrative draft Preparation of public comment draft
3rd Quarter (January – March)	Public comment period Preparation of FEMA review draft
4th Quarter (April – June)	Cal OES delivers FEMA review draft to Region 9 to initiate 45-day formal comment period. (FEMA review may take longer than 45 days, so extra time is built into these dates.)
Year 5	
1st Quarter (July – September)	Cal OES Director approves and adopts finalized SHMP FEMA Region 9 review and approval of SHMP
Begin new five-year cycle	

48.3.4. Ad Hoc Reviews

The need for ad hoc reviews outside of the milestone schedule may arise during the Plan's five-year life cycle. These ad hoc reviews may be prompted by a disaster, the availability of updated data that would significantly impact the Risk Assessment, or completion of major risk reduction activities that substantially reduce the vulnerability of the State.

48.4. ASSURANCES

S20 – 44 CFR 201.4(c)(7): Did the State provide assurances?
Section 48. 4 includes assurances that California will manage and administer FEMA funding in accordance with applicable federal statutes and regulations, and that the SHMP will be updated whenever necessary to reflect changes in federal laws and statutes.

In accordance with 44 CFR 201.4(c)(7), the State assures that it will manage and administer FEMA funding and comply with all applicable federal statutes and regulations in effect with respect to the periods for which the State receives grant funding. These efforts will comply with the following:

- 2 CFR Part 200—Office of Management and Budget Guidance: Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards
- 2 CFR Part 3002—Department of Homeland Security adoption of the Office of Management and Budget Guidance listed in 2 CFR Part 200, giving regulatory effect to the guidance and supplementing the guidance as needed for the Department of Homeland Security

The State also assures that it will amend the California SHMP as required by 44 CFR 201.4(c)(7) to reflect changes in State or federal statutes and regulations.

The SHMP assurances were reviewed and updated for the 2023 SHMP.

Part 6—Enhanced State Plan Requirements

Cal OES
GOVERNOR'S OFFICE
OF EMERGENCY SERVICES

Standard 4.2.4: The Emergency Management Program, consistent with the scope of the mitigation program does the following:

- **Identifies ongoing mitigation opportunities and tracks repetitive loss**
- **Provides technical assistance in implementing mitigation codes and ordinances**
- **Participates in jurisdictional and multi-jurisdictional mitigation efforts**

California's status as an Enhanced Hazard Mitigation Plan state, as described in the chapters within Part 6 of this SHMP, lends itself to robust interagency coordination and aggressive risk reduction efforts. The State's capabilities include an active NFIP program and widespread community participation in the CRS program to aid in tracking repetitive loss and identifying opportunities for further minimization of the risk. The State's capabilities and efforts aimed at reducing vulnerability and building resilience are described throughout the 2023 State Hazard Mitigation Plan.

49. What is an Enhanced State Hazard Mitigation Plan?

E1 – 44 CFR Section 201.5(b): Does the Enhanced Plan include all elements of the Standard state mitigation plan?
The 2023 SHMP meets all the elements of a Standard state hazard mitigation plan, per FEMA Region 9's review.

A Federal Emergency Management Agency (FEMA)-approved Enhanced state hazard mitigation plan demonstrates a state's sustained, proven commitment to hazard mitigation. An Enhanced Plan recognizes current and ongoing proactive efforts in implementing a comprehensive mitigation program. Enhanced status acknowledges the coordinated effort the state is taking to reduce losses from natural hazards, protect life and property, and create safer and more resilient communities. Approval of an Enhanced state hazard mitigation plan results in eligibility for increased funding under the Hazard Mitigation Grant Program (HMGP).

An Enhanced Plan must meet the Standard state hazard mitigation plan minimum requirements outlined in 44 CFR 201.4 and demonstrate a comprehensive and coordinated mitigation program statewide. California's Enhanced State Hazard Mitigation Plan (Enhanced Plan) showcases the integration of State hazard mitigation efforts into other State, regional, and FEMA initiatives to build resilience and protect life, property, the environment, and community lifelines. Examples of this integration with other hazard mitigation and resilience planning efforts may be found in Chapter 51.

This part of the 2023 State Hazard Mitigation Plan (SHMP or Plan) documents California's day-to-day statewide mitigation and resilience activities that meet the requirements for an Enhanced designation, including the administrative requirements and coordination efforts. Additional information regarding Enhanced State capabilities is detailed in Chapter 46. The maintenance of the State's capabilities and its ongoing planning and implementation efforts are key elements of California's commitment to hazard mitigation.

49.1. PURPOSE OF ENHANCED STATE HAZARD MITIGATION PLANNING

To receive Enhanced status, a state must approach hazard mitigation and resilience from a comprehensive perspective. The SHMP serves as a consolidated repository to document operational functions that are required for the State to receive an Enhanced designation. An Enhanced SHMP documents statewide mitigation and resilience activities and efforts. States with Enhanced SHMP status receive an additional 5 percent in HMGP funds following disasters. This results in a combined 20 percent of the total estimated eligible Stafford Act assistance, rather than the 15 percent provided for states with Standard hazard mitigation plans. This funding is critical to carrying out hazard mitigation efforts and fulfilling the mission to protect people, the environment, property, and community lifelines. In 2021, California had an estimated $485 million available in HMGP funding—$24 million more than if the State did not have an Enhanced SHMP. Since 2018, California has been awarded $1.6 billion in HMGP and HMGP-Post Fire funding, $409 million more than if the State did not have an Enhanced SHMP.

49.2. REQUIREMENTS

In addition to meeting the requirements for a Standard Plan, 44 CFR 201.5 details the additional requirements that must be met for Enhanced Plans. States with Enhanced Plans must demonstrate that the responsibility for reducing risk is shared across state agencies and departments. Risk reduction efforts must be prioritized in state actions and efforts. States must demonstrate their commitment to mitigation by establishing their own funding sources and seeking resources and funding from entities in addition to FEMA. The state must also demonstrate that the capacity and capability exist to sustain these actions through the state and to support local governments in building resilience and implementing hazard mitigation efforts.

Additionally, the state must demonstrate that planning efforts are integrated across disciplines. The hazard mitigation plan should incorporate recommendations and data from the state's comprehensive, growth management, economic development, land development, and emergency management plans. In turn, these planning documents should integrate information and principles from the state hazard mitigation plan.

The state must demonstrate the ability to effectively manage and implement mitigation activities. This includes:

- Establishing eligibility criteria for reviewing grant applications
- Determining cost effectiveness
- Complying with grant program guidelines and timeframes
- Maintaining the capability to submit complete, accurate grant applications, including benefit-cost analyses and environmental and historic preservation (EHP) reviews
- Maintaining the capability to submit complete and accurate progress and financial reports

In addition to demonstrating that grant programs can be administered effectively, the state must show efforts that adequately support local jurisdictions in carrying out hazard mitigation planning initiatives and implementing mitigation actions. This may include establishing a technical assistance program consisting of workshops, training, and job aids, or providing state resources to meet a portion of the non-federal match for federal grant programs.

These factors together form a comprehensive hazard mitigation approach. By adopting a comprehensive approach, the state demonstrates that hazard mitigation is a fundamental priority for the state. Guided by this priority, the state's agencies and departments should promote and encourage risk reduction activities, such as adopting risk-reducing building codes, establishing metrics to measure the effectiveness of mitigation actions, developing resilience-supporting legislation and policies, and making risk-informed decisions about development and growth.

49.3. THE ENHANCED STATE PLAN FOR CALIFORNIA

The California Governor's Office of Emergency Services (Cal OES) develops and maintains the SHMP, which describes mitigation efforts within Cal OES's purview and those of partners across the State. The Plan's development process demonstrates the comprehensive and multi-disciplinary nature of the State's hazard mitigation efforts by engaging more than 150 partners throughout California. This engagement results in active participation by State, federal, local, and non-governmental partners, which allows for more effective implementation of mitigation actions and Enhanced resilience benefits for California communities.

The SHMP demonstrates California's commitment to long-term risk reduction and increased resilience by showing the collaboration and coordination among government and non-governmental partners, as well as the State's skilled administration of federal and State mitigation programs. As hazard risks to California's people, property, and environment evolve over time, the State actively works to build its capacity, capabilities, and resources to increase resilience across the State. The following sections detail these efforts to expand beyond the minimum required hazard mitigation initiatives, and additional efforts to prioritize climate resilience and equity throughout the State's mitigation activities.

50. GRANT MANAGEMENT PERFORMANCE

This chapter details Cal OES's grant management process for the Hazard Mitigation Assistance (HMA) programs in accordance with the Enhanced Plan requirements. It further outlines Cal OES's process for ensuring compliance with State and federal statutes and programmatic guidance. Cal OES meets all Enhanced Plan requirements for program administration, including adherence to time frames, collaboration, environmental reviews, benefit-cost analysis (BCA), reporting, and closeouts.

50.1. HMA APPLICATION TIME FRAMES

E2 – 44 CFR Section 201.5(b)(2)(iii)(A): Regarding Hazard Mitigation Assistance (HMA), is the state maintaining the capability to meet application time frames and submitting complete project applications?
Cal OES actively submits completed subapplications within application submission deadlines and requests time extensions as needed ahead of deadlines, as noted in Section 50.1

Application timelines for FEMA and State funding depend on when the funding is announced or becomes available. California receives HMA funding through the HMGP following a presidentially declared major disaster. Thus, the timeline for this program is consequently unpredictable and not tied to annual cycles. Other programs within the HMA portfolio, including Building Resilient Infrastructure and Communities (BRIC) and Flood Mitigation Assistance (FMA), are available annually as determined by FEMA, and funding amounts vary.

This section describes timelines for federal HMA programs. State mitigation program timelines and funding amounts are dependent on legislation. The continuation or update of these programs is dependent on further legislative action.

Cal OES develops timelines for FEMA funding opportunities based on several factors, starting with the application due dates set by the funding agency. The timeline for each funding cycle accounts for sub-application development and review. Major milestones include release of a notice of funding opportunity (NOFO), the submission of notices of interest, sub-application submission, preparation of the overall application package, and submission of the application by Cal OES—as the applicant—to FEMA.

What is a Sub-Application?

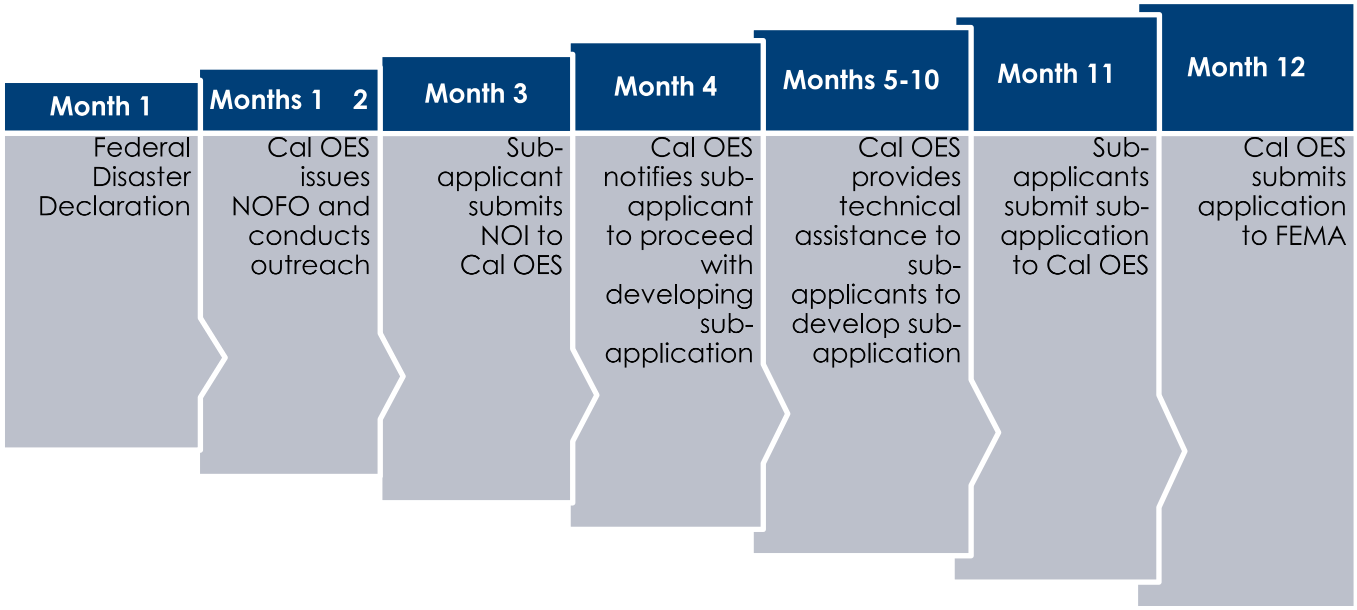
Some federal grant programs limit direct applications for funding to states, territories, and federally recognized Tribal Nations. Funds for such programs may be available to other entities, such as local governments or non-profit organizations, through a sub-application. In such cases, the sub-applicant applies to the state, territory, or Tribal Nation for a portion of the federal funding available, and the state, territory, or Tribal Nation applies for and receives the federal funds to be distributed to the sub-applicant.

50.1.1. HMGP Funding

Figure 50-1 shows the general timeline for HMGP funding. The HMGP application period officially opens on the date of a Presidential Disaster Declaration. At that stage, Cal OES—as the applicant—begins to develop a NOFO to announce the State's timeline and priorities. Cal OES must submit an application to FEMA within one year of the declaration date, with the possibility of two 90-day time extensions.

Cal OES's notice of interest (NOI) submission deadline for sub-applicants is set to allow for program outreach to inform eligible jurisdictions of the NOFO and provide support for NOI submission. An approved NOI secures an eligible sub-applicant an invitation to submit a sub-application. After sub-applications are submitted, Cal OES reviews the sub-applications and works closely with sub-applicants through a robust technical assistance and request for information (RFI) process to prepare sub-applications for submission to FEMA. Cal OES then prepares the application package and submits full and complete sub-applications to FEMA by FEMA's stated deadline.

Figure 50-1. HMGP Funding Timeline



50.1.2. HMGP Post Fire Funding

The HMGP Post Fire application period opens at the start of the federal fiscal year (October 1), and the funding amount is determined by the number of Fire Management Assistance Grants (FMAGs) awarded in the State the previous fiscal year. The application must be submitted to FEMA by March 31 of the following year, with the possibility of two 90-day time extensions. Cal OES sets an NOI submission date typically two months after the end of the fiscal year, with a sub-application due date two months later. Cal OES then submits the application package to FEMA by the required deadline.

50.1.3. BRIC and FMA Funding

The BRIC program replaced the Pre-Disaster Mitigation program in 2020. FEMA's annual application period for both BRIC and FMA is in August with applications due in January. Just as with HMGP, Cal OES establishes a timeline to allow for outreach, technical assistance, NOI, and sub-application development. Historically, the NOI submission was six to eight weeks after FEMA's NOFO, with another two to three months for sub-application support and review. Cal OES prepares and submits the application package to FEMA by the due date established in FEMA's NOFO.

50.1.4. New Programs

For new programs such as the Revolving Loan Fund, Legislative Pre-Disaster Mitigation, or any future programs, Cal OES follows a similar process to meet FEMA's submission deadline. The NOI submission is typically six to eight weeks after FEMA's NOFO, with another two to three months for sub-application support and review.

50.2. CAL OES OUTREACH AND TECHNICAL ASSISTANCE

Once a NOFO is released by FEMA or Cal OES, Cal OES publicizes the funding opportunity via several means, including the Cal OES website, email distribution, and direct outreach. Cal OES utilizes evolving technology and best practices for outreach to advance engagement processes to ensure maximum effectiveness of available communication modalities.

The State delivers technical assistance in the form of workshops, meetings, webinars, one-on-one meetings, and other means as appropriate to build capacity for State agencies, local governments, Tribal Nations, and other eligible entities to develop grant sub-applications. Topics include:

- Overview of the funding opportunity and general eligibility
- Program requirements (eligibility, feasibility, and cost-effectiveness)
- How to apply using the current tools or platforms
- Specific project eligibility
- Optimizing quantitative and qualitative scoring, for the nationally competitive programs

Cal OES strives to ensure that all sub-applicants receive sufficient technical support and resources to successfully apply for and compete for funding on the State and national stage.

50.3. HMA SUB-APPLICATIONS

The first stage of sub-application development is the submission of an NOI. Instructions are found on the Cal OES website. Cal OES accepts NOIs year-round to build a pipeline of projects and to provide ongoing guidance and technical assistance to potential sub-applicants. The NOI consists of a brief summary of the hazard, problem, proposed solution, and estimated cost and timeline for the project.

Interested entities complete the NOI and submit it to Cal OES via the prescribed method—currently the Engage Cal OES Portal. Cal OES reviews the NOIs before inviting entities to submit sub-applications. As deemed necessary, Cal OES will schedule a meeting with a sub-applicant at the time of NOI submission to clarify the proposed project or to aid in sub-application development. NOIs are approved or denied based on eligibility (Cal OES 2022j). Approval of NOIs is based on the eligibility of both sub-applicant and the proposed mitigation activities in accordance FEMA's HMA guidance.

Cal OES provides technical assistance to sub-applicants to support their drafting of eligible, feasible, and cost-effective proposals that align with FEMA's HMA guidance and State and local priorities. Project proposals must consist of independent and long-term mitigation solutions that will reduce risk to people, property, and the environment as their primary benefit. Additionally, Cal OES strongly encourages the submission of projects that achieve multiple benefits. Prior to submission to FEMA, Cal OES may issue a RFI to sub-applicants for clarification of project goals, feasibility, cost effectiveness, and environmental compliance. Incomplete or untimely responses to requests for information may render project proposals ineligible.

Sub-applications are submitted in Cal OES's application package via a variety of web-based platforms, depending on the HMA funding source:

- FEMA GO for BRIC and FMA
- e-Grants for Legislative Pre-Disaster Mitigation
- National Emergency Management Information System and Cal OES Engage Portal for HMGP and HMGP Post Fire

Upon submission of full and complete sub-applications, Cal OES prioritizes and selects sub-applications to submit to FEMA that align with the with the State's mitigation and resilience priorities. For each submitted sub-application, Cal OES completes and submits a Minimum Criteria Checklist or equivalent document to FEMA. Sub-applications not selected may be retained by Cal OES for future consideration if funding becomes available.

FEMA reviews the submitted sub-applications for programmatic and EHP compliance prior to obligating funds. If FEMA identifies information that is missing or needs clarification, Cal OES collaborates with FEMA and the sub-applicant to obtain and provide necessary documentation. Within 90 days of FEMA submission or selection for further review for non-disaster programs, Cal OES provides requested information to ensure the application is completed per FEMA's requirements.

To further facilitate collaboration, Cal OES supplies FEMA with an organizational chart and a listing of Cal OES staff assigned to each sub-application and sub-award. Cal OES maintains a regularly checked email inbox for general correspondence and continuity for FEMA, other partners, sub-applicants, and sub-recipients.

50.4. ENVIRONMENTAL REVIEWS AND BENEFIT-COST ANALYSES

E3 – 44 CFR Section 201.5(b)(2)(iii)(B): Regarding HMA, is the state maintaining the capability to prepare and submit accurate environmental reviews and benefit-cost analyses?
Section 50.4 outlines Cal OES' ability to complete environmental reviews and benefit-cost analyses that align with FEMA requirements.

The EHP review and BCA are required critical components of the sub-application to ensure that projects do not have adverse environmental or cultural impacts and are cost-effective. To ensure that the State maintains capability to aid sub-applicants and effectively review the EHP and BCA components, Cal OES Hazard Mitigation Grant Specialists complete training for EHP and BCA through the Emergency Management Institute and other resources. If funding eligibility and sub-application workload exceed Cal OES's capability to provide technical assistance for BCA or EHP compliance, Cal OES may surge staff through contract mechanisms.

Cal OES requires sub-applicants to submit FEMA's EHP checklist with every sub-application. Cal OES provides one-on-one assistance, as necessary, to discuss eligibility, feasibility, and cost-effectiveness with a validated and well-documented BCA. If FEMA identifies deficiencies in EHP or BCA information, Cal OES collaborates with FEMA and the sub-applicant to obtain necessary documentation within deadlines set by FEMA.

50.5. QUARTERLY REPORTING

E4 – 44 CFR Section 201.5(b)(2)(iii)(C): Regarding HMA, is the state maintaining the capability to submit complete and accurate quarterly progress and financial reports on time?
Section 50.5 outlines Cal OES quarterly report duties.

Cal OES monitors all sub-awards to reduce the risk of non-compliance and audit findings. Every three months, sub-applicants and Cal OES complete quarterly reporting to provide the status of programmatic and financial tasks, provide the current budget, and discuss any issues with the implementation or management of a project. Cal OES complies with Financial Management Standards described in 2 Code of Federal Regulations (CFR) 200.300 to 200.309 (Subpart D) by setting expectations for sub-recipients through webinars, sub-award kickoff meetings, and informal communications prior to and during grant award life cycles. Cal OES confirms compliance by conducting formal site visits, quarterly performance reviews, quarterly financial reviews, and detailed sub-award closeout. Cal OES continuously refines and improves these processes based on lessons learned and best-practices.

Cal OES Grant Specialists review sub-recipients' quarterly reports for accuracy, completeness, procurement compliance, and sub-award progress against the approved scope of work, schedule, and budget. All sub-award reports are compiled and conveyed to FEMA timely. The Federal Financial Report (form SF-425) is submitted on time to FEMA on a quarterly basis. Every quarter, and at closeout, Cal OES produces an accounting report for each award and submits it timely in e-Grants and FEMA GO, as required.

Additional financial monitoring may occur in instances where Cal OES provides a mechanism for non-federal entities to request advanced funds, provided the non-federal entity can manage and account for the advanced payments. Advances are limited to the minimum necessary and timed in accordance with actual, immediate cash requirements of the non-federal entity for the purpose of the award. The non-federal entity must request the advance from Cal OES, including a cost estimate and anticipated burn rate over the period.

50.6. PROJECT COMPLETION

E5 – 44 CFR Section 201.5(b)(2)(iii)(D): Regarding HMA, is the state maintaining the capability to complete HMA projects within established performance periods, including financial reconciliation?
Section 50.6 outlines project completion and closeout steps/paperwork that Cal OES works with subapplicants to complete within allowable timeframes to remain in compliance with HMA requirements.

In addition to coordinating with the sub-recipient on quarterly reports, Cal OES confirms project timelines with the sub-recipient about six months prior to the end of the sub-award period of performance. Cal OES's steps for project closeout prioritize completing and closing projects in a timely manner to remain in compliance with HMA requirements. Cal OES completes a review of actual expenditures to ensure documentation and consistency with Federal Financial Reporting forms SF-424A or SF-424C. All grant closeout activities, including financial reconciliation, are completed within 120 days from the end of the performance period as outlined in 2 CFR 200.344.

In order to ensure all FEMA requirements are met for sub-award closeout, Cal OES uses a check list including, but not limited to, the following:

- Final claim form
- Project accomplishments and results statement
- Project budget summary
- Sub-recipient management costs budget summary
- Inspection report
- Planned maintenance activities statement
- Project photographs/materials
- Final reimbursement requests

If the project requires additional time for completion, Cal OES coordinates with the subrecipient to request a period-of-performance extension. The request must explain why the project is delayed and provide a clear plan for project completion within the requested time extension.

After a thorough and layered review, a time extension or the sub-award closeout package is sent to FEMA in accordance with the HMA guidance.

51. Integrated Planning

E6 – 44 CFR Section 201.5(b)(1): Does the plan demonstrate integration (to the extent practicable) with other state and/or regional planning initiatives and FEMA mitigation programs and initiatives?
Chapter 51 outlines all of the aspects of the plan that detail plan integration and alignment with other planning mechanisms and programs. These opportunities for alignment help ensure that California has a comprehensive statewide mitigation program.

Mitigation plan implementation is most effective when planning efforts are integrated and coordinated with other State and federal programs and initiatives. Under 44 CFR Section 201.5(b)(1), a state must detail how its hazard mitigation plan is specifically integrated into other State, regional, and FEMA initiatives. California's hazard mitigation efforts are more integrated in 2023 than any other time in its history. The integration of mitigation into other programs and progress on 2018 SHMP actions relating to collaborative planning are discussed further in Chapter 46: Capability Assessment, Part 5: Mitigation Strategy, and Appendix N: Plan Integration.

Chapter 1 presents the general legal, institutional, and policy framework that integrates mitigation practice in California. It also summarizes integration of the SHMP with other planning, emergency management, and climate adaptation efforts. Section 1.2.2 discusses coordination among agencies including sector specific coordination.

Chapters 2 and 3 examine the complex relationships involving California's disaster history, growth factors exacerbating hazards and risk, development trends, vulnerable populations, and new statewide climate change mitigation and adaptation planning initiatives.

Chapters 4 through 40 present multiple statewide, regional, and local hazard mitigation programs, strategies, and projects addressing specific natural, human-caused, and technological hazards. These chapters incorporate the data, knowledge, and findings from other planning efforts throughout the State. In addition, these chapters include selected projects to highlight how mitigation principles have been put into action to reduce risk.

Chapter 44 discusses State mitigation goals and objectives. Mitigation actions are detailed in Chapter 47 and emphasize horizontal coordination between State agencies and the private sector, as well as vertical coordination among federal, State, and local agencies. Chapter 46 assesses the State's capabilities across multiple agencies to carry forward mitigation goals and objectives and implement mitigation actions.

The following sections address integration with other planning initiatives by providing information on multiple dimensions, including legislative, policy, State agency, and financial, and by offering examples of how these dimensions are being manifested in day-to-day action.

SHMP Goals

Some of the discussions in this chapter refer by number to the goals established for this SHMP. The wording of these goals is provided below for quick reference.

- Goal 1—Significantly reduce risk to life, community lifelines, the environment, property, and infrastructure by planning and implementing whole-community risk reduction and resilience strategies.
- Goal 2—Build capacity and capabilities to increase disaster resilience among historically underserved populations, individuals with access and functional needs, and communities disproportionately impacted by disasters and climate change.
- Goal 3—Incorporate equity metrics, tools, and strategies into all mitigation planning, policy, funding, outreach, and implementation efforts.
- Goal 4—Apply the best available science and authoritative data to design, implement, and prioritize projects that enhance resilience to natural hazards and climate change impacts.
- Goal 5—Integrate mitigation principles into laws, regulations, policies, and guidance to support equitable outcomes to benefit the whole community.
- Goal 6— Significantly reduce barriers to timely, efficient, and effective hazard mitigation planning and action.

51.1. INTEGRATION WITH LEGISLATION AND POLICY

California's substantial body of work relating to hazards has grown over the past several decades. California has an extensive landscape of climate mitigation and adaptation policies that support the goals outlined in the SHMP and enhance the State's efforts to build resilience to future hazard events. California passed Assembly Bill (AB) 32, the California Global Warming Solutions Act, in 2006. AB 32 required California to reduce greenhouse gas (GHG) emissions to 2000 levels by 2010, 1990 levels by 2020, and 80 percent of 1990 levels by 2050. The California Air Resources Board (CARB) was tasked with setting emission standards to reduce GHG emissions. This was the first program in the country to take a strong stance on climate change, demonstrating California's commitment to climate adaptation.

As one method to reduce GHG emissions, California used the revolutionary cap-and-trade program, in which GHG emissions are capped by the State and the cap decrease every year. Emitters can buy, sell, and trade their allotments. This program decreased GHG emissions and brought in revenue for the State. The funds are deposited in the Greenhouse Gas Reduction Fund. Funds are distributed to groups that advance environmental health, human health, economic health, and equity goals that are core to the SHMP. Through this program and fund, California is leading the way on climate adaptation policy and forwarding mitigation goals.

Multiple policies and regulations reduce California's reliance on fossil fuels and reduce GHG emissions. For example, an Executive Order (2022) affirmed a proposed rule by CARB to ban the sale of non-electric cars by 2035. AB 1020 (2022), named the "100% Clean Electric Grid Bill," states that California's energy consumption will be 90 percent green by 2035, and 100 percent green by 2045. Shifting to renewable sources of energy is critical for slowing climate change and mitigating the risks posed by climate change. Clean energy will contribute to creating a sustainable and resilient future.

AB 1320 (2020) tasked a collaborative of State agencies with writing the California Climate Change Assessment every 5 years. The project is led by the California Governor's Office of Planning and Research (OPR), with input from other State agencies, non-profits, and academia. The assessment will use state-of-the-art climate model predictions with California-specific data to predict local impacts of climate change. The Fifth Climate Change Assessment is being drafted and is expected to be completed in 2026. Understanding climate change and how to adapt at a fine spatial scale is important for understanding hazards in the State, so the assessment will be used to inform SHMP updates and local hazard mitigation plans (LHMPs). It also aligns directly with Goal 4 of the SHMP, which aims to actively promote climate-focused programs, policies, projects, and initiatives.

California has passed proactive mitigation-related legislation since the 2018 SHMP. Senate Bill (SB) 1076 (2018) anticipates the possibility of electromagnetic and geomagnetic threats and hazards, one of the hazards addressed in the 2023 SHMP. AB 747 (2019) requires local jurisdictions to identify evacuation routes as part of their emergency planning. AB 3074 (2020) updates the residential wildfire defensible space requirements to establish "ember resistance zones." AB 38 (2019) creates a pilot program to retrofit at-risk homes to proactively prepare against fires. Policies are being enacted in the executive branch as well. The Governor signed an Executive Order (2020) which set the goal of conserving at least 30 percent of the State's land and waters by 2030 to combat issues of biodiversity and climate change. All of these policies advance the aim of the SHMP, to prepare for hazards and have tools available to combat them when they arise.

Examples of legislative and executive-level mitigation integration include State-local and public-private sector integration initiatives. Cross-sector collaborations are an important component of the SHMP and a valuable mitigation tool. One example of a State-local integration initiative is SB 52 (2021), which outlines new requirements for small water suppliers, county governments, the California Department of Water Resources (DWR) and the State Water Resources Control Board to implement more proactive drought planning to better prepare for future water shortage events or dry years. Another example is SB 1425 (2022), which requires every city and county to review and update its local open-space plan by January 1, 2026. These updates must include plans and an action program addressing specified issues, including climate resilience and other co-benefits of open space. SB 63 (2021) directs the Office of the State Fire Marshal (OSFM) and the California Department of Housing and Community Development (HCD) to propose building standards for high fire hazard severity zones and to consider, if appropriate, standards for moderate severity zones. The bill also directs the California Building Standards Commission (CBSC) to adopt these standards.

Cross-sector collaborations are a critical component of the SHMP, and address Goals 1, 5, and 6, which aim to promote collaborations with local, non-profit, private, and other groups and Tribal Nations.

51.2. INTEGRATION WITH GOVERNMENTAL GROUPS

Supporting integration of hazard mitigation efforts in California began in 1991 with Governor's Executive Order W-9-91, which authorized the Cal OES Director to assign specific emergency support functions to State agencies through administrative orders. Federal, State, local, and non-governmental partners involved in the specific emergency support functions and recovery support functions have been incorporated into hazard mitigation planning, implementation, funding, and education efforts. This horizontal and vertical integration is an ongoing process in support of various 2023 SHMP Goals and Objectives. Goals 1, 4, and 5 specifically promote and encourage Plan integration across the State. These goals are further supported by objectives which call for cross-sector collaboration, data sharing, incorporation of climate change and equity considerations, and risk-informed policy and legislation.

As part of this ongoing process, California has increased State-level coordination through a modified stakeholder engagement process. For the 2018 SHMP, California utilized a State Hazard Mitigation Team consisting of horizontal and vertical stakeholder partners that met at least quarterly. For the 2023 SHMP, California adopted a Hazard and Working Group model. The Working Groups analyzed and counseled on overarching themes in the 2023 SHMP. The four Working Groups included: Goals and Objectives, Climate Impacts, Equity, and Geographic Information System (GIS) Technical Assistance. The Hazard Groups analyzed the hazard-specific content and provided recommendations for updates. These groups corresponded with the four hazard chapters in the 2018 SHMP: Seismic Hazards, Flood Hazards, Fire Hazards, and Other Hazards. Partners in these groups included stakeholders from federal, State, local, non-profit, private sector, academic, and Tribal Nations. For more information on the 2023 SHMP Planning Process, please refer to Section 1.2. For the roster of stakeholders involved in the Hazard and Working Groups, please refer to Appendix D.

51.2.1. Horizontal Integration

In addition to the SHMP planning process, various agency programs and actions bolster horizontal integration. Horizontal integration describes the coordinated efforts across State agencies and departments to bolster the State's hazard mitigation program. The bill also directs CBSC to adopt these standards. Coordination between State agencies on both planning and program implementation is critical to the ongoing success of California's Enhanced mitigation efforts.

California has undertaken a variety of multi-agency planning efforts since the 2018 SHMP that support the State's hazard mitigation goals. Cal OES has contributed to these efforts to ensure alignment with the SHMP. For example, in July 2022, OPR began the Fifth Climate Change Assessment, the Fourth Assessment having been completed in 2018-19. The Cal OES Hazard Mitigation Section and the Cal OES Science and Climate Advisor have consulted with OPR to determine what aspects and changes should be included in the Fifth Assessment and will continue to do so until the Assessment's approval. Cal OES and many other State agencies also contributed to California's Extreme Heat Action Plan to build resilience to extreme heat events. The Action Plan's goals include building public awareness and notification systems, strengthening community services and response, increasing resilience of the built environment, and utilizing nature-based solutions. All these goals are consistent with the SHMP's goals for building resilience. Information from the Action Plan was used in the development of the Extreme Heat chapter of this SHMP, and the common themes of public awareness and community response were used more broadly throughout the SHMP. The California Department of Transportation (Caltrans) has conducted statewide vulnerability assessments focusing on potential climate impacts and is working with Cal OES and other State partners to address identified stressors, including wildfire, flood, and seismic hazards.

Many of the project leads that developed these plans also participated in the SHMP Hazard and Working Groups during the 2023 SHMP update. Through this coordination, the State has ensured alignment between the various planning efforts. Many of the SHMP actions align with the goal of interagency collaboration and horizontal integration. For example, Action 2018-001 will support legislative efforts that formalize California's comprehensive mitigation program, and is a collaboration between Cal OES, the Delta Stewardship Council, California Department of Forestry and Fire Protection (CAL FIRE), OSFM, CARB, California Natural Resources Agency (CNRA), and OPR. Similarly, Actions 2018-010 and 2018-011 work with the California Strategic Growth Council (SGC), DWR, Cal OES, OPR, and CNRA to mitigate risks associated with climate change and maintain communication between organizations.

California has multiple agencies that are involved in mitigation planning and implementation. Cal OES hosts a monthly "State Partners" call with representatives of relevant State agencies to ensure the various planning and funding efforts are aligned. For example, through this regular coordination, Cal OES and HCD have successfully worked to leverage Community Development Block Grant (CDBG) funding to match some HMGP and Public Assistance (PA) projects for recently impacted communities. Cal OES also coordinates regularly with OPR, which has a Cooperative Technical Partnership grant with FEMA. Through this collaboration, Cal OES and OPR have worked together to identify State funding opportunities that could be used to match federal mitigation investments in an effort to create a pipeline of shovel-ready mitigation funds. Through this partnership, Cal OES also provided feedback on the development of a new grant program operated by OPR—the Adaptation Planning Grant Program—to align eligible activities within the program so that communities would be able to use this funding to prepare to apply for FEMA HMA dollars or create LHMPs. This type of interagency coordination is critical to the successful implementation of the State's comprehensive mitigation efforts.

Further examples of horizontal coordination can be found in Section 51.3.

51.2.2. Vertical Integration

Vertical integration describes efforts throughout the various levels of government that allow for cross-jurisdictional coordination. For example, a federal-funded, State-administered, local-delivered grant program is a type of vertical integration. In California, vertical integration is strengthened by the fact that most agencies engaged in hazard mitigation have long-established relationships with first responders, city managers, county administrative officers, and other local government entities. One example of vertical integration is CAL FIRE's Land Use Planning Program, which assists cities and counties throughout California as they address the risk from wildfire in State Responsibility Areas and Very High Fire Hazard Severity Zones in Local Responsibility Areas. Program staff work collaboratively with local governments and CAL FIRE Units assisting in planning for new development, satisfying California Government Code Section 65302(g)(3), drafting updated safety elements of general plans, completing Subdivision Review Surveys per Public Resources Code Section 4290.5, and obtaining recognition for local jurisdictions through the National Fire Protection Association's Firewise USA Program.

Ongoing agency integration efforts include implementation of task force recommendations, such as those from the California Wildfire and Forest Resiliency Task Force—which brings the best science to wildfire resilience and forest management—and the California Cybersecurity Task Force—which mitigates against online attacks. Both of these task forces support statewide partnerships comprising key State agency stakeholders, local jurisdictions, subject matter experts, private industries, and academia. Cal OES participates in these task forces to promote a hazard mitigation-informed approach to these efforts and to ensure alignment with the goals outlined in the SHMP. Furthermore, information from these task forces is subsequently incorporated into SHMP updates where appropriate. For example, Action 2018-006 calls for enhanced collaboration for the development and sharing of data systems and GIS modeling for risk assessments. Action 2018-108 calls for a reduction in the likelihood and severity of cyber incidents.

In partnership with CAL FIRE, the Cal OES Hazard Mitigation Section oversees the California Wildfire Mitigation Program to retrofit and create defensible space around homes in equity priority communities. This partnership was established through a joint powers agreement, which was authorized by AB 38 (2019). The demonstration projects for this program leverage federal, State, and local funding, and are administered by Cal OES but implemented on the ground by local partner agencies or non-government organizations within the communities. The vertical integration in this program creates a standardized approach to residential retrofits across the State while allowing for customization of the program by the local implementing entity to ensure the program aligns with local goals. The retrofit and defensible space methodology applied in the California Wildfire Mitigation Program was developed collaboratively with the scientific community, including the Institute for Business and Home Safety. The institute subsequently launched the complementary Wildfire Prepared Home program, a voluntary mitigation certification backed by the insurance industry that promotes residential retrofit and construction approaches that utilize the best available science to increase survivability of structures for wildfire.

Concurrently, the Safer from Wildfire Initiative, an interagency partnership between the California Department of Insurance (CDI) and State emergency response and readiness agencies, works to protect consumers by reducing wildfire risk in their communities with an analogous mitigation approach. The Safer from Wildfire Initiative is coordinating to make wildfire insurance available and affordable for all Californians by supporting mitigation actions. Cal OES and CAL FIRE participate in this effort to ensure the initiative aligns with the retrofit approach outlined in the California Wildfire Mitigation Program. These complementary efforts that vertically integrate through levels of government and with private and non-profit partners to support wildfire resilience are emblematic of California's comprehensive approach to mitigation.

Other vertical integration efforts include the development of planning alignment resources to guide local jurisdictions as well as the California Adaptation Planning Guide. These resources are developed through collaboration of State and federal agencies. One example is the Climate Resilience Plan Alignment Toolkit which includes a Guide Series providing planning resources relating to Wildfire, Flood-After-Fire, and

Coastal Resilience for local jurisdictions. The Coastal Resilience Guide is also referred to as the "Coastal Compass" Guide. These Guides were developed through collaborative efforts led by OPR. Contributors included State and federal agencies, local jurisdictions, regional governments, and non-governmental organizations (NGOs). The Guides were intended to assist communities in aligning various local and regional plans to promote climate resiliency and meet State planning requirements, including general plan safety elements, LHMPs, disaster recovery frameworks and plans, community wildfire protection plans, Local Coastal Programs (LCPs), and climate adaptation plans.

51.2.3. Hybrid Integration

Hybrid integration describes efforts across governmental organizations on the same level that also intersect with cross-jurisdictional coordination; this is a combination of horizontal and vertical integration. Cal OES's mitigation grants program review process leverages partnerships with State agencies to identify eligible mitigation projects for FEMA funding. OPR, through its FEMA Cooperative Technical Partnership Grants, partners with Cal OES to help align State climate resilience priorities with FEMA HMA funding requirements. Cal OES also partners with DWR and CAL FIRE to identify and prioritize local jurisdiction grant applications for FEMA funding. This type of collaboration and coordination supports horizontal integration by ensuring mitigation priorities and climate resilience goals are aligned across State agencies, and vertical integration by ensuring those same priorities and goals across local jurisdictions receiving funding.

For example, State mitigation grants are potentially available to help local agencies finance the preparation of inundation maps and dam safety emergency action plans (EAPs) under SB 92 (2017). The dam safety EAPs are required by SB 92 and are reviewed by Cal OES's Dam Safety Planning Division. Inundation maps approved by DWR's Division of Safety of Dams (DSOD), are integrated into these EAPs. To further this integration, Cal OES encourages jurisdictions with dams to identify the dam inundation areas in their LHMPs. Cal OES can then consider financing the identified mitigation projects through HMA grant programs. For more integration information, see Section 52.3.

State agencies also coordinate State and local review of applications for federal assistance under select programs that support resilience goals. OPR maintains a State Clearinghouse in compliance with Executive Order 12372 that functions as the "State Single Point of Contact" for coordinating these grant applications (OPR 2022b). In this capacity, the State Clearinghouse coordinates State and local review of federal financial assistance applications, federally required State plans, direct federal development activities, and federal environmental documents. When Cal OES applies for FEMA HMA funding, Cal OES submits the standard reporting forms to the State Clearinghouse. The purpose of the process is to allow State and local participation in federal activities occurring within California.

51.3. INTEGRATION WITH OTHER STATE AND REGIONAL INITIATIVES

Within California, there are many State programs and initiatives that foster integration and coordination for hazard mitigation planning and implementation. These programs and initiatives are summarized below with further details discussed in Chapter 45. Cal OES used the 2023 SHMP update process as an opportunity to further promote integration by adopting the Working and Hazard Group model. Compared to the previous State Hazard Mitigation Team model, the 2023 SHMP update process engaged a higher number of partners more consistently, leading to more robust data and information relating to the State's hazards, efforts underway to mitigate those hazards, and considerations regarding equity and climate. In addition, numerous plans were reviewed and integrated into the 2023 SHMP as documented in Chapter 51. The following sections highlight integration opportunities during the planning process as well as a sampling of plans that were integrated into the Risk Assessment.

51.3.1. Emergency Management

Mitigation has been formally recognized in State law since 1970 through the California Emergency Services Act, which noted the importance of coordinated emergency preparedness, response, recovery, and mitigation efforts. The 2017 update of the State Emergency Plan (SEP) acknowledges that understanding the potential severity and occurrence of natural hazard events is a major consideration in emergency management. Mitigation, then, is a prime tool integrated into the SEP for disaster risk reduction.

The Safeguarding California Plan, also called the California Climate Adaptation Strategy, establishes guiding principles informing the State's climate adaptation goals, actions, and metrics. The 2021 Update to the California Climate Adaptation Strategy embeds emergency management directly into the guiding principles. One of the priorities is "Bolster Public Health and Safety to Protect Against Increasing Climate Risks," which recognizes that climate-driven events including droughts, floods, extreme heat, wildfires, and sea-level rise pose a broad range of harms to health and safety.

Actions under this priority include:

- Integrating climate risk into emergency planning and response at the State, local, and regional level, and for Tribal Nations
- Promoting special considerations for critical infrastructure and facilities during planning processes to proactively ensure safety of coastal resources against coastal hazards, including sea-level rise
- Prioritizing investments that reduce climate risk to California's transportation system based on exposure and sensitivity analyses of climate change and natural disasters
- Increasing community-scale climate resiliency through innovative, research-supported emergency planning grants and projects, such as those that offer multiple co-benefits, are scalable at the regional level, and bring multiple funding sources or in-kind resources from private and public sector stakeholders

Mitigation is also integrated across several post-disaster recovery operations and plans to exceed the standard relationship between recovery and mitigation. These procedures are constantly evolving to integrate mitigation to the maximum extent possible. Recovery operations in California are conducted with a strong mitigation lens to promote equitable long-term resilience for communities as they rebuild. For example, Cal OES has invested substantial resources to maximize the use of the 406 PA Mitigation program after recent disaster events to ensure damaged infrastructure is rebuilt stronger. California further supports a "build back better" approach by similarly investing State funds in hardening public infrastructure damaged by a natural disaster through the California Disaster Assistance Act (CDAA). Additional examples of integration with post-disaster recovery operations and plans include the following:

- **State Emergency Plan—**The State of California Emergency Plan provides an overview of how to prepare for, mitigate, respond to, and recover from natural or human-caused emergencies in California. The SEP outlines how mitigation is integrated into other emergency management efforts within State operations.

- **Flood and Earthquake Catastrophic Plans**—These plans outline the State's response to catastrophic events. Planners involved in these efforts are integrated into the SHMP planning process to ensure the State prioritizes mitigation actions for critical facilities and other key assets to reduce losses in such an event.
- **California Earthquake Loss Reduction Plan—**The California Earthquake Loss Reduction Plan is devoted to developing a comprehensive post-earthquake economic recovery plan that will enable California to continue maintaining its economic vibrancy and leadership and provide employment and services for its residents. The plan supports California's approach to a mitigation–informed recovery process.
- **California Disaster Recovery Framework**—This framework establishes a State recovery coordination structure consistent with the federal model to facilitate the delivery of State and federal disaster assistance to impacted communities. The framework guides all disaster recoveries within the State. Crucially, it recognizes that hazard mitigation and disaster preparedness activities are keys to reducing the impact of disasters and reliance on mutual State or federal aid.
- **The Watershed and Debris Flow Task Force**—The Watershed and Debris Flow Task Force supports emergency and long-term mitigation for post-wildfire hazards. Areas impacted by wildfires are particularly prone to debris flows. Post-wildfire risk includes landslide, soil erosion, and water and soil contamination. The task force works to mitigate immediate risk of landslide and impacts on the water supply from burn scars. It also works to identify long-term mitigation activities that can be later funded under HMA programs to build long-term resiliency to post-wildfire hazards.
- **Recovery Support Teams**—Cal OES organizes Recovery Support Teams to assist impacted communities following disasters. These teams include subject matter experts from the major recovery programs, such as PA, Individual Assistance (IA), and Hazard Mitigation. These teams work closely with the communities to assist them in accessing all available funding to support their recovery. Mitigation team members assist communities in completing their LHMP, if necessary, and help to identify opportunities for hardening public infrastructure on the rebuild and pursuing HMA grants or other relevant mitigation funding for long-term risk reduction.

51.3.2. Economic Development

Many integrated State mitigation efforts minimize the disruption of economic activity following a disaster. One example is Outsmart Disaster, an awareness campaign from the California Office of the Small Business Advocate, focused on providing California businesses with resources to prepare for and recover from all types of disaster-related business interruptions. The campaign allows groups of businesses to request training workshops and links stakeholders to disaster management resources from Cal OES, CAL FIRE, Ready.Gov, National Safety Council, and the American Red Cross. Outsmart Disaster also provides the Resilient Business Challenge, which takes businesses through a five-step training to prepare for business interruptions and develop relevant resilience. Another example is the U.S. Chamber of Commerce Foundation's Disaster Help Desk for Business, which is available 24 hours a day for small businesses to call and get one-on-one expert assistance related to business disaster preparedness, response, and recovery.

Within Cal OES, the Office of Private Sector & Non-governmental Organization Coordination is an important link between the State and various economic development agencies. The purposes of the Cal OES Office of Private Sector & Non-governmental Organization Coordination are to design, coordinate, and implement statewide outreach programs to foster relationships with businesses, associations, companies, and universities, as well as non-profit, non-governmental, and philanthropic organizations. This Office works to maximize the inclusion and effective use of private sector, philanthropic, and NGO staff and resources in all phases of emergency management, including mitigation. After the initial response, disaster recovery becomes the focus of government resources. Private industry, working with government, can provide necessary help to Californians affected by the disaster through recovery assistance, rebuilding efforts, and volunteer services.

The Cal OES Office of Private Sector & NGO Coordination also operates the Business Operations Center, which organizes the synchronous exchange of information and resources between public and private sector organizations in mitigating against, preparing for, responding to, and recovering from disaster events. For more information about the Cal OES Office of Private Sector & NGO Coordination, visit https://www.caloes.ca.gov/office-of-the-director/policy-administration/private-ngo-coordination/.

The State administers the CDBG program to provide investments for community and economic development in many disadvantaged areas, and HCD has incorporated climate considerations into this program. HCD is administering over $70 million in federal funds from the National Disaster Resilience Competition to be invested in Tuolumne County for recovery from the 2013 Rim Fire, in partnership with other State, federal, and local partners (HCD 2022a). Cal OES is an integral partner with this initiative and meets with HCD monthly to discuss and evaluate opportunities to use these funds as a match for HMA grants. The goal of this program is to support rural economic development and environmental resilience through community, forestry and watershed health, and biomass utilization strategies.

51.3.3. Land Use Development

In California, general plans are required by State law for all municipalities and counties, and they must include a safety element. The safety element informs the land use element, allowing for integration for mitigation action within individual plans. All elements of a general plan, whether mandatory or optional, must be consistent with one another. California's updated 2017 General Plan Guidelines published by OPR include hazard identification requirements for general plan safety elements. In 2018, OPR updated the Wildfire Technical Advisory document pursuant to SB 901 (2018) and AB 2911 (2018). This update included "specific land use strategies to reduce fire risk to buildings, infrastructure, and communities." OPR completed these updates in consultation with CAL FIRE, the Board of Forestry and Fire Protection (BOF), and other fire and safety experts. Additionally, OPR released Environmental Justice Element guideline updates in 2020.

California uses a multi-agency review procedure in the land use development process. Various State agencies and local municipalities can be involved in hazard assessment and mitigation before development is permitted. For example, for approval of a hydraulic fracking permit, a county planning agency and the California Department of Conservation (DOC) Division of Oil, Gas, and Geothermal Resources are involved at a minimum. Depending on the permit location, the California State Water Resources Control Board may be involved in relation to aquifer protection, and the California Department of Toxic Substances Control (DTSC) and the CARB can conduct chemical hazards and air quality reviews, respectively. This multi-agency review procedure allows varied expertise and input to promote hazard reduction across disciplines.

The State has seen significant legislative efforts to integrate hazard mitigation with land use development since 2018. For example, SB 99 (2019) requires local jurisdictions revising their housing elements to review and update the safety element as necessary to identify residential developments in any hazard area identified in the safety element that do not have at least two emergency evacuation routes. Another example is SB 716 (2021), which extends the provisions of the Habitat Restoration and Enhancement Act and the provisions of the Planning and Zoning Law from 2022 to 2027. The Habitat Restoration and Enhancement Act authorizes habitat restoration projects and has a special focus on mitigation efforts, funds, and properties. The Planning and Zoning Law allows local governments, special districts, or non-profit organizations to hold mitigation lands under an endowment overseen by that same entity, if the endowment meets specific requirements. A third example is AB 747 (2019). This bill requires local jurisdictions to identify evacuation routes and their capacity, safety, and viability in emergencies, and to include these routes in future LHMP updates or in the jurisdiction's safety element in another emergency operations plan. This law was updated by AB 1409 (2021) to also require the identification and inclusion of evacuation locations in LHMP updates.

The Safeguarding California Plan: 2018 Update includes recommendations for land use planning and community development. Safeguarding California recommends coordination of "state guidelines and policies to promote climate resilience and hazard avoidance through local government general plans, zoning ordinances, subdivision regulations, and development incentives." California further promotes "aggressive smart growth" in land use planning around the State in A Strategy for California @ 50 Million, published in November 2015 by OPR. This concept prioritizes taking bold actions to reduce haphazard sprawl and promote higher density, mixed use development to accommodate the State's increasing population.

51.3.4. Housing and Community Development

Various mitigation efforts support housing resiliency and community development goals around the State. By reducing the number of homes that are lost or damaged in disasters, mitigation efforts support the State's initiatives to promote affordable housing while protecting residents and communities.

HCD administers the CDBG, which provides annual grants on a formula basis to states, cities, and counties to develop viable urban communities by providing decent housing and a suitable living environment, and by expanding economic opportunities, principally for low- and moderate-income persons. HCD administers the CDBG Disaster Recovery and Mitigation programs, when allocated by Congress, after disaster events to support equitable recovery and mitigation outcomes. HCD has incorporated disaster planning into the State's administration of the CDBG program. Applications that include strategies to address these issues receive more points in this highly competitive grant program. Cal OES works with the HCD Division of Codes and Standards to review mitigation actions related to mobile home installations. Additionally, HCD is charged with certifying local jurisdiction general plan housing elements, which are updated every five years. The update now triggers an associated review of the safety element. This change further ties the location of future housing, especially workforce and affordable units, to hazard mitigation issues. Cal OES and HCD coordinate monthly to identify opportunities for agencies to fund unmet needs from disaster impacted communities and to leverage CDBG and HMA programs to cover local cost-shares between the programs.

The California Green Building Standards Code (CALGreen) is administered by HCD and is California's first green building code (HCD 2022). It is formally codified in Title 24, Part 11, of the California Code of Regulations (CCR). The code aims to improve public health, safety, and general welfare through enhanced design and construction of buildings using concepts that reduce negative impacts, promote positive environmental benefits, and encourage sustainable construction.

Additionally, OSFM's Code Development and Analysis Division reviews all of California's regulations relating to fire and life safety for relevancy, necessity, conflict, duplication, or overlap. The Division also prepares the California State Fire Marshal's fire and life safety regulations and building standards for review and adoption by CBSC.

The National Disaster Recovery Competition is a $1 billion federal program administered by the U.S. Department of Housing and Urban Development (HUD) that provides grants to communities to rebuild in a more resilient way following major disasters. An exceptional integration effort is underway in Tuolumne County, where $70 million of funding under the program is supporting a three-part program: forest watershed health, biomass utilization for employment and fire risk reduction, and a Community Resilience Center for social capital development in the region. The partnership is between HCD, the county, and the U.S. Forest Service.

California has invested substantial resources toward retrofitting existing housing stock to increase survivability during hazard events. The California Earthquake Authority (CEA) implements seismic retrofits on residential structures through the Brace and Bolt, Soft-Story, and Multi-Family Mitigation Programs to reduce residential losses during earthquakes. Cal OES has supported this program extensively with HMA program funds. Cal OES and CAL FIRE are developing the California Wildfire Mitigation Program, which will fund wildfire retrofits and defensive space for residences in equity priority communities. Finally, through the HMA programs, Cal OES has implemented residential flood elevation programs around rivers that flood frequently, particularly the Russian and Sacramento Rivers. Outside of Cal OES, the State has also invested over $227 million in weatherization for low-income housing through the Greenhouse Gas Reduction Fund. All these home retrofit efforts support long-term housing resiliency in the face of future hazard events.

51.3.5. Health and Social Services

Wealth, education, housing, transportation, environmental quality, social capital, access to resources and services, experiences of violence and trauma, and other factors shape living conditions. These factors and living conditions strongly determine people's and communities' capacity for resiliency in the face of disasters and climate change. California's strong mitigation integration with the health and social services sectors enhances this capacity in these communities, bolstering the State's overall disaster resiliency.

To pursue equitable health outcomes, the State established the Health in All Policies Task Force in 2010 through a Governor's Executive Order. Health in All Policies is a collaborative approach to improving the health of all people by incorporating health, equity, and sustainability considerations into decision-making across sectors. The Task Force brings together 30 State departments, agencies, and offices and is facilitated by the California Department of Public Health (CDPH), the Strategic Growth Council, and the Public Health Institute. The Task Force creates multi-agency collaboration and initiatives to address barriers to advancing health and racial equity. Topics include State-administered grants, contracting, and procurement practices; data collection and information systems; community engagement; violence prevention; building racial equity competencies; and other critical topics. Members of the Task Force include OPR, CAL FIRE, HCD, CARB, CNRA, the California Department of Social Services (CDSS), the California Department of Food and Agriculture (CDFA), and more.

The strategic priorities of the California Health and Human Services Agency (CHHS) include building climate resilient communities where every Californian can lead a healthy life, regardless of origin or income. This priority is reflected in the departments and offices that comprise CHHS. A prime example is the CDPH Climate Change and Health Equity Section (CCHES), which works across sectors to embed health and equity into California's climate change programs and policies. CCHES ensures integration by collaborating with other agencies to leverage existing State investments in addressing climate change by embedding health equity metrics, tools, and considerations. Examples of CCHES activities include:

- Collaborating with OPR and CNRA to author the public health content for the State Climate Adaptation Strategy
- Working with CARB and the California Environmental Protection Agency (CalEPA) Office of Environmental Health Hazard Assessment (OEHHA) in developing the health analysis for the 2022 Update of the California Climate Change Scoping Plan, the State's roadmap for achieving carbon neutrality by 2045
- Providing consultation, input, tools, and resources to State agencies in the development of various climate grant funding programs and guidelines to elevate public health and racial and health equity priorities
- Working with the California Department of Community Services (CSD) and Development to integrate low-income home weatherization and energy-efficient services with home visitation efforts led by community health workers to advance healthy and climate-resilient housing

The goal of these activities is to ensure that climate-focused programs addressing housing, land use, transportation, jobs, and other factors related to health outcomes work collectively to reduce underlying inequities in living conditions, decrease vulnerability to the harms of climate change, and improve health equity overall. CCHES also engages with community-based stakeholders to elevate their presence and increase their decision-making power in State climate change efforts. Additionally, CCHES provides technical assistance and tools to State, local, and Tribal Nation health programs and departments to address the human health impacts associated with climate change. One example of these tools is the Climate Change and Health Vulnerability Indicators for California data visualization tool.

Cal OES leverages mitigation funding and programs to support public health goals. For example, Cal OES has allocated substantial HMA funding to wildfire resiliency projects. In addition to reducing loss of life and property, these projects improve air quality by reducing the amount of smoke in the air after major wildfire events. The Cal OES Watershed and Debris Flow task force works to, among other things, promote water quality by reducing landslides and runoff into water sources near burned areas. Other HMA efforts to support housing resiliency through residential retrofits help maintain the State's housing stock after disasters, reducing instances of homelessness post-disaster. Cal OES has further developed programs that support mitigation projects, particularly for equity priority communities such as the Prepare California Initiative. This initiative funnels mitigation funding toward communities that generally have higher rates of negative health outcomes due to historical marginalization and environmental degradation. By prioritizing projects that implement nature-based solutions to reduce risk, Cal OES leverages its mitigation funding to both reduce risk and increase access to nature, thereby promoting positive public health outcomes.

Health and social services mitigation strategies also assist community lifelines toward resilient recovery. The Cal OES Health and Social Services Recovery Support Function facilitates recovery programs toward creating a more equitable, resilient future for communities. The Recovery Support Function operates under the California Disaster Recovery Framework and works with State and federal partners as outlined in the framework to support resilient recovery measures for disaster-impacted communities.

The federal Health and Human Services Administration for Strategic Preparedness and Response and the Office of Disease Prevention and Health Promotion lay out a whole-of-government approach to strengthen resilience and improve well-being in communities. The federal plan for Equitable Long-Term Recovery and Resilience provides a framework based on restoring vital conditions. The plan was developed to address the deep disparities in health, well-being, and economic opportunity that were laid bare during the Coronavirus Disease 2019 (COVID-19) pandemic. An interagency workgroup developed the plan and identified opportunities for collaboration to maximize available resources across government agencies and improve resilience in communities. The plan's stated vision is "All people and places thriving, no exceptions." State hazard mitigation and climate programs and policies aim at supporting public health goals and improving community resilience through improved air quality and drinking water, align with the Thriving Natural World vital condition. California's Recovery Support Function is actively working with State and federal partners to integrate the framework into State health and social service recovery activities.

51.3.6. Infrastructure

Climate adaptation is central to planning and implementation efforts to promote infrastructure resiliency in California. For example, following the statewide climate vulnerability assessments by Caltrans, the California State Transportation Agency (CalSTA) released the Climate Action Plan for Transportation Infrastructure in 2021. This report identified critical actions to be taken in the next few years, including updating transportation infrastructure competitive program guidelines to incentivize climate adaptation and strategies, and exploring incentivizes for land conservation through transportation programs.

The California Utilities Emergency Association supports restoration of utility services, which allows businesses to return to operation with a minimum amount of functional downtime. The association serves as a point-of-contact for critical infrastructure utilities, Cal OES, and other governmental agencies before, during, and after disaster events. The work of the California Utilities Emergency Association is membership-supported, demonstrating non-governmental resources devoted to mitigation.

The State created the California Cyber Security Task Force to address increasing cyber threats to communications infrastructure, to facilitate information sharing and integration across departments, and to audit agencies for cyber protection. These are efforts to protect agency data and procedures across all departments statewide. In 2013, the California Cyber Security Integration Center (Cal-CSIC), housed within Cal OES, was tasked to oversee the Cyber Security Task Force. The SHMP integrates these efforts. For example, Action 2018-109 calls for protecting the critical power grid infrastructure from cyber threats through ongoing coordination with the Cal-CSIC and the statewide Cyber Security Task Force.

With dam safety, the State has built upon the federal tools to establish its own safety and integration program. DWR and Cal OES are charged with dam and flood safety. DWR emphasizes climate resilience and incorporates lessons learned from recent impacts of extreme weather on the State's water system. Responding to the 2017 Orville Dam spillway failure, DWR restructured itself to further bolster these efforts. This action complements the Cal OES Dam Safety Planning Division, which reviews dam repair and improvement projects and approves dam owners' EAPs. The Cal OES program integrates dam safety with emergency management and critical infrastructure by working with local jurisdictions to incorporate EAPs into other emergency plans and elements.

Cal OES coordinates with DWR, Caltrans, and other agencies that oversee the State's critical infrastructure to ensure appropriate data sources and priorities are considered in the SHMP process. Furthermore, during the maintenance and implementation phase, Cal OES coordinates with relevant agencies to determine whether HMA or other mitigation funding can be leveraged or layered with complementary State funding to harden critical infrastructure in high-risk areas.

51.3.7. Natural and Cultural Resources

Evidenced by its strong environmental laws, California prioritizes the preservation and enhancement of natural and cultural resources. For example, the California Department of Fish and Wildlife (CDFW) leads planning and coordination efforts evaluating human-wildfire conflict to mitigate the effects of extreme drought, fire, and related factors on the environment and to ensure long-term biodiversity. DWR leads bi-weekly meetings with natural resource agencies and emergency management partners across the State to discuss, identify, and address drought and flood mitigation measures.

Notably, OPR began the Fifth Climate Change Assessment planning process in July 2022. This process engages partners from federal, State, and local agencies for input, and provides critical updates to the data and circumstances identified in the Fourth Climate Change Assessment, which was released in 2018-19. Cal OES is making concerted efforts to contribute to the Fifth Climate Change Assessment, with the Cal OES Science and Climate Advisor and representatives from the Cal OES Hazard Mitigation Section attending planning sessions.

California recognizes that risk reduction can be achieved through strong environmental stewardship. The State invests resources in coordination and planning to promote a healthy environment, thereby reducing risk to life and property. Numerous State agencies are dedicated to helping California prepare for sea-level rise, with the goal of making all of California, including its coastlines, inland areas, and bays and estuaries, resilient to the impacts of sea-level rise, such as flooding, erosion, and habitat degradation and loss. In 2020, CNRA, CalEPA and over 15 departments and agencies, including Cal OES, developed sea-level rise principles to guide unified, effective action toward sea-level rise resilience for California's coastal communities, ecosystems, and economies (OPC 2020). In 2022, the State released the State Agency Sea-Level Rise Action Plan to guide efforts to increase resiliency to sea-level rise.

To address the increasing instances of catastrophic wildfire, the State created the California Wildfire & Forest Resilience Task Force, bringing together an unprecedented coalition of the best available resources for preventing catastrophic wildfires by creating healthier, more sustainable natural environments. The task force is a proactive effort that is already showing progress toward long-term forest health and safe, sustainable coexistence with fire. Cal OES is a key partner in this task force, bringing a strong risk reduction and long-term recovery lens to the coalition. Lessons learned from this coalition are integrated into the SHMP process and subsequent administration of the HMA programs.

Cal OES works to identify and allocate funding under the HMA programs for nature-based solutions that bolster risk reduction. These projects, which seek to enhance the environment while providing protection from natural hazards, align with the State's goals to adapt to climate change by enhancing its Natural and Working Lands and to protect 30 percent of the State's land and water by 2030. Since the 2018 SHMP update, Cal OES has made substantial strides in building relationships with environment-oriented partners to assist in identifying nature-based projects for HMA funding. For example, Cal OES coordinates with The Nature Conservancy, the California Association of Resource Conservation Districts, and other environmental organizations during HMA program outreach. Furthermore, Cal OES leverages the expertise of State partners with environmental expertise to identify projects, including CAL FIRE, DWR, the California Coastal Conservancy, the Sierra Nevada Conservancy (SNC), the California Ocean Protection Council (OPC), OPR, and others.

51.4. INTEGRATION WITH FINANCIAL PROGRAMS

The strength of California's mitigation approach stems from the utilization of multiple funding sources, including federal grant funding, State grant funding, and municipal/county funding. The diversity of funding sources provides stability and continuity to projects and lessens the downside of single-source funding.

California promotes funding opportunities consistently through coordination with local, Tribal Nation, regional, State, and federal agencies. The Cal OES Hazard Mitigation Assistance Branch (Cal OES HMA Branch) works with local, Tribal Nation, and State agencies and stakeholders to promote available funding opportunities to support implementation of their mitigation and adaptation projects and activities. A list of funding mechanisms available to applicants through HMA is available on the Cal OES website. For projects that have not yet been implemented, potential applicants are encouraged to work with Cal OES HMA Branch staff or visit the California Grants Portal for additional funding opportunities.

State funds have bolstered support for additional mitigation programs. In 2021, the legislature appropriated funding to establish the Prepare California initiatives. A portion of these funds, known as Jumpstart, supports local mitigation capacity building and is intended to help Californians in equity priority communities overcome barriers to accessing mitigation funding. The remaining funds, known as Match, cover the local cost share for equity priority communities with the greatest hazard risk. Combined, the legislature allocated $100 million to Cal OES to deliver these programs.

The State further invested $50 million in the California Wildfire Mitigation programs between 2021-2023, to be administered by Cal OES. The program is a partnership between Cal OES, FEMA, HCD, the Institute of Building and Home Safety, and academic partners. The program provides funding in equity priority communities to implement retrofits and create defensible space around homes in high-wildfire risk areas. In addition to this funding, the State legislature appropriated $670 million in 2022 for additional wildfire efforts, such as CAL FIRE's Wildfire Prevention Grants Program, forest health, business, and workforce development, the California Forest Improvement Program (CFIP), the Forest Legacy Program, Urban and Community Forestry Grant Programs, and Forest Health Research Grant Programs.

Special funds and the State General Fund provide support for various other legislatively mandated programs. For example, CEA is a self-sufficient program that offers residential earthquake insurance and is funded through insurance policy premiums. In 2022, $250 million was approved by the legislature for CEA's Multi-Family Soft Story Retrofit Program. If appropriated in the State's fiscal year (FY) 2023 budget, the program will provide funding to seismically retrofit multi-family dwellings in equity priority communities prone to earthquake risk. In addition to these programs, CEA has developed a supplemental grant for income-eligible homeowners in ZIP codes where the Earthquake Brace + Bolt program (EBB) is available.

Some of California's mitigation efforts are also self-sustaining. For example, the continuous upgrading of seismic hazard maps by the California Geological Survey (CGS) is funded by a levy on local building permit fees that replenishes the program's funding on an annual basis.

Another example of financial integration for mitigation planning was passage of AB 2140 (2007), mentioned previously. This bill provides incentives for LHMP preparation by authorizing cities and counties to adopt LHMPs as part of their required general plan safety element updates. The bill authorizes the California legislature to provide to such cities and counties a State share of costs exceeding 75 percent of total State-eligible post-disaster costs under the CDAA. It also requires Cal OES to give future priority to local jurisdictions without an LHMP to prepare and adopt one.

California's financial integration efforts also include identifying investments to bolster the State's climate mitigation and adaptation activities. California's Climate Change Assessments support cutting-edge climate science that includes climate impact projections at scales relevant to State, regional, and local decision-making, supporting the integration of the best available science into policy and investment decisions. As of December 2022, OPR is developing an update to the Planning and Investment for a Resilient California Guidebook. This update will provide revised data, resources, and best practices to inform climate-resilient investment decisions. Cal OES and its partners are working to incorporate efforts to reduce climate risks through hazard mitigation activities where climate science provides critical support, including but not limited to reducing wildfire hazard, enabling climate-resilient rehabilitation, and improving flood protection.

The State has made robust investments in climate mitigation efforts across several programs. The CARB-operated Cap-and-Trade provides financial support to numerous other State agencies and organizations to reduce GHG emissions and promote economic, environmental, and public health improvements. As of September 2022, $21 billion was appropriated by the legislature for FY 2022 – 2023. Programs funded by Cap-and-Trade include the Greenhouse Gas Reduction Fund, which supports the objectives of the California Global Warming Solutions Act of 2006. Investments from the Greenhouse Gas Reduction Fund support programs such as the Water-Energy Efficiency Program run by DWR, and the Affordable Housing and Sustainable Communities Program run by the SGC, which prioritizes projects through Climate Adaptation and Community Resiliency scoring. Other programs funded through the Greenhouse Gas Reduction Fund that align with hazard mitigation efforts include the Urban Greening Program, which received $156 million in FY 2022 – 2023 appropriations, and the Regional Forest and Fire Capacity Programs at CNRA, which received $20 million in FY 2022 – 2023 appropriations. Funded programs span across disciplines and hazards to include Fire Prevention Grants, Forest Health, Urban and Community Forestry Programs at CAL FIRE; Wetlands and Watershed Restoration program at CDFW; the Climate Ready Program at the California Coastal Conservancy; and the Transformative Climate Communities program at SGC. A full list of programs funded by the Cap-and-Trade program as well as a history of fund allocations by year since the program's establishment is available on the CARB website.

Another example is the financial integration mandated by AB 1550 (2016) which requires a minimum of 25 percent of GHG reduction funding to be allocated to projects located within and benefiting individuals living in disadvantaged communities and provides additional funding to benefit low-income households. Investments from the Greenhouse Gas Reduction Fund support programs such as the DWR Water-Energy Efficiency Program and the SGC's Affordable Housing and Sustainable Communities Program, which prioritizes projects through Climate Adaptation and Community Resiliency scoring. Additional programs funded through the Greenhouse Gas Reduction Fund that align with hazard mitigation efforts include the Urban Greening Program, which received $156 million in FY 2022 – 2023 appropriations, and the Regional Forest and Fire Capacity Programs at CNRA, which received $20 million in FY 2022 – 2023 appropriations.

Funded programs span across disciplines and hazards to include Fire Prevention Grants, Forest Health, Urban and Community Forestry Programs at CAL FIRE; Wetlands and Watershed Restoration program at CDFW; the Climate Ready Program at the California Coastal Conservancy; and the Transformative Climate Communities program at SGC. Another example is the financial integration mandated by AB 1550 (2016), which requires a minimum of 25 percent of greenhouse gas reduction funding to be allocated to projects located within and benefiting individuals living in disadvantaged communities and provides additional funding to benefit low-income households.

Within the last two years, Cal OES, SGC, and the U.S. Environmental Protection Agency (EPA) have become members and presenting partners of the California Financing Coordinating Committee (CFCC). CFCC organizes funding fairs that highlight federal, State, and regional granting agencies. These fairs occur at least four times each year and serve over 100 people per fair. Immediately after the presentation portion at these fairs, grant seekers have the opportunity to ask clarifying and substantive questions. Also, within the last two years, Cal OES, SGC, and the EPA have presented at the Integrated Regional Water Management Roundtable of Regions meetings, discussing information on upcoming grants.

51.5. INTEGRATION OF FEMA MITIGATION INITIATIVES

Several federal programs provide essential resources that foster integration and coordination among agencies directly responsible for hazard mitigation efforts and with other entities throughout the State. These programs include the HMGP, FMA, BRIC, 406 PA Mitigation, National Flood Insurance Program (NFIP), Community Rating System

(CRS), Risk Mapping, Assessment, and Planning (Risk MAP), CDBG Disaster Recovery, CDBG Mitigation, and other grant programs.

51.5.1. Hazard Mitigation Assistance

California is responsible for administering FEMA's HMA programs, which include HMGP, HMGP Post Fire, FMA, legacy Pre-Disaster Mitigation, and BRIC. HMGP is available to develop hazard mitigation plans and rebuild in a way that mitigates future disaster losses. HMGP is available after a presidentially declared disaster. FMA funds projects that reduce or eliminate the risk of repetitive flood damage to buildings. Pre-Disaster Mitigation funds programs that plan for and implement sustainable cost-effective measures designed to reduce the risk from future hazards. BRIC, similar to HMGP, supports recipients as they undertake hazard mitigation projects.

These programs are administered through the Cal OES HMA Branch and are utilized to fund non-disaster and post-disaster mitigation activities that minimize or eliminate risk to natural hazards. HMA funding is available for eligible mitigation activities that implement independent solutions to mitigate risks long-term or permanently. The programs provide funding to support 75 to 100 percent of the total cost of the project, with any remaining funding provided by a non-federal source.

The non-disaster programs below are available on an annual basis. From 2017-2022, California submitted 128 applications for $1.3 billion in requested Federal Share amounts in non-disaster HMA program grant funding, comprising:

- 33 Pre-Disaster Mitigation (replaced by BRIC in 2020) projects totaling $35.3 million
- 71 BRIC projects totaling $1.2 billion
- 24 FMA projects totaling $98.0 million

When a federal disaster is declared by the President, HMGP funds become available to support mitigation planning and project efforts to mitigate the effects of future disasters. The Governor may request that HMGP projects are targeted to areas impacted by the disaster, but the funding is typically available statewide. The amount of HMGP funding is based upon the estimated total federal assistance provided to the State under certain Stafford Act programs. HMGP Post Fire funding—a subset of the more general HMGP—is based on a national aggregate calculation of Fire Management Assistance Grant (FMAG) designations in the proceeding 10 years. Funding from HMGP Post Fire is utilized to propel wildfire mitigation activities such as creating defensible space, supporting ignition-resistant construction, reducing hazardous fuels, implementing erosion control, and reducing flash floods. In 2021, post-disaster funding provided through HMGP totaled $485 million for traditional HMGP, and an additional $7.8 million was made available through the HMGP Post Fire grant program.

The funding from FEMA HMA programs administered by Cal OES provides California the opportunity to leverage both pre- and post-disaster assistance programs to support resilient planning, mitigation, and reconstruction that consider and anticipate future climate conditions. As part of this effort, California continues to work to align BRIC and FMA funding opportunities for projects that maximize whole-community climate readiness and resilience. For additional information on the prioritization methodology Cal OES employs to align projects to specific funding opportunities, see Section 53.1.1.

Each non-disaster funding cycle and HMGP disaster cycle has characteristics that influence the State's specific mitigation priority determination. Priority determination also considers the nature of the disaster. Specific post-disaster priorities are determined as part of initial program guidance to potential applicants. Information to be considered in establishing priority categories may include the evaluation of natural hazards in the disaster area, state-of-the-art knowledge and practices relative to hazard reduction, existing State mandates or legislation, existing State or local programs, and long-term mitigation goals and objectives at the State, local, and community level. Also, an important consideration for prioritization of grant funding are those communities with high levels of growth and development, as well as those with repetitive loss (RL) issues.

Cal OES works with eligible sub-applicants, which includes State agencies, local jurisdictions, and in some instances special districts and private non-profits, to identify and scope projects that align with local and State mitigation goals and objectives. The HMA grant programs serve as one of the primary vehicles to implement the State and local mitigation strategies.

51.5.2. Fire Management Assistance Grant Program

The FMAG program was authorized by the Disaster Mitigation Act of 2000 (DMA) and is available to states, local, and Tribal Nation governments for the mitigation, management, and control of fires on publicly or privately owned forests or grasslands where the fire threat could become a major disaster. The FMAG Program provides a

75 percent federal cost share with the local jurisdiction responsible for the remaining 25 percent. Mitigation of wildfires is an important part of this grant program, as funds can be provided based on where a potential threat exists.

The Fire Management Assistance declaration process is initiated when a state submits a request for assistance to the FEMA Regional Director at the time a "threat of major disaster" exists. The entire process is accomplished on an expedited basis, and a FEMA decision is rendered in a matter of hours. Before a grant can be awarded, a state must demonstrate that total eligible costs for the declared fire meet or exceed either the individual fire cost threshold, which is applies to single fires, or the cumulative fire cost threshold, which recognizes numerous smaller fires burning throughout a state. The funds are used primarily for fire suppression services (response) but also for essential assistance (emergency protective measures). Cal OES Recovery staff provide information on cost-effective Section 406 hazard mitigation measures.

51.5.3. Hazard Mitigation Grant Program Post Fire Grant Program

The HMGP Post Fire grant program was established by the federal Disaster Recovery Reform Act, enacted in October 2018. The resulting changes to the Stafford Act allow FEMA to provide HMGP assistance for hazard mitigation measures that substantially reduce the risk of future damage, hardship, loss, or suffering in any area affected by a major fire, or any area affected by a fire for which assistance was provided under FMAG. These changes mean that the availability of this assistance is not contingent on a Presidential Disaster Declaration.

California has received over $38 million in additional funding through the HMGP Post Fire program under declarations FM-5189, FM-5278, FM-5293, FM-5380, and FM-5419. The breakdown for this funding is detailed in Table 51-1.

Table 51-1. Funding Through the HMGP Post Fire Program

FM Number	Federal Fiscal Year	Amount
FM-5189	FFY-2018	$18,133,664
FM-5278	FFY-2019	$1,817,727
FM-5293	FFY-2020	$4,722,610
FM-5380	FFY-2021	$7,787,780
FM-5419	FFY-2022	$6,292,416
Total		**$38,754,197**

Funding is first made available to the county or counties that received an FMAG declaration. Projects may be outside of the area as long as the risk reduction activity benefits the declared county or counties. If funding cannot be used in the affected area, then it may be made available statewide regardless of whether it benefits a declared county. Cal OES leverages the HMGP Post Fire funds for immediate post-fire mitigation needs, such as erosion control or reforestation, as well as for long-term risk reduction activities such as home hardening and hazardous fuels reduction. By prioritizing communities that were impacted by major fires that year, Cal OES seeks to reduce the risk of secondary impacts in the post-wildfire period and prevent additional fires in the same area in future years.

51.5.4. Section 406 Public Assistance Mitigation

FEMA's PA grant program provides federal assistance to government organizations and certain private non-profit organizations following a Presidential Disaster Declaration so that communities can quickly respond to and recover from major disasters or emergencies. The PA program is administered through a coordinated effort between FEMA, the state or Tribal Nation receiving the funding, and the applicants on behalf of the jurisdiction. PA supports local communities with opportunities to strengthen infrastructure that has been proven to fail under disaster conditions. Cal OES leverages the program to assist impacted communities in hardening damaged public infrastructure during the recovery process to promote long-term resiliency and reduce impacts from future disasters.

The program provides assistance to supplement federal disaster grants for debris removal, life-saving emergency protective measures, and the repair, replacement, or restoration of disaster-damaged publicly owned facilities and the facilities of certain private non-profit organizations. The PA program also encourages protection of these damaged facilities from future events by providing assistance for hazard mitigation measures during the recovery process. Mitigation activities may be completed and funded through Section 406 of the Stafford Act. Section 406 PA Mitigation is defined as incorporating cost-effective betterments into a permanent work project to harden or protect disaster damaged facilities from repetitive damage in future similar disaster events. The non-federal cost share of this assistance is provided by state funds.

In recent years, starting with DR-4558 and including DR-4569, DR-4610, and DR-4619, Cal OES overcame the barriers inherent in the PA process and succeeded in increasing the number of projects that incorporate Section 406 Mitigation. More than 55 percent of all Category C through G projects in these disasters included mitigation components, up from the previous rates of approximately 5 percent to 10 percent. While the dollar amount of Section 406 mitigation actions as a percentage of the total

PA project costs are low, at about 2 percent, Cal OES PA will continue to offer increased levels of protection when rebuilding damaged infrastructure.

Challenges of implementing the PA program since 2013 include the need for more FEMA PA support and enhanced training of FEMA staff to ensure staff promote and effectively support PA hazard mitigation. To address this, Cal OES is working with FEMA Region 9 for expanded support of the PA program. PA is a priority for the State and working with FEMA to ensure that adequate support exists to further the program and efforts to reduce risk is a high priority. Cal OES PA staff are using outreach to teach communities about PA and to share Cal OES's PA program information with incoming State and FEMA staff when a Joint Field Office is established.

The Section 406 mitigation program is a beneficial source that can boost California's resiliency to disaster effects. It would benefit the State and FEMA Region 9 to dedicate more mitigation experts to ensure that PA funds are used to increase the protection of infrastructure or facilities that have already been found to be faulty in disaster conditions. This will help to bolster resilience within local communities. This additional dedication would align with the State's mitigation strategy to assist local and Tribal Nation governments in implementing robust and successful hazard mitigation efforts.

In addition to those listed above, the PA program administers several additional programs, including the following:

- **Federal Highway Administration Emergency Relief Program—**This program gives aid for the repair or reconstruction of federal-aid highways and roads on federal lands that have suffered serious damage as a result of natural disasters or catastrophic failures from an external cause. This grant is a subset of the FEMA PA grant program and offers funding for mitigation efforts.
- **Natural Resources Conservation Service Emergency Watershed Protection Program—**This program offers technical and financial assistance to help local communities relieve imminent threats to life and property caused by floods, fires, windstorms, and other natural disasters that impair a watershed. It does not require a disaster declaration by federal or state government officials for program assistance to begin. This grant is a subset of the FEMA PA grant program and offers funding for mitigation efforts.
- **U.S. Department of Housing and Urban Development Disaster Housing Assistance Program—**This program provides short-term, emergency rental assistance for families and individuals displaced by a natural disaster.

51.5.5. FEMA Hazard Mitigation Planning

Cal OES's Hazard Mitigation Planning Division coordinates with the FEMA Region 9 Mitigation Division to co-administer the State's local hazard mitigation program. This program administration consists of providing hazard mitigation technical assistance and training to local jurisdictions and Tribal Nations. Cal OES and FEMA Region 9 also work together to conduct and expedite joint reviews of some LHMPs, in order to ensure reviews are completed within the 45-day LHMP review timeframe (a shared Cal OES-FEMA goal), or in a timely manner when HMA funding is pending. For more information about the LHMP Program, see Chapter 41.

For Tribal Nation plans, Cal OES coordinates closely with the FEMA Region 9 planner who leads the Tribal Nation mitigation plan reviews. Cal OES provides plan reviews and trainings for Tribal Nations if requested, but historically has not reviewed Tribal Nation hazard mitigation plans.

51.5.6. Threat and Hazard Identification and Risk Assessment

The State of California Threat and Hazard Identification and Risk Assessment (THIRA) is a three-step risk assessment process that helps communities understand their risks and what they need to do to address those risks. The THIRA relies on the mitigation analysis contained in the SHMP to complete THIRA Step 1: Identify the Threats and Hazards of Concern and Step 2: Give the Threats and Hazards Context. FEMA requires the State of California to submit its assessment annually through the Unified Reporting Tool.

The Cal OES Hazard Mitigation Planning Division contributes to the State's THIRA every three years, and to the accompanying Stakeholder Preparedness Review annually. This process includes coordinating with other Cal OES divisions to align responses and accurately capture the State's capability to prepare for, respond to, recover from, and mitigate various disaster scenarios. Since 2018, Cal OES has made concerted efforts to ensure that hazard mitigation is better integrated into the THIRA than in previous cycles.

51.5.7. Emergency Management Performance Grant Program

The purpose of the Emergency Management Performance Grant (EMPG) Program is to provide federal funds to states to assist State, local, and Tribal Nation governments in preparing for all hazards. In California, the EMPG Program continues to be leveraged by State, local, and Tribal Nation emergency management agencies to acquire the resources necessary to ensure a well-organized and rapid response to disasters. In addition to supporting local capabilities, the EMPG Program supports California's Standardized Emergency Management System (SEMS) activities. This system unifies all elements of California's emergency management community into a single integrated system and standardizes key elements. This system and the Incident Command System, which provides guidance for how to organize assets to respond to an incident and processes to manage the response through its successive stages, are the cornerstone for the National Incident Management System (NIMS). NIMS guides all levels of government, NGOs and the private sector to work together to prevent, protect against, mitigate, respond to and recover from incidents.

In California, eligible subaward subrecipients are local and State agencies and federally recognized Tribal Nations. Funds provided under the EMPG Program must be used to support activities that effectively contribute to capabilities to prevent, prepare for, mitigate against, respond to, and recover from natural or human-caused emergencies and disasters. In support of the Department of Homeland Security Notice of Funding Opportunity that is issued by FEMA when funds are available, California issues the "California Supplement to the Federal Notice of Funding Opportunity," otherwise known as the State Guidance.

The State Guidance is the authority document for California's EMPG Program, providing State, local, and Tribal Nation governments with guidance and forms to apply for, perform, and close out an EMPG subaward, as well as other subaward-related information and requirements.

51.5.8. National Flood Insurance Program

The NFIP, established in 1968 by the National Flood Insurance Act, is a federal program which local jurisdictions may voluntarily participate. It is intended to provide affordable flood insurance to residents and encourage floodplain management.

The goals of the NFIP include:

- Decreasing the risk of flood losses
- Reducing the costs and consequences of flooding
- Reducing the demand for Federal assistance
- Preserving and restoring the natural beneficial floodplain functions

Communities participating in the NFIP, and their residents and businesses, are eligible for federally backed flood insurance coverage, certain federal grants and loans, and disaster assistance. To receive these benefits, communities must adopt and enforce floodplain management regulations. Within California, there is a 99 percent participation rate among communities, with only five communities out of 533 not currently participating in the NFIP as of April 1, 2022.

The State's NFIP is administered by DWR. DWR is charged with statewide flood forecasting, flood operations, and other key flood emergency response and management activities to help reduce flood risk, including FloodSafe California, the Central Valley Flood Protection Plan (CVFPP), and the Statewide Flood Management Plan (DWR 2022i). FloodSafe California includes implementation plans, strategic plans, five-year resource plans, and integrated water management products. Some new flood risk reduction programs were established, and some existing programs were enhanced. The CVFPP and Statewide Flood Management Plan are both strategic blueprints to improve flood risk management. These efforts are all in the aim of flood mitigation.

DWR, on behalf of FEMA, conducts Community Assistance Visits and Community Assistance Contacts to each NFIP community to provide individual technical assistance. A Community Assistance Visits consists of a tour of the floodplain, an inspection of community permit files, and meetings with local appointed and elected officials. FEMA and DWR workshops also assist community officials to learn how to comply with NFIP requirements. DWR provides statewide NFIP workshops that are designed to interpret and explain the NFIP regulations and to give an overview of the need for community-based floodplain management. Workshops are scheduled by DWR but may also be requested and provided on-demand.

Workshop topics include the following:

- FEMA Elevation Certificates
- Floodplain Management and Duties of the Local Administrator (Basic Course)
- Floodplain Management Review Course
- Obtaining and Developing Base Flood Elevations in Zone A Areas (Advanced Course)
- Substantial Improvement/Substantial Damage

In addition to these in-person visits and trainings, DWR provides assistance through outreach and education, such as the National Flood Insurance Program in California Quick Guide, to provide guidance and assistance to communities for floodplain management (DWR 2022i). DWR developed the Flood Emergency Response Information Exchange to make flood information available in real-time through an online GIS platform. DWR published the California Building Code Coordinated Floodplain Management Model Ordinances to help communities adopt local regulations that are in compliance with the California Building Standards Code for buildings and structures in the Special Flood Hazard Area (SFHA).

51.5.9. Risk MAP

FEMA's Risk MAP program develops and publishes data to support long-term hazard mitigation and community resilience. According to FEMA, all Risk MAP projects begin with a project planning and discovery step to define the location and scope of future projects. The discovery process is particularly relevant to hazard mitigation planning in that federal and state agency representatives meet with emergency response officials, floodplain management staff, public works staff, planning officials, and other appropriate stakeholders to determine what natural hazard information already exists, identify what natural hazard information is still needed to make mitigation decisions, and identify which areas and resources could be most vulnerable during a natural hazard event. The meeting provides information regarding risk and hazards impacting the community and provides an overview of available resources to support community risk reduction.

This information is assembled into a report with maps that are presented to and discussed with communities at the discovery meetings. The discovery process is also an opportunity to assess community capability and plan for needed technical assistance and training based on that capability. The information from the discovery meetings is made publicly available with the goal of supporting community resilience, building partnerships, and supporting long-term hazard mitigation planning.

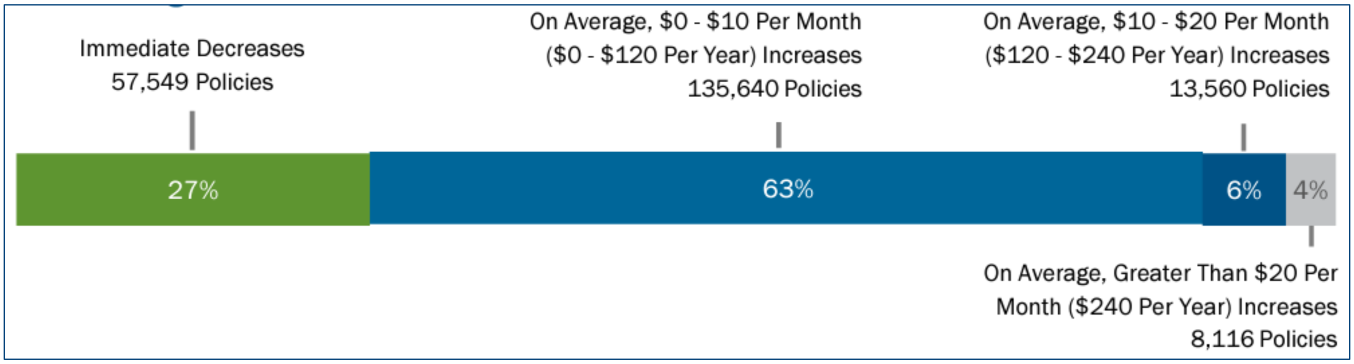
In California, discovery meetings have been hosted for various communities by FEMA Region 9, the National Oceanic and Atmospheric Administration (NOAA), the U.S. Geological Survey (USGS), University of Southern California Sea Grant, California Coastal Commission, California Coastal Conservancy, and The Nature Conservancy, in collaboration with Cal OES, DWR, Caltrans, and other State agencies.

51.5.10. Risk Rating 2.0

In 2021, policyholders in the NFIP began to see a transition to a new rating program known as Risk Rating 2.0. The goal of Risk Rating 2.0 is to pivot to a program in which flood insurance premiums are based on the insurable structure's flood risk (FEMA 2022t). This transition does not impact the requirement to have flood insurance, which is still based on the flood zone when a federally backed mortgage is involved, but it does incorporate individual property characteristics to determine flood insurance premium rates. Characteristics such as proximity to water, rebuild cost, and flood hazard type are all now considered in each individual structure rating.

Between October 1, 2021, and October 1, 2022, policyholders in the State of California began experiencing the impacts of Risk Rating 2.0. Figure 51-1 shows estimates developed by FEMA of potential rate increases in the program's first year. At the time FEMA produced the estimation, 73 percent of all NFIP policyholders in the State of California would experience an annual increase in premiums. (FEMA; Floods.org; Floodscienceceter.org 2022)

Figure 51-1. Estimated California NFIP Policy Premium Changes in First Year of Risk Rating 2.0



Source: (FEMA 2021f)

51.5.11. Community Rating System

The CRS is a voluntary federal program. California's floodplain management law allows local governments to adopt and exceed floodplain management regulations to reduce and seek premium discounts, as outlined in 44 CFR. By permitting the enforcement of higher regulatory standards, California communities are provided the opportunity to participate in the CRS, which provides insurance premium discounts of up to 45 percent based on the community's enforcement of higher regulatory standards.

Implemented in 1990, the CRS is a voluntary incentive program under the NFIP that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. As a result, flood insurance premium rates are discounted to reflect the reduced risk. For participation in the program, communities must apply, annually recertify after entry is granted, and participate in full verification assessments every three or five years.

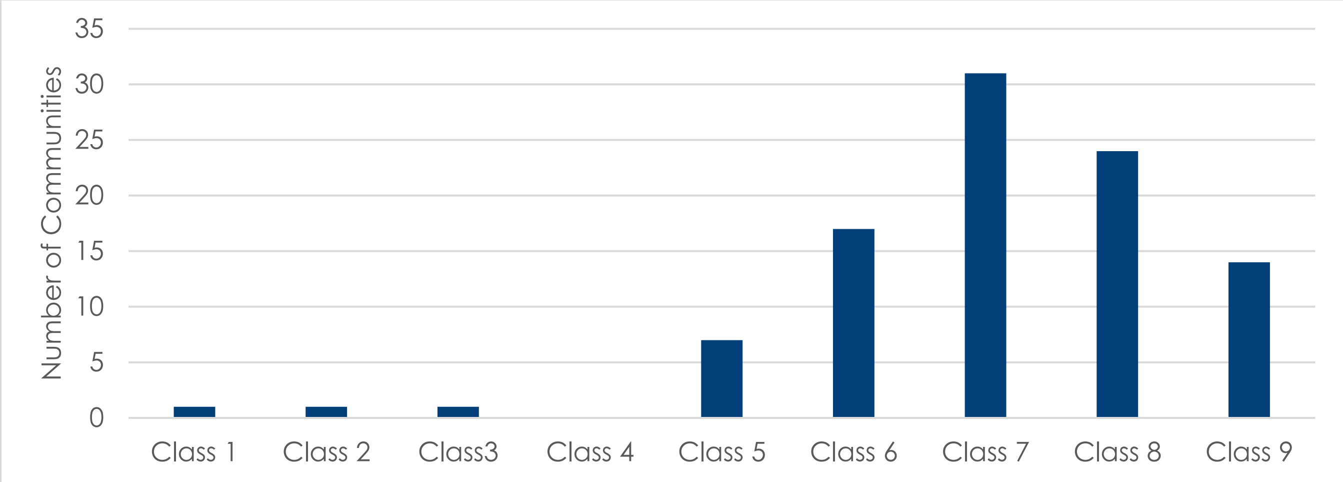
The goals of the CRS support those of the NFIP and the advancement of community resilience:

- Reduce flood damage to insurable property
- Strengthen and support the insurance aspects of the NFIP
- Encourage a comprehensive approach to floodplain management

As of April 2022, there were 1,520 communities nationwide participating in the CRS, including 96 in California. Most of the participating California communities are in the Central Valley or along the coast where the highest concentrations of active NFIP policies can be found. The concentration of coverage in the Central Valley is likely due to the concerns of riverine flooding, which can be widespread. The 96 participating communities in California allow for discounted premiums for 130,843 policies, translating to $13.3 million saved on the total premiums of $104 million paid in annually by the residents of the State according to www.crsviz.com.

Figure 51-2 summarizes the distribution of communities by CRS class rating. The CRS program uses a Class rating system to determine flood insurance premium reductions for policy holders. Participating communities are rated from 1 to 9, with Class 1 communities receiving the largest discount. Each class achieves a 5 percent discount to applicable NFIP policies in the community; however, minus rated, severe repetitive loss (SRL), or structures with violations may not receive the discount. A Class 9 community receives a 5 percent discount. Each CRS class improvement produces a 5 percent greater discount on the flood insurance policy premiums, with a Class 1 community receiving a 45 percent discount.

Figure 51-2. California CRS Participating Communities by Class



Source: (FEMA 2022c)

CRS participation and interest in California is supported by two user groups. These groups are formed to represent municipal, county, regional, and State networks that collaborate to meet local flood mitigation goals and support each other in qualifying for CRS credit. Participation in these groups is open to both current CRS communities and interested communities. The two groups are the North Central CRS Users Group of California and the Santa Clara County California CRS Users Group. While these groups do not earn credit in the program themselves, they do provide a platform for learning and an opportunity to discuss changes, obstacles, and successes.

In addition, DWR developed a CRS strategy to support community participation and to aid communities with increasing their CRS classification. The strategy has four main elements and a series of projects associated with them (DWR 2022a):

- Encourage Participation: State staff promote the CRS and help communities join the program. DWR explains the benefits of the CRS to elected officials and other local decision makers so they will encourage their staff to devote the resources needed to join the CRS or improve their classification.
- Facilitate Credits: DWR and other State agencies help communities receive credit for State programs.
- Improve Local Programs: Training, templates, models, and examples help communities improve their floodplain management activities and receive CRS credit for them.
- Track Progress: DWR can see where improvements are made, make adjustments, and measure the worth of its efforts.

51.5.12. Cooperating Technical Partner

Various entities in California have accessed funding through FEMA's Cooperative Technical Partnership to support flood risk reduction. Cal OES has developed strong partnerships with several of the Cooperative Technical Partnership recipients. For example, Cal OES coordinates closely with The Nature Conservancy in its work to develop tools and resources to support communities in accessing funding for nature-based projects. Cal OES provides feedback on these tools and engages with The Nature Conservancy to assist in program outreach and education on nature-based solutions. Cal OES also works closely with OPR to establish a pipeline of projects that incorporate nature-based solutions for FEMA funding and to align State funding programs and timelines to be available to match the FEMA dollars. These collaborations assist communities in accessing the HMA programs and increasing their resiliency through nature-based approaches.

51.5.13. National Dam Safety Program

California has partly based its Dam Safety Program on the National Dam Safety Program. The State has taken the federal tools as a base for its own program and then expanded on them. As part of this program, DSOD has categorized State-regulated, jurisdictional dams based on FEMA's hazard classifications. For California's dam program, DSOD split FEMA's "high" classification into two classifications: high and extremely high. California's Government Code Section 8589.5 even references FEMA's guidelines for dam EAP development, as dam owners are required to develop their EAPs based on the federal guidelines.

As required by the FEMA guidelines, California also mandates that dam owners must execute an EAP notification exercise, as well as update the EAPs and inundation maps on a prescribed schedule. In conjunction with DSOD, Cal OES will work with local public safety agencies to help them incorporate the EAPs into local hazard planning efforts.

51.5.14. California Disaster Assistance Act

The CDAA authorizes the Director of Cal OES to administer a disaster assistance program that provides financial assistance from the State for costs incurred by local governments as a result of a disaster event. Funding for the repair, restoration, or replacement of public real property damaged or destroyed by a disaster is made available when the Director concurs with a local emergency proclamation requesting

State disaster assistance. The program also provides for the reimbursement of local government costs associated with certain emergency activities undertaken in response to a State of Emergency proclaimed by the Governor. In addition, the program may provide matching fund assistance for cost sharing required under federal PA programs in response to a Presidential Major Disaster or Emergency Declaration. When the Director determines there are mitigation measures that are cost-effective and that substantially reduce the risk of future damage, hardship, loss, or suffering in an area where a State of Emergency has been proclaimed by the Governor, the Director may authorize the implementation or replacement of mitigation measures under the CDAA. This program fills the gap when the damage in an area is not sufficient to trigger a Presidential Disaster Declaration and open a PA funding opportunity. The Act is a key element of California's commitment to assisting communities in recovering from disasters and building long-term resilience.

52. DEMONSTRATING COMMITMENT

E7 – 44 CFR Section 201.3(c), 201.5(b)(4), and 201.6(d): Does the state demonstrate commitment to a comprehensive mitigation program?
Chapter 52 explicitly outlines how California is committed to implementing a comprehensive statewide mitigation program that includes state-level collaboration, local program support, and implementation of building codes.

Under FEMA guidance for Enhanced Plans, a state must detail how its plan reflects a commitment to a comprehensive mitigation program. California's commitment to a comprehensive mitigation program is expressed through the sum of its integrated mitigation efforts to address various hazards that are implemented at the State, regional, and local levels. The State's comprehensive program is reflected in SHMP goals which collectively prioritize reducing risk to life, property, community lifelines, and the environment; building capacity and capabilities; integrating equity; using the best available data and science; and integrating mitigation principles into laws, regulations, and policies.

California's commitment to a comprehensive hazard mitigation program is further demonstrated by its annual validation meetings with FEMA Region 9. Since 2020, the State has participated in three annual validation meetings: August 13, 2020; August 5, 2021; and August 12, 2022. Each of these meetings resulted in findings by FEMA Region 9 that California has sufficient planning coverage to enable a high number of jurisdictions to apply for hazard mitigation funding, that California is coordinating across sectors to deliver its hazard mitigation program, and that the State has sufficient staffing and capabilities to implement its hazard mitigation program successfully.

Additional efforts that demonstrate California's commitment to a comprehensive and integrated mitigation program are described in detail in Chapter 51.

52.1. STATEWIDE MITIGATION AND RESILIENCE ACTIVITIES

The strength of California's mitigation program is the diversity of efforts by various agencies throughout the State. These critical efforts are individual with seismic and wildfire home hardening upgrades, jurisdictional with incorporating climate and equity into planning and implementation efforts, and overarching with cybersecurity and natural hazard mitigation efforts impacting regions and the State as a whole. The 2023 SHMP builds on the 2018 SHMP update's content, broadening discussion on equity and climate change considerations. The State's efforts around and commitment to addressing climate change were significant themes of the Governor's State of the State address in 2019, 2021, and 2022. Equity and justice were overarching themes in 2019, 2020, and 2022, and was a major focus of the State of the State address in 2021.

Chapter 45 describes California's statewide hazard mitigation program, including legislative initiatives, mitigation task forces/technical advisory groups, and executive actions that promote hazard mitigation. Following are some examples that demonstrate further California's commitment to hazard mitigation.

The California Fire Safe Council (CFSC) is an active mitigation council in the State that acts as a federal grant clearinghouse providing subgrant funding to local fire safe councils for wildfire mitigation activities.

As of July 2022, the CEA EBB program has provided over 7,628 grants to homeowners for seismic retrofit in specifics areas of the State. An additional 5,291 households are in the process of acquiring retrofit funding, and 4,619 homeowners are on the waitlist for the grant program. Initial funding for the EBB program was provided through CEA's Loss Mitigation Fund. In addition to legislatively allocated funding, the EBB program seeks funding from HMGP when available. To date, over 17,000 single-family residences have been seismically retrofit through the California Residential Mitigation Program's EBB Initiative (EBB 2022).

The State also mandates that local jurisdictions include safety elements as part of their general plans; this requirement is unique to California. Multiple State-mandated planning regulations stipulate the incorporation of climate resilience in LHMPs by reference in general plan safety elements. SB 379 (2015) requires safety elements to include a climate change vulnerability assessment, measures to address vulnerabilities, and a comprehensive hazard mitigation and emergency response strategy. This requirement may be met by updating the LHMP, climate adaptation plan, or other similar plan and incorporating it into the safety element by reference. AB 2140 (2007) authorizes financial incentives for cities and counties to integrate LHMPs with mandated general plan safety elements. SB 1035 (2018) requires regular subsequent safety element reviews and, if necessary, updates to identify new information relating to flood and fire hazards, climate adaptation, and resiliency strategies after initial revisions.

Executive Order B-30-15 integrates directives on climate change mitigation and adaptation, thus providing a powerful framework for action. This order requires all State agencies to take current and future climate impacts into account in all planning and investment. It directs the preparation of implementation plans to ensure coordinated progress on the objectives of the Safeguarding California Plan and emphasized the State's commitment to protecting vulnerable populations and making flexible, adaptive, and natural infrastructure solutions a top priority. To implement this direction, OPR prepared the Planning and Investing for a Resilient California Guide. Additionally, OPR is preparing an update to the Executive Order B-30-15 guidance pursuant to Executive Order N-19-19.

52.2. STATE-LEVEL PLANNING INITIATIVES AND COLLABORATION

The SHMP is an important supporting document to the California SEP. The 2022 SEP defines and describes the fundamental systems, strategies, policies, assumptions, responsibilities, and operational priorities that California uses to guide and support emergency management efforts. The SEP and the SHMP are closely interlinked. Section 7 of the SEP identifies mitigation as one of the four emergency management functions and references the role of the SHMP in describing and mitigating hazards, risks, and vulnerabilities, thereby reducing disaster losses.

"Protecting Californians from Extreme Heat: A State Action Plan to Build Community Resilience," released in April 2022, is an example of mitigation and recovery linkages in various California single-hazard mitigation and climate adaptation plans. The Plan has two action tracks specifically focused on mitigation and resiliency efforts. These are Action Track C: Increase Resilience of Our Built Environment, and Action Track D: Utilize

Nature-Based Solutions. These two tracks identify goals relating to updating building codes and regulations, using the best available science to inform actions, investments in resiliency-building infrastructure, promoting nature-based solutions, and enhancing the ability of the State's natural resources to withstand increasing temperatures.

In an effort to advance interagency cooperation and learning about mitigation, strategic working groups have been formed by Cal OES Hazard Mitigation and engaged at various times over the last 15 years. These groups include the following:

- 2018 SHMP Goal and Objectives Strategic Working Group
- Social Vulnerability Model Update Strategic Working Group
- GIS Technical Assistance Working Committee
- Cross-Sector Communications and Knowledge Sharing Strategic Working Group
- Mitigation Progress Indicators and Monitoring Strategic Working Group
- Land Use Mitigation Strategic Working Group

For the 2023 SHMP update, this strategic working group model became the official format for collecting input and facilitating relationship-building between partner agencies. The 2023 SHMP update utilized four Hazard Groups and four Working Groups, each consisting of various federal, State, local, Tribal Nation, and non-governmental partners. Additional information on these Hazard and Working Groups can be found in Appendix D.

52.3. ASSISTANCE WITH LOCAL PLANNING AND MITIGATION ACTIVITIES

Cal OES staff continues to maintain positive working relationships with local government constituents through informal contact, such as phone and e-mail communications, as well as attendance at regional meetings, and letters providing continued technical assistance support and information as needed. In addition to technical assistance, all levels of government participate in funding disaster mitigation measures. This multi-level participation is part of California's comprehensive mitigation approach.

At the State level, billions of dollars have been spent on earthquake, flood, and wildfire mitigation measures. Most recently, the State legislature approved $100 million for the Prepare California Jumpstart and Match programs to bolster equity priority communities that encounter barriers accessing federal mitigation funding. State voters have approved billions of dollars in mitigation investments, including the notable approval of a State bond act in 2014, authorizing over $11 billion to fund water supply infrastructure, reliability, and mitigation efforts.

California's local governments are also creative and innovative in their mitigation financing approaches. At the county and city levels, hundreds of millions of dollars have been spent on retrofitting buildings and supporting flood control. At these local levels, special bonding, sales tax districts, and tax rebate programs have been established to fund earthquake, flood, and wildfire mitigation. Most of these efforts require local voters to approve the finance mechanism, usually in the form of additional fees and taxes. Thus, Californians do use their "pocketbook" to mitigate hazards.

With regard to technical assistance, Cal OES Local Mitigation Planning Unit (LMP Unit) hosts LHMP development workshops and presentations that are well attended by city, county, special district, and Tribal Nation representatives, as well as NGO representatives. The workshops and presentations are provided to help local governments develop their LHMPs and to identify local mitigation opportunities. The 2023 SHMP planning process ensures that the content is robust and actionable for local jurisdictions that use the SHMP as a resource in their own planning efforts.

With this, the Cal OES LMP Unit and the Cal OES State Mitigation Planning Unit (SMP Unit) held a joint County Emergency Managers' Webinar and follow-up listening sessions with local jurisdictions to collect firsthand suggestions of what information, presentation, and guidance would be useful to include in the 2023 SHMP to support local mitigation planning efforts. For more information about Cal OES's LHMP Technical Assistance and Training Program, see Chapter 5, Section 5.1.

The Cal OES website includes links to a recorded session of G-318: Local Hazard Mitigation Planning, delivered jointly by Cal OES and FEMA in July 2020. Additionally, Cal OES has placed links to county LHMPs and FEMA local mitigation planning resources on the Cal OES Hazard Mitigation Division web page to support local jurisdictions' LHMP development and update efforts. Other resources for local mitigation planning on the Cal OES website include the "MyPlan" and "MyHazards"

Internet Mapping Tools, which provide users with practical GIS-based information at the local level to begin a risk assessment.

Commitment to support local mitigation planning is further represented by the ongoing educational program operated by the California Specialized Training Institute in San Luis Obispo (Cal OES 2022e). As an outreach operation of Cal OES, the institute has been providing training in mitigation planning to local agencies since long before the DMA was passed by Congress in 2000. Its focus is on facilitating and providing the best possible solutions in training, exercises, and education with an eye on building capabilities, using an all-hazards, total resource approach.

Various other State agencies also provide workshops with mitigation content. These agencies include OPR, which performs the crucial role of coordinating regional and local adaptation efforts with State initiatives to coordinate California's comprehensive strategy to adapt to climate change. Other agencies providing workshops addressing mitigation include CNRA, which coordinates Safeguarding California and FEMA coastal mapping workshops; the California Seismic Safety Commission (SSC); DWR and California Silver Jackets; Caltrans; CAL FIRE Land Use Planning and Firewise Community programs; the American Planning Association; and the California Utilities Emergency Association, which provides workshops for its members and associate members.

Updates to the California Adaptation Planning Guide provide additional support for local hazard mitigation planning. The Planning Guide includes an interactive web application to provide users with the best available climate-relevant data and tools. Additionally, future updates of the guide may include a process for surveying its users with the goal of incorporating feedback into future updates and refinements. The 2022 California Climate Adaptation Strategy includes a lengthy discussion on steps for climate adaptation and emergency management integration.

Significant investments in hazard risk mapping have been made by major State agencies responsible for mitigation of California's primary hazards. For example, the CGS implements the Seismic Hazards Mapping Act program that identifies ground shaking, liquefaction, landslides, probabilistic earthquake maps (www.quake.ca.gov), and other earthquake-related hazards. DWR has developed 200-year flood maps that will significantly increase flood hazard information, and CAL FIRE continues to update data sets on wildland urban interface (WUI), High Fire Hazard Severity Zones, and other wildfire hazards.

DWR also maintains Levee Flood Protection Zone (LFPZ) maps. These maps are limited to areas directly protected by State Plan of Flood Control (SPFC) levees and consider the maximum area likely to be inundated based on a series of levee failures when river channels are completely full. Though there is no specific frequency associated with these maps, they are useful in identifying areas that could be flooded under the worst-case scenarios. In practice, these maps tend to cover an area greater than FEMA's levee protected 100-year floodplains, known as the SFHA Shaded Zone X. Annual flood risk notifications are mailed to around 300,000 property owners for these mapped areas, reminding them to purchase flood insurance, prepare an evacuation route, and have a list of valuables to take with them in the event of a levee failure. These maps are periodically updated based on input from cities and counties.

Many of the State's hazards mapping tools along with many other GIS tools are accessible on the State of California Geoportal website (CDT 2020). In addition, OPR has also released the General Plan Guidelines Data Mapping Tool, which can be used for hazard mitigation planning (OPR 2022d). All these efforts combine to provide critical science-based information to benefit State and local agency users in creating and implementing effective and comprehensive mitigation plans and projects. For additional information on support for local hazard mitigation planning refer to Chapter 43.

52.3.1. Helping Local Governments Update Expiring Plans

Under Enhanced State Mitigation Planning Requirement E7-c, states must demonstrate a commitment to mitigation planning by helping local governments prepare and adopt updated plans before current plans expire. FEMA has established a target that 75 percent of local governments that have previously submitted a mitigation plan should have plans that remain current or are in the process of being updated. Based on the most currently available information (as of December 2022), this target is met for California's communities.

52.4. BUILDING CODES

California has led the nation in requiring local governments to adopt current versions of nationally applicable model building codes, enhanced by State laws specifically requiring local governments to address natural hazards. This applies not only for design and construction of State-sponsored mitigation projects, but also for all private construction. In 2005, CBSC approved OSFM's emergency regulations amending the California Building Code, to add Chapter 7A Materials and Construction Methods for Exterior Wildfire Exposure. These codes are updated regularly. California and local jurisdictions have adopted the 2016 California Building Code and Fire Code, with the 2015 International Building Code and the International Fire Code as the base documents. These codes include provisions for ignition-resistant construction standards in the WUI.

The adoption of building codes for the WUI is a key component of the State's wildfire resilience approach. Research shows that homes that were constructed after the 2008 adoption of the new building codes were 40 percent less likely to be destroyed in a wildfire (National Bureau of Economic Research 2021). California further supports bringing older homes up to a standard equivalent to the Chapter 7A codes through the California Wildfire Mitigation Program.

Another example affecting local development is the linking of DWR floodplain management programs to city and county statutory general plan processes. State law requires local commitments to comprehensive mitigation action through State-mandated general plan safety elements with which local development actions must be consistent. AB 162 (2007) modified the State's planning law to require inclusion of floodplain mapping in several elements of mandatory local general plans. DWR has completed a user guide for local governments to implement that law. Local governments in the Central Valley must amend their general plans and zoning to be consistent with the CVFPP adopted in 2012.

A more recent example affecting local regulation of flood risk has been the preparation of a new model building code ordinance. In coordination with CBSC, DWR updated the California Building Code to require new structures built within FEMA-identified SFHAs to be elevated an additional foot above the base flood elevation, which is currently the projected 100-year flood event water surface level. Upon completion of a new FEMA Flood Insurance Study, communities participating in the NFIP are required to adopt the resulting Flood Insurance Rate Maps (FIRMs) and updates to the California Building Code. The model ordinances were designed to assist communities easily incorporate these changes to the California Building Code to mitigating future flood damages by exceeding the NFIP standards.

In 2010, CBSC adopted the nation's first mandatory green building code, known as the CALGreen Code, which became effective in January 2011. This code outlines standards for newly constructed buildings and covers all residential, commercial, hospital, and school buildings. The CALGreen Code was updated in FY 2016 – 2017. The code requires builders to install plumbing that cuts water usage by up to 20 percent, to divert 65 percent of construction waste from landfills to recycling, and to use low-pollutant paints, carpeting, and flooring. Under this code, the inspection of energy systems is mandated to ensure efficiency. For non-residential buildings, the code requires installation of different water meters for indoor and outdoor water usage. Local jurisdictions may adopt ordinances with more stringent green building codes. The CALGreen Code is adopted by State and local government as part of the CCR (Title 24, Part 11).

Through SSC, the State has sponsored comprehensive, multi-year efforts to mitigate risks posed to existing buildings identified as necessary for post-disaster response and recovery operations. For example, after the December 23, 2003, San Simeon Earthquake, SSC assessed the need for accelerated local mitigation of unreinforced masonry (URM) buildings, stimulating the legislature to pass new occupant disclosure requirements for URM buildings not yet retrofitted.

California recognizes that building codes are a key component of resilient communities. California's Building Code for the Wildland Urban Interface is one of the most stringent in the country, and the State's regulation in the floodplain has led to a reduction in RL and SRL properties. Cal OES has sought to fund Building Code Enforcement through the HMA programs for local jurisdictions. California's strong building code has also been critical in securing funding under the BRIC program, which considers building code in its technical scoring criteria.

53. Effective Use of Existing Mitigation Programs

E8 – 44 CFR Section 201.5(a), and 201.5(b)(3): Is the state effectively using existing mitigation programs to achieve mitigation goals?
As outlined in Chapter 53, California leverages its full use of federal funding opportunities available. These grants complement state and local matching programs to ensure California communities can take advantage of all opportunities presented.

The Enhanced Plan must demonstrate that the State effectively uses existing mitigation programs to achieve its mitigation goals. The State must document that it has fully and effectively made use of FEMA and other funding already at its disposal, such as taking full advantage of FEMA programs to fund mitigation actions and using other FEMA and non-FEMA funding to support mitigation. California's commitment to mitigation has resulted in a wide array of available non-federal resources to support a statewide comprehensive approach to reducing risk and building resilience.

53.1. EXISTING FEDERAL PROGRAMS

Federal programs dedicated to providing financial assistance and resources to propel mitigation and resilience activities range across agencies. California makes full and effective use of programs available through FEMA, HUD, the U.S. Army Corps of Engineers (USACE), and the U.S. Forest Service. Below is a non-exhaustive list of programs utilized in California.

53.1.1. Hazard Mitigation Assistance

Since 2018, there have been numerous HMGP and HMGP Post Fire declarations in the State with many events still ongoing. Cal OES has consistently maximized full use of these opportunities. In this time, Cal OES has submitted 530 sub-applications for more than $1.05 billion. To be able to address withdrawals or denials, Cal OES submits waitlists for each grant.

Since the 2018 SHMP, Cal OES has completed over 2000 mitigation projects funded through HMA programs for a total investment of over $1.6 billion in federal dollars. Within this timeframe projects have been completed and closed under HMGP, FMA, and legacy programs such as Pre-Disaster Mitigation, Legislative Pre-Disaster Mitigation, and Severe Repetitive Loss. The distribution of completed projects by funding program is provided in Table 53-1; there are no completed projects under the BRIC program as of this 2023 SHMP update.

Table 53-1. Distribution of Completed Projects by Funding Program, 2018 – October 2022

FEMA Grant Program	Total Funding Obligated	Number of Projects
Hazard Mitigation Grant Program	$1,508,572,186.37	1691
Pre-Disaster Mitigation	$114,651,908.98	241
Flood Mitigation Assistance	$16,926,935.70	56
Legislative Pre-Disaster Mitigation	$13,731,511.95	31
Severe Repetitive Loss	$8,415,985.02	5
Total	**$1,662,298,528.02**	**2024**

Source: (FEMA 2023e)

Table 53-2 provides the funding totals for HMGP and HMGP Post Fire disasters since 2018 as of October 2022. These figures demonstrate the continued opportunity to maximize the usage of federal dollars to implement mitigation throughout the State. Declarations that have not been provided a lock-in amount of funding are not included.

Many of these disasters have active pending projects being reviewed for approval by FEMA. The total available is the available amount the State is able to apply for. The obligated amount is the total the State and its subrecipients have been awarded and the pending projects represent projects waiting approval and the corresponding amount of funding for those projects is show in in the Federal Share Pending column.

Table 53-2. Funding for HMGP and HMGP Post Fire Disasters, 2018 – October 2022

Declaration	Total Available (HMGP Locked in Ceiling)	Total Obligated	Projects Pending	Federal Share Pending
DR-4353	$56,578,663.00	$28,136,819.05	6	$15,782,576.71
DR-4382	$40,492,823.00	$14,825,276.16	27	$57,508,209.52
FM-5278	$1,817,728.00	$540,775.90	4	$2,250,020.50
DR-4407	$318,145,901.00	$111,676,269.65	54	$195,938,070.42
DR-4422	$66,707.00	$8,628.00	0	—
DR-4423	$315,711.00	$40,833.00	1	$272,808.00
DR-4425	$1,304,439.00	$206,208.00	1	$971,745.00
DR-4431	$7,730,527.00	$2,310,216.40	11	$35,056,573.25
DR-4434	$7,895,795.00	$4,947,792.08	11	$35,811,658.61
FM-5293	$16,371,706.00	$1,354,253.16	14	$26,186,096.00
DR-4482	$403,653,220.00	$1,581,174.54	22	$204,582,050.78
DR-4558	$130,525,642.00	$20,642,212.32	38	$107,789,940.82
DR-4569	$81,842,177.00	$4,113,586.74	32	$167,960,875.36
FM-5380	$7,787,780.00	$472,744.07	10	$7,989,292.00
DR-4610	$46,492,511.00	$369,785.26	0	—
DR-4619	$35,293,281.00	$225,989.39	0	—
FM-5419	$6,292,416.00	—	0	—

Source: (FEMA 2023e)

Cal OES will continue to fully utilize all available sources of hazard mitigation funding, including all programs available from FEMA. Cal OES will apply for all available HMGP funding after Major Disaster Declarations and HMGP Post Fire grants resulting from FMAG declarations at the close of each federal fiscal year, up to the available HMGP funding ceiling. For each HMGP disaster grant submission, Cal OES will submit a waitlist of sub-applications, exceeding the ceiling, in case any sub-applications submitted to FEMA are withdrawn.

For non-disaster grants programs, such as BRIC and FMA, Cal OES will fully utilize the State maximum allocations available for Capability and Capacity Building activities and submit viable sub-applications for the nationally competitive portions of the BRIC and FMA programs. Since 2018, Cal OES has submitted 128 sub-applications totaling more than $1.3 billion under the non-disaster grant programs.

53.1.2. Public Assistance

Since 2018, California has made full and effective use of available PA funding. Between 2018 to 2022, 34 percent of permanent work completed under the PA program contained projects incorporating mitigation measures under the Section 406 Mitigation funding (see Table 53-3). California will continue to promote the inclusion of 406 Mitigation measures when PA funding is available.

Table 53-3. PA and Section 406 Projects for Recent Disaster Declarations

Declaration Number, Date	PA Category C-G Projects		Section 406 Mitigation Projects			
	Number of Projects	Net Cost	Number of Projects	% of PA Total Number	Cost	% of PA Total Cost
4353DR-CA, 1/3/2018	111	$432,850,634.74	11	9.91%	$334,316.00	0.08%
4382DR-CA, 8/5/2018	43	$371,357,291.21	8	18.60%	$397,139.03	0.11%
4407DR-CA, 11/12/2018	173	$2,244,673,631.69	23	13.29%	$5,994,278.46	0.27%
4431DR-CA, 5/1/2019	155	$53,705,041.85	34	21.94%	$2,217,042.41	4.13%
4434DR-CA, 5/18/2019	143	$61,990,125.29	72	50.35%	$2,216,404.50	3.58%
4558DR-CA, 8/22/2020	224	$633,440,956.32	133	59.38%	$1,800,070.16	0.28%
4569DR-CA, 10/16/2020	43	$246,783,473.07	17	39.53%	$114,095.81	0.05%
4610DR-CA, 8/24/2021	35	$322,378,710.93	7	20.00%	$182,556.66	0.06%
4619DR-CA, 9/12/2021	43	$156,817,871.95	25	58.14%	$337,414.99	0.22%
Total	**970**	**$4,523,997,737.05**	**330**	**34.02%**	**$4,523,997,737**	**0.30%**

53.1.3. Cooperating Technical Partners

Various entities in California have made use of the Cooperative Technical Partnership (CTP) program. In 2022, seven entities had active CTPs with FEMA:

- **CGS**—Tsunami mapping, bay, and harbor risk assessments, mitigation action reports
- **OPR**—Tools and resources for plan integration, flood after fire planning, and State-level partnership development

- **DWR**—Flood hazard mapping for FIRM updates in Butte County and Tehama County, future climate flood modeling in Merced; teacher training program on floodplain management
- **Sacramento County**—Flood hazard mapping for FIRM updates
- **Western Shasta Resource Conservation District**—Floodplain mapping for mitigation projects alternatives assessment
- **Placer County**—Flood hazard mapping for FIRM updates
- **The Nature Conservancy, California Chapter**—Tools and resources for nature-based flood mitigation project development

These partnerships support long-term flood resilience around the State, and Cal OES has been engaged with several of the recipients to ensure their efforts are incorporated into planning and funding decisions.

53.1.4. National Earthquake Hazards Reduction Program

Other programs available to Cal OES include the National Earthquake Hazards Reduction Program (NEHRP). In 2021 and 2022, Cal OES sub-awarded NEHRP funds to the Disaster Resistant Business Toolkit Work Group to increase earthquake resilience by increasing earthquake mitigation at food distribution facilities within the Charitable Food Assistance System. In FY 2021, non-structural risk assessments were conducted at 12 large Regional Food Banks located in high-risk seismic areas in California, and structural risk assessments were done at three of the Food Bank facilities. Additional structural risk assessments are funded in FY 2022. These risk assessments will be used to support the development of Notice of Intents for future HMGP funding. The work group will create the Scope of Work and conduct the BCA required for the HMGP application for structural and non-structural seismic retrofit activities. The goal is to implement the mitigation recommendations identified during the risk assessments with the assistance of HMGP funding so that these facilities will be able to support their communities by providing essential services following a large earthquake.

The Disaster Resistant Business Toolkit Work Group will also receive NEHRP funds to conduct webinars for small and medium-sized business with a focus on Spanish-speaking business owners. During the webinars participants will receive access to free resources to facilitate continuity planning and mitigation information to increase the likelihood that, if implementing these mitigation steps, businesses can reopen sooner following a large earthquake. This will reduce economic losses for businesses and their communities.

The University of Southern California, Southern California Earthquake Center will receive a NEHRP sub-grant award from Cal OES to support The Great California ShakeOut Drill and to fund Earthquake Country Alliance activities, including the Mini Awards Program. This Program solicits applications for projects from local partners including non-profit organizations to implement non-structural mitigation. This funding also supports the California Secure Your Space Campaign. Earthquake Country Alliance members work with partners to educate the public and coordinate non-structural mitigation projects, including bookshelf straps, television straps, wall hangers, and putty to secure small fragile items, to increase earthquake resilience throughout California.

53.1.5. Rehabilitation of High Hazard Potential Dams Grant Program

FEMA's Rehabilitation of High Hazard Potential Dams (HHPD) Grant Program makes federal funds available to eligible states for pass through to non-federal governmental organizations or non-profit organizations for the rehabilitation of dams that fail to meet minimum State dam safety standards and pose unacceptable risk to life and property. For the purposes of the HHPD Program, rehabilitation means the repair, replacement, reconstruction, or removal of a dam that is carried out to meet applicable State dam safety and security standards. The grant provides funding for technical, planning, design, and construction assistance. California has been awarded the following amounts since 2019 when the grant program started:

- $260,484 in 2019
- $267,244 in 2020
- $921,442 in 2021
- $1.0 million in 2022

The National Dam Safety Program State Assistance Grant Awards provide assistance to encourage the establishment and maintenance of effective State programs intended to ensure dam safety, to protect human life and property, and to improve State dam safety programs. The program funds the following types of activities: dam safety training for State personnel, increase in the number of dam inspections, increase in the submittal and testing of EAPs, more timely review and issuance of permits, improved coordination with State emergency preparedness officials, identification of dams to be repaired or removed, and conduct dam safety awareness workshops and creation of dam safety videos and other outreach materials. California was awarded the following amounts since 2018:

- $130,134 in 2018
- $134,180 in 2019
- $121,041 in 2020
- $114,985 in 2021
- $220,586 in 2022

53.1.6. U.S. Department of Housing and Urban Development Programs

HCD administers the Community Development Block Grant Mitigation (CDBG-MIT) program. CDBG-MIT is provided at the federal level by the U.S. Department of Housing and Urban Development. Since 2017, HCD has received $177.6 million in CDBG-MIT funds to award to California's communities. Only the funds made available in 2017 have been awarded so far, totaling $83 million. In 2018, HUD made $61 million available for California, which has yet to be awarded. In 2020, HUD rolled CDBG-MIT into the CDBG Disaster Recovery (DR) program. Under this program, California received $30 million in 2020 and is estimated to have received $3.6 million in 2021. California did not receive CDBG allocations in either 2019 or 2022. The full list of CDBG programs is available on the HCD website.

53.1.7. U.S. Army Corps of Engineers Programs

DWR oversees federal dollars received from USACE. These funds are allocated to flood protection, basin construction, ecosystem restoration, and other floodplain management projects. Since 2018, California has received over $2.7 billion in funds, which have been allocated across 14 projects statewide. In that same time, California has expended over $675 million of those funds on those projects. Examples of these projects include the Natomas Basin construction, the Sacramento Riverbank Protection Project, the Hamilton City Flood Damage Reduction and Ecosystem Restoration Project, and the Folsom Dam Raise. Additional information on these and other projects is available on the USACE Sacramento District Website.

53.2. EXISTING STATE PROGRAMS

The State of California invests in hazard mitigation and climate adaptation through various State grant programs across a variety of partner agencies. Below is a non-exhaustive list of these programs.

53.2.1. Prepare California Initiative

The Prepare California initiative seeks to build capacity and support mitigation actions in equity priority communities at the greatest risk for hazard impacts. The Initiative was funded under the 2021-22 State Budget at $100 million. The funding was allocated to two new grant programs: Prepare California JumpStart and Prepare California Match. Cal OES identified communities for funding by prioritizing California census tracts according to their estimated hazard exposures and equity priority using the best available data.

Prepare California JumpStart allocated $15 million to help jumpstart eligible communities in their development and implementation of resilience planning and activities. The program primarily provides support to augment resiliency staff at the local level to develop local initiatives that directly and primarily benefit eligible equity priority and communities with high-risk hazard. Resiliency staff funded under this initiative focus on mitigation planning and implementation, community education on mitigation, recovery planning, and future mitigation project scoping. This program is meant to fill gaps in staffing capacity and expertise at the local level to ensure that under-resourced communities can effectively and meaningfully convene stakeholders to produce effective mitigation and climate adaptation plans and ultimately compete effectively for federal and State mitigation funds.

Prepare California Match allocated $85 million in State funding to cover the required non-federal cost share for eligible communities and projects applying for FEMA's HMGP, BRIC, and FMA programs. This program was intended to ensure that lack of local financial resources does not continue to prevent communities from undertaking critical mitigation activities. Along with covering the non-federal match to participate in the HMA programs, Cal OES provided enhanced technical assistance to qualified communities to develop projects and activities that directly and primarily benefit eligible equity priority and communities with high-risk hazards and reduce risk to loss of life and property from natural disasters.

53.2.2. CAL FIRE Programs

CAL FIRE administers a number of State-level grant programs, including the Forest Health Grant Program, the Wildfire Prevention Grant Program, the Urban and Community Forestry Grant Program, the CFIP, and the Wildfire Resilience Block Grants program.

The Forest Health Grant Program awards funding to landscape-scaled land management programs that restore forest health and bolster disaster resilience on forest lands, protect the State's upper watersheds, promote long-term storage of carbon in forest trees and soil, minimize the loss of forest carbon from unnaturally high-severity wildfires, and further the goals of various State climate and land management plans. The program has made available $155 million in FY 2020-21, $159 million in FY 2021-22, and $120 million in FY 2022-23, for a total of $434 million.

The Wildfire Prevention Grants Program provides funding for wildfire prevention projects and activities in and near fire-threatened communities that focus on increasing the protection of people, structures, and communities. Funded activities include hazardous fuels reduction, wildfire prevention planning, and wildfire prevention education, with an emphasis on improving public health and safety while reducing GHG emissions. Applications submitted for this program are evaluated against the project development roadmap laid out in California's Strategic Fire Plan. A total of $369 million has been made available since 2020, with $137 million in FY 2020-21, $117 million in FY 2021-22, and $115 million in FY 2022-23.

The Urban and Community Forestry Grant Program aims to optimize the benefits of trees and related vegetation in urban areas. The grants are designed to help communities to create or implement projects with a focus on reducing GHG emissions, increasing climate resilience, and providing optimal co-benefits, with a particular focus on disadvantaged communities. Most of the grants from this program will be directed to populations meeting the CARB criteria for being located within AB 1550-designated disadvantaged communities. The program has made $204 million available since 2020: $7 million in FY 2020-21, $30 million in FY 2021-22, and $167 million in FY 2022-23. There are seven grant types under the program:

- Urban Forest Expansion and Improvement
- School Greening/Green Schoolyards
- Urban Forestry Education and Workforce Development

- Urban Forest Management Activities
- Urban Wood and Biomass Utilization
- Urban Forestry Regional or Statewide Impact
- Regional or Statewide Education and Outreach

The CFIP was established by the California Forest Improvement Act of 1978. It is the State's primary assistance program for nonindustrial private forest owners. CFIP provides eligible landowners with technical and financial assistance for planning, reforestation, and resource management investments to improve the health and resilience of California's forestland. As funding is available, the program provides funding to create forest management plans, implement reforestation and restoration projects, reduce fuel hazards, and conduct forest thinning. CFIP is a cost-share program that reimburses landowners between 75 percent and 90 percent of allowable activity costs. CFIP has made $51 million available since 2021: $40 million in FY 2021-22 and $11 million in FY 2022-23.

CAL FIRE created the Wildfire Resilience Block Grants program in 2020 to fund technical and financial assistance for smaller, private forestland owners. The purpose of the grant is to allow prospective grantees the ability to assist nonindustrial forest landowners. The grantee serves as the supervising entity, providing outreach or assistance to conduct forest restoration or management activities. The program is dependent on special funds and has provided $22.2 million in funding since 2020: $2.2 million in FY 2020-21 and $20 million in FY 2021-22. Funds for FY 2022-23 are to be determined.

Cal OES has partnered with CAL FIRE to develop a State home hardening initiative to retrofit, harden, and create defensible space for homes at high risk to wildfires, focusing on equity priority communities and providing financial assistance for low- and moderate-income households. Governor Gavin Newsom signed AB 38 in 2019 authorizing Cal OES and CAL FIRE to enter into a joint powers agreement to oversee the development and implementation of the Program. Known as the Home Hardening Program, this effort encourages cost-effective wildfire resilience measures to create fire-resistant homes, businesses, public buildings, and public spaces. Mitigation measures such as home hardening, vegetation management, defensible space, and other fuel modification activities provide neighborhood or community-wide benefits against wildfire. Cal OES has developed the program to align with federal funding requirements to match State investments in the program. In the 2021-2022 budget, California allocated $20.9 million for the pilot phase of the program, with an additional $25 million to follow in the 2022-23 and 2023-24 State budgets.

53.2.3. Governor's Office of Planning and Research Programs

In addition to using funding effectively, California is committed to leveraging funds to advance equity within the State's mitigation practices. OPR administers the Adaptation Planning Grant Program, which was created to prioritize equitable planning outcomes while supporting integrated social and physical infrastructure to achieve community resilience. This program provides funding to help address local, regional, and Tribal Nation planning needs; provides resources to identify climate resilience priorities; and supports the development of a pipeline of climate-resilient infrastructure projects statewide. The program leverages $25 million for these projects, distributed in three rounds over three fiscal years. The first round of funding, totaling $6.6 million, was made available in January 2023. Information on public engagement efforts to develop this grant program is available on OPR's website.

53.2.4. Strategic Growth Council Programs

The California Strategic Growth Council administers the Transformative Climate Communities Program, which empowers communities most impacted by pollution to choose their own goals, strategies, and projects to reduce GHG emissions and local air pollution. Transformative Climate Communities uses a place-based strategy for reducing GHG emissions to catalyze collective impact through a combination of community-driven climate projects in single neighborhoods throughout the State. Projects must reduce GHG emissions significantly over time, leverage additional funding sources, and provide health, environmental, and economic benefits to the communities receiving funding. Since 2018, SCG has awarded over $230 million in grant funding for planning and implementation projects to 26 communities statewide. As of January 2023, the program has awarded four rounds of funding and is preparing the application for a fifth round. The program is administered in collaboration with DOC and is funded by the California Climate Investments cap-and-trade program. Additional information and resources on the Transformative Climate Communities Program are available on the SGC website.

53.2.5. Greenhouse Gas Reduction Fund

Through the Greenhouse Gas Reduction Fund, California has appropriated $19.6 billion toward the State's climate goals and implemented $11.4 billion in projects as of August 2022. These investments support programs and projects that reduce GHG emissions in the State and deliver major economic, environmental, and public health benefits for Californians, including meaningful benefits to the most disadvantaged communities. The fund supports programs and projects within the following three priority areas: transportation and sustainable communities, clean energy and energy efficiency, and natural resource and waste diversion. The fund received continuous appropriations and annual appropriations through the Legislature's yearly budget deliberations.

The following is a summary of appropriations from this fund (see Appendix Q for details):

- $18.3 billion appropriated prior to FY 2022-23
- $1.6 billion appropriated for use in FY 2022-23
- 23 agencies receiving funds
- 81 programs or sub-programs supported

53.2.6. Other State Programs

In addition to the programs listed above, California continuously makes other investments to support the State's mitigation focused activities, such as partnership building, increasing disaster recovery capacity, wildfire prevention and resilience, critical infrastructure protection, habitat protection, environmental justice advocacy, and providing funding to leverage additional resources. Appendix Q lists these appropriations for the most recent five fiscal years. The following is a summary of amounts invested in specific categories:

- **Emergency Management**—$3.5 billion (2018 – 2023)
- **Climate Change**—$14.3 billion (2019 – 2023)
- **Natural Resources**—$159.6 million (2020 – 2021)
- **Climate Change and Natural Resources (combined)**—$4.4 billion (2018 – 2019)
- **Environmental Protection**—$2.6 billion (2018 – 2023)
- **Sustainable Agricultural**—$40 million (2021 – 2022)

- **Resilience retrofits for the University of California (UC) and California State University (CSU)**—$250 million (2022 – 2023)

53.3. EXISTING NON-GOVERNMENTAL PROGRAMS

In addition to government-sponsored funding programs, California makes full and effective use of non-governmental funding to bolster mitigation and enhance resiliency. Below is a non-exhaustive list of these programs in California.

53.3.1. California's Fire Safe Council Programs

CFSC is a non-profit organization that provides grant funding, technical assistance, and support to local Fire Safe Councils and other community wildfire preparedness groups throughout the State. Under their Fire Safe Concept, CFSC provides funding to community-based organizations to implement hazardous fuel reduction projects on landscapes, organize residents to develop community fire planning for homes, and educate and mobilize people to create fire prevention workshops and educational products. Since 2004, CFSC has awarded 1,163 projects totaling over $118.4 million in grant funding. Since 2018 alone, CFSC has awarded 203 projects totaling $22.9 million in grant funding for 123 communities. These funds resulted in 174 wildfire community protection plans, 291 educational products, 42 community and technical workshops, over 2,300 educational programs, and over 66,400 acres treated to minimize wildfire risk. Partners who provide this funding include Cal OES, CAL FIRE, CGS, California Volunteers (CalVolunteers), the U.S. Forest Service, the U.S. Bureau of Land Management, Pacific Gas & Electric (PG&E), Southern California Edison (SCE), Fire Adapted Communities Learning Network, State Farm, and Farmers Insurance. More information on CFSC's available programs and successes is detailed on the CFSC website.

53.3.2. League of California's Community Foundation Programs

The League of California Community Foundations is a coalition organization composed of 32 community foundations across California. This organization develops and implements local, statewide, and national initiatives by providing grants and scholarships. This funding helps advance work in the areas of health, human services, education, youth development, environmental sustainability, economic development, arts, culture, leadership development, and disaster resilience. The League maintains a dedicated Disaster Relief, Recovery, and Resilience Fund, leveraging community foundations and their relationships to get resources where they are needed most in a crisis and to adapt quickly to communities' changing needs. The fund focuses on preparing for and minimizing damage from catastrophic events, investing in hazard mitigation for communities, and supporting coordinated disaster planning with both the public and private sectors.

Since 2020, the League of California Community Foundations has awarded 36 grants totaling $2.0 million through 18 community foundations statewide. Roughly 32 percent of these grants have focused on resilience specifically. The Disaster Relief, Recovery, and Resilience Fund is supported by the California Endowment, the Chan Zuckerberg Initiative, Schwab Charitable, JPMorgan Chase, PhilaFound.org, CrankStart, the American Hellenic Educational Progressive Association, the Shinnyo-en Foundation, and the Anonymous Foundation. Additional information about the fund and the League's work is available on the website.

53.3.3. California Earthquake Authority Programs

CEA is one of the world's largest providers of residential earthquake insurance, with more than 1 million California households holding policies. CEA is backed by 25 participating insurance companies and a claim-paying capacity of about $19 billion. In addition to providing insurance, CEA is active in advancing California's overall mitigation and resiliency through its EBB program. This program provides funding of up to $3,000 to retrofit homes built prior to 1980 to bolster resistance to earthquakes. Properly retrofitted qualifying homes are eligible to receive a premium discount through CEA of up to 25 percent. As of July 2022, the EBB program has provided over 7,628 grants to homeowners for seismic retrofit in specific areas of the State. An additional 5,291 households are in the process of acquiring retrofit funding, and 4,619 homeowners are on the waitlist for the grant program. Initial funding for the EBB program was provided through CEA's Loss Mitigation Fund. In addition to legislatively allocated funding, the EBB program seeks funding from HMGP when available. To date, over 17,000 single-family residences have been seismically retrofitted through the California Residential Mitigation Program's EBB Initiative. As of January 2023, the EBB program is closed. Additional information on the program is available on the CEA website.

54. IMPLEMENTATION CAPABILITY

E9 – 44 CFR Section 201.5(b)(2)(i), 201.5(b)(2)(ii), and 201.5(b)(2)(iv): Does the Enhanced Plan document capability to implement mitigation actions? Chapter 54 outlines the ways that California has built capacity to manage a statewide program.

Maintaining capabilities to effectively implement the mitigation program is critical. Cal OES is designated by the Governor as the State administrative agency responsible for the implementation of FEMA funding. In addition to FEMA funding, Cal OES is also responsible for administering federal programs made available through the Department of Homeland Security (DHS), the Bureau of Justice Assistance, the Violence Against Women Grant Office, the Department of Health and Human Services (HHS), the National Institute of Justice (NIJ), and other federal funding agencies.

In addition, Cal OES must document the system and strategy by which the State assesses implemented mitigation actions including a record of the effectiveness of each mitigation action. The State must describe how effectiveness of each completed mitigation action is assessed and what agency or agencies are involved in the assessment and indicate the time frame for carrying out this assessment. The State must also describe how it tracks potential losses avoided for each action taken.

54.1. MITIGATION STAFFING

The Cal OES Hazard Mitigation Section is composed of full-time professional staff dedicated to the review, approval, processing, monitoring, and financial management of federal grants. In addition to permanent staff, Cal OES has the ability for surge capacity to onboard limited-term staff to supplement efforts during disasters and times of crisis.

There are three Divisions within the Hazard Mitigation Section:

- The Hazard Mitigation Grants Division is organized into three units and is responsible for administering hazard mitigation activities and projects through State and federal grant programs, including HMGP, BRIC, FMA, and State-led special initiatives.
- The Hazard Mitigation Planning Division is composed of two units: the SMP Unit and the LMP Unit. The SMP Unit develops, maintains, and implements the SHMP; the LMP Unit supports the development of and the State's approval of LHMPs. The Hazard Mitigation Planning Division Units work to identify the State's and locals' risk to hazards, current mitigation capabilities, and potential mitigation strategies.
- The Hazard Mitigation Quality Assurance Division consists of two units: the Mitigation Administration Unit and the Mitigation Assessment Unit. The Mitigation Administration Unit is responsible for supporting the Hazard Mitigation Section's grant administration efforts and data analytics support. The Mitigation Assessment Unit is responsible for supporting loss avoidance analysis, BCA, and promotion of Section 406 mitigation under the PA program.

54.2. MITIGATION MEASURE RANKING

S15 – 44 CFR 201.4(c)(4)(iii): Does the plan describe the criteria for prioritizing funding?
Section 54.2 describes the State's criteria for prioritizing funding.

Cal OES identifies and prioritizes mitigation projects for funding in alignment with the goals outlined in the SHMP. Cal OES works to identify projects that meet FEMA's eligibility requirements and have the greatest probability of effectively mitigating hazards in the highest risk areas while providing environmental, social, and economic co-benefits. Cal OES seeks projects that align with local and regional planning efforts and the long-term goals of both the sub-applicant and State, funding communities with high levels of growth and development or those expected to see significant increases in risk from climate change.

Cal OES uses a system to evaluate and rank proposed mitigation actions that satisfies evolving State and FEMA priorities while meeting FEMA's strict eligibility criteria. For pre-disaster programs, such as FMA and BRIC, Cal OES releases the priorities for each funding opportunity with the NOFO. Projects that incorporate nature-based solutions and meet the qualitative criteria of BRIC are selected for submission under the BRIC program.

For post-disaster programs, such as HMGP and HMGP Post Fire, a Hazard Mitigation Operational Strategy is developed and outlines how Cal OES and FEMA will operate in the Joint Field Office, or JFO, to address the priorities identified for the disaster. Funding priorities align with the State mitigation goals and may shift depending on the type of disaster, other ongoing complementary State mitigation efforts, changing guidance, or other factors. For post-disaster funding, counties that are declared for the event are prioritized for funding. Cal OES always seeks to prioritize the highest impact projects and incorporates the principals of social justice, equity, and inclusion to strengthen investments and funding decisions.

If multiple HMA funding opportunities are available, Cal OES advises communities on which programs to apply for, based on how the project proposal maximizes the quantitative and qualitative scoring criteria for the funding opportunity. For example, Cal OES advises projects that maximize the competitive criteria under the BRIC program to apply to compete nationally for funding. Conversely, projects that meet fewer of the BRIC criteria would be advised to apply to HMGP, where they are competing on a State level rather than national level.

Cal OES evaluates the geographic distribution of funding through the State and assesses how much funding a sub-applicant has received during past grant opportunities. New sub-applicants and those who have received minimal funding during previous grant opportunities are prioritized for funding.

Although the details of priorities may be refined from year-to-year, Cal OES generally considers how the project advances resiliency, impacts equity priority populations, presents a strong implementation plan, considers future conditions, and provides a plan for community engagement and outreach. Cal OES also seeks to ensure a fair geographical distribution of funding, while prioritizing recently impacted communities and communities that have received less funding from the HMA programs in the past. The overarching principles described in the sections below guide the prioritization and ranking of projects.

54.2.1. Protecting Lives and Property at Risk From Imminent Hazards Created or Exacerbated by Disasters

Mitigating risk in high-hazard areas of the State is a priority both pre- and post-disaster. Priority is given to projects that will mitigate imminent hazards, are highly cost-effective, and incorporate critical efforts to help communities recover from the disaster. The State also promotes and gives priority to those projects and activities that would not cause adverse environmental impacts, ensuring that California is in compliance with all relevant State and federal environmental and historical preservation laws. California utilizes and promotes green infrastructure methods to support its overall mission of using natural infrastructure to manage stormwater and water supplies while delivering environmental, social, and economic benefits for communities. These priorities together all lead toward better protection of lives and property. Establishing these priorities provides guidance for local and Tribal Nation governments to build in flexibility for identifying critical mitigation needs that may arise from a disaster when there is no time to update a local and Tribal Nation plan.

54.2.2. Protecting Vulnerable Critical Facilities and Infrastructure

Another important priority for federal funding is to help with protecting critical facilities and infrastructure. Though the State and many communities have ongoing capital improvement programs, there remains an overwhelming need to retrofit, replace, protect, or relocate facilities and infrastructure important to the State's communities that are at risk from hazards.

54.2.3. Reducing Repetitive Losses

Mitigation areas with repetitive losses are high priorities for hazard mitigation funding and resiliency efforts. Repetitive losses are a drain on community, State, and national disaster management resources and are cost-effective to mitigate. The current national and State priority is the reduction of repetitive flood losses because these translate into a loss to the NFIP. California has numerous areas of repetitive flood loss. Through the CRS, building codes, education, and resiliency programs, California works to reduce these losses. Additionally, many areas of the State experience repetitive losses from other hazards which are also mitigated through education, and various funding opportunities.

54.2.4. Supporting the Development and Adoption of Local Multi-Hazard Mitigation Planning

The HMA programs administered by Cal OES, require approved projects to be consistent with local- and State-developed hazard mitigation plans and comprise a cost-effective long-term mitigation program. Each HMA program makes a portion of funding available for hazard mitigation planning efforts. Encouraging communities to develop and implement LHMPs is a high priority for California. LHMPs are necessary to ensure that local communities are made aware of the hazards and vulnerabilities within their jurisdictions, develop strategies to reduce those vulnerabilities, and applicable federal financial assistance for hazard mitigation.

54.2.5. Addressing Climate Impacts

For HMA funding, the State is working with FEMA to set priorities for projects that address climate impacts or adaptation efforts. This effort includes the Climate Resilient Mitigation Activities identified by FEMA as eligible for HMA funding. Climate change will change the hazards impacting California and are likely to increase vulnerability due to changes in location, magnitude, and frequency of hazards. Cal OES prioritizes projects that consider future conditions in the design of the project, including changes in population, land use, and the location, intensity, and frequency of hazard events.

54.2.6. Protecting Vulnerable Populations

The HMA sub-application process gives priority to funding of mitigation projects in disadvantaged communities. Disadvantaged communities within California are identified by the Centers for Disease Control and Prevention (CDC)'s Social Vulnerability Index (SVI), CalEPA's CalEnviroScreen tool, or the best available data for the purpose. Often vulnerable populations experience disaster impacts first and more severely. Ensuring measures are prioritized to improve the protection of these communities is a priority for Cal OES.

54.2.7. Areas Experiencing Increases in Risk

Cal OES prioritizes sub-applicants that are experiencing increases in risk because of development pressure or impacts of climate change. Because California is a strong growth management state, local governments are equipped with significant capabilities to manage growth as it impacts hazard areas through the safety elements of their general plans. However, these tools alone do not always alleviate outside pressures for development. Local governments may lack the capacity or capabilities to enforce their growth management standards. Cal OES views these situations as great opportunities to prioritize and leverage programs such as the Capacity and Capability Building component of the BRIC program.

Cal OES will also give a funding priority to sub-applicants that are experiencing an increase in risk due to climate change. This is monitored via LHMPs when they are submitted to Cal OES for review. Additionally, these impacts are monitored when sub-applicants are asked to identify whether they are experiencing increased risk due to climate change.

54.2.8. Providing Protection to High Hazard Potential Dams

HHPD7: Did Element S15 (prioritizing funding) describe the criteria for prioritizing funding for high hazard potential dams?
Section 54.2.8 outlines how dams eligible for HHPD funding are prioritized.

FEMA's HHPD grant program provides technical, planning, design, and construction assistance for eligible rehabilitation activities that reduce dam risk and increase community preparedness. Cal OES will coordinate with DSOD to track and monitor opportunities to leverage this funding source to mitigate identified deficiencies on State-owned and -regulated high hazard potential dams. Cal OES will also promote the HHPD program and its requirements in its training and outreach for local mitigation planning in the State.

Upon receiving sub-applications, Cal OES ranks them in accordance with the stated priorities for that funding opportunity and then conducts eligibility and completeness reviews in priority order. Cal OES undertakes enhanced technical assistance to ensure that projects meet FEMA criteria. After sub-applications are thoroughly reviewed, they are scored within each priority based on a variety of factors, which may include the community's natural hazard risk, impact of the project on community resiliency and equity priority communities, incorporation of future conditions and climate change impacts into the project, and the quality of the implementation plan. Projects are proposed for funding based on both their priority and score.

Limitations to HHPD Funding

The greatest limitation to maximizing HHPD funding in California is meeting the Planning Requirements for HHPD funding eligibility. This SHMP can provide a State-level perspective of HHPD program capacity in California, but it does not have the full resolution that can be provided by local level planning. The SHMP can provide HHPD compliance for State-owned dams but not for privately owned dams. For privately owned dams to be eligible for funding under the HHPD program, the HHPD Planning Requirements need to be addressed by LHMPs, or HHPD-specific plans developed by the dam owners themselves. At the time of this SHMP update, only three LHMPs have been reviewed and approved by FEMA Region 9 for HHPD compliance.

The HHPD Planning Requirements have been added to the FEMA Plan Review Tool for LHMPs based on FEMA guidance that becomes effective on April 19, 2023. The HHPD elements are considered to be optional. It is hoped that increased awareness of the HHPD program benefits and requirements, combined with the availability of better data on risk, will spur more interest in HHPD planning as part of local hazard mitigation planning efforts in the State. Cal OES staff will promote and provide technical assistance to those local governments with an interest in HHPD program compliance through the programs and capabilities identified in this chapter.

54.3. EFFECTIVENESS OF MITIGATION ACTIONS

Cal OES will evaluate the effectiveness of mitigation activities when completed projects are tested by natural hazard events using the following mitigation assessment process:

- Level I Assessment: GIS mapping initiated during or immediately after a hazard event to determine if any completed mitigation projects are in the vicinity of the impacted area
- Level II Assessment: Initiated when projects are identified in the vicinity of the hazard event
- Level III Assessment: Loss Avoidance Study is conducted to estimate the dollar value of damages that would have occurred as a result of the hazard event if the site or structure had remained in the pre-mitigation state

The Level II Assessment includes contacting the sub-applicant, reviewing the project Scope of Work, and evaluating the need for outside subject matter experts to assist in the assessment. Cal OES will communicate with the subrecipient entity or facility owner to discuss specifics of the event and resulting impacts. Cal OES will examine the project Scope of Work to determine what measures, events, conditions, or hazard intensity levels the specific mitigation action was designed to withstand or protect against. This trigger event analysis will determine if the recent hazard event would have likely caused damage to the mitigation site or structure in the pre-mitigation state. If determined that damage would have likely occurred in the pre-mitigation state, a Level III Assessment is conducted.

During the Level III Assessment, Cal OES may involve applicable outside agencies such as CAL FIRE, DWR, or the USGS, to provide critical expertise. These dollar value estimates are compared to the actual cost of damages that occurred to determine the savings resulting from the mitigation investment.

Timeliness of the assessment activities is critical to reduce the loss of information needed to perform the analysis. To improve the efficiency and effectiveness of future analysis Cal OES collects, in the sub-application, a description of specific hazard event conditions that currently will result in property damage or loss of life to establish a baseline for future analysis. After completion of the mitigation activity, the presence of these conditions will serve as the trigger to conduct loss avoidance analysis. Cal OES proactively reviews previously completed projects, in advance of actual hazard events, to develop a database of trigger events to aid future loss avoidance analysis. Loss Avoidance Studies will be utilized to shape priorities for selecting mitigation activities and inform mitigation strategy. Cal OES will investigate opportunities to capture non-monetized benefits to vulnerable communities that result from successful mitigation investment.

DEFINITIONS OF TERMS AND ACRONYMS

0.2% annual chance flood – a flood that has a 0.2 percent chance of being equaled or exceeded in any given year; often referred to as the 500-year flood (USGS 2018h)

1% annual chance flood – a flood with a 1 percent chance of being equaled or exceeded in any given year; often called the 100-year flood (USGS 2018h)

AB – see Assembly Bill

Access or Functional Needs (AFN) – an individual may have an access or functional need if they have a developmental or intellectual disability, a physical disability, a chronic condition, an injury, limited English proficiency or are non-English speaking, are an older adult, are a child, are a person living in an institutionalized setting, or are low income, experiencing homelessness, or transportation disadvantaged, including, but not limited to, those who are dependent on public transit, or those who are pregnant (Government Code 8593.3). When referring to individuals, the term is used as "access or functional needs" with lowercase words and without using the acronym. When referring to the entire population, resources, considerations, or department title, the term is used as "Access and Functional Needs" and the acronym AFN may be used

ARCCA – Alliance of Regional Collaboratives for Climate Adaptation

Assembly Bill (AB) – a draft of a proposed law introduced by a Member of the California State Assembly

asset – any human-caused 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

atmospheric river – long, narrow regions in the atmosphere that transport water vapor. These columns of vapor move with the weather, carrying an amount of water vapor roughly equivalent to the average flow of water at the mouth of the Mississippi River.

When the atmospheric rivers make landfall, they often release this water vapor in the form of rain or snow (NOAA 2015)

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% annual 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 (USGS 2018h)

Base Flood Elevation (BFE) – the water surface elevation of the base flood (DWR 2020)

basin – 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 called "watersheds" (USGS 2019a)

BCA – see benefit-cost analysis

BCDC – San Francisco Bay Conservation and Development Commission

BCEGS – see Building Code Effectiveness Grading Schedule

BCSH – California Business, Consumer Services, and Housing Agency

benefit – a net project outcome and is usually defined in monetary terms. Benefits may include direct and indirect effects. For benefit-cost analysis of proposed mitigation measures, benefits are limited to specific, measurable risk reduction factors, including a reduction in expected property losses (buildings, contents, and functions) and protection of human life (FEMA 2022b)

benefit-cost analysis (BCA) – a systematic, quantitative method of comparing projected benefits to projected costs of a project or policy. It is used to measure cost-effectiveness (FEMA 2022b)

BFE – see Base Flood Elevation

BIPOC – Black, Indigenous, and People of Color

BOF – California Board of Forestry and Fire Protection

bovine spongiform encephalopathy (BSE) – a fatal disease in cattle

BRIC – see Building Resilient Infrastructure and Communities

BSE – see bovine spongiform encephalopathy

Building Code Effectiveness Grading Schedule (BCEGS) – a system of rating community building codes and their enforcement (Verisk 2023)

Building Resilient Infrastructure and Communities (BRIC) – this program aims to categorically shift the federal focus away from reactive disaster spending and toward research-supported, proactive investment in community resilience. Examples of projects under this program demonstrate innovative approaches to partnerships, such as shared funding mechanisms and/or project design (FEMA 2022a)

CAISO – California Independent System Operator

CAL FIRE – California Department of Forestry and Fire Protection

Cal OES – California Governor's Office of Emergency Services

Cal OES HMA Branch – California Governor's Office of Emergency Services (Cal OES) Hazard Mitigation Assistance Branch

Cal-Adapt – a state program providing data and tools for climate adaptation planning, building resiliency, and fostering community engagement (Cal-Adapt n.d.)

Cal-CSIC – California Cyber Security Integration Center

CalEPA – California Environmental Protection Agency

CalGEM – California Geologic Energy Management Division

CALGreen Code – the California Green Building Standards Code – Part 11, Title 24, California Code of Regulations (CCR) – called CALGreen, is the first-in-the-nation mandatory green building standards code. In 2007, the California Green Building Standards Code developed green building standards to meet the goals of California's landmark initiative Assembly Bill (AB) 32, which established a comprehensive program of cost-effective reductions of greenhouse gases to 1990 levels by 2020 (DGS n.d.)

California Code of Regulations (CCR) – the official compilation and publication of the regulations adopted, amended, or repealed by State agencies under the Administrative Procedure Act. Properly adopted regulations have the force of law (OAL 2023)

California Disaster Assistance Act (CDAA) – the California Disaster Assistance Act authorizes the Director of the California Governor's Office of Emergency Services (Cal OES) to administer a disaster assistance program that provides financial assistance from the State for costs incurred by local governments as a result of a disaster event. Funding for repairing, restoring, or replacing public real property damaged or destroyed by a disaster is made available when the Cal OES Director concurs with a local emergency proclamation requesting State disaster assistance. The program also provides for the reimbursement of local government costs associated with certain emergency activities undertaken in response to a state of emergency proclaimed by the Governor. In addition, the program may provide matching fund assistance for cost-sharing required under federal Public Assistance (PA) programs in response to a Presidential Major Disaster or Emergency Declaration (Cal OES 2023b)

California Emergency Services Act (California ESA) – passed in 1970, the California Emergency Services Act bolstered emergency mitigation, preparedness, and response by granting emergency powers to the Governor, establishing the California Governor's Office of Emergency Services (Cal OES) and the emergency support functions framework, enabling the State to better facilitate mutual aid (California Government Code Sections 8550-8669.7)

California Environmental Quality Act (CEQA) – one of California's fundamental environmental laws. The purposes of this act are to: (1) inform government decision makers and the public about the potential environmental effects of proposed activities; (2) identify the ways that environmental damage can be avoided or significantly reduced; (3) prevent significant, avoidable environmental damage by requiring changes in projects, either by the adoption of alternatives or imposition of mitigation measures; and (4) disclose to the public why a project was approved if that project has significant environmental impacts that cannot be mitigated to a less than significant level (OPR 2022e)

California ESA – see California Emergency Services Act

California Forest Improvement Program (CFIP) – assistance program for nonindustrial private forest owners providing technical and financial assistance for planning, reforestation, and resource management investments to improve the health and resilience of California's forestland (CAL FIRE n.d.)

CalRecycle – California Department of Resources Recycling and Recovery

CalSTA – California State Transportation Agency

Caltrans – California Department of Transportation

capability assessment – an analysis of a community's capacity to address hazard-related threats. The assessment includes two components: an inventory of an agency's mission, programs, and policies and an analysis of its capacity to carry out the mission, programs, and policies (FEMA 2020b)

CARB – California Air Resources Board

CBSC – California Building Standards Commission

CCC – California Conservation Corps

CCHES – Climate Change and Health Equity Section of the California Department of Public Health

CCR – see California Code of Regulations

CDAA – see California Disaster Assistance Act

CDBG – see Community Development Block Grant

CDC – U.S. Centers for Disease Control and Prevention

CDCR – California Department of Corrections and Rehabilitation

CDFA – California Department of Food and Agriculture

CDFW – California Department of Fish and Wildlife

CDPH – California Department of Public Health

CDT – California Department of Technology

CEA – California Earthquake Authority

CEC – California Energy Commission

Central Valley Flood Protection Plan (CVFPP) – California's strategic blueprint to improve flood risk management in the Central Valley (CVFPB n.d.)

CEQA – see California Environmental Quality Act

CESA – California Emergency Services Association

CFIP – see California Forest Improvement Program

CFR – see Code of Federal Regulations

CFSC – California Fire Safe Council

CGS – California Geological Survey

CHHS – California Health and Human Services Agency

CHP – California Highway Patrol

climate change – a change in global or regional climate patterns, in particular, apparent from the mid to late 20th century onwards and attributed mainly to the increased levels of atmospheric carbon dioxide produced by the use of fossil fuels (National Geographic 2022c)

climate change adaptation – the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects (IPCC 2022)

climate change mitigation – a human intervention to reduce the human impact on the climate system; it includes strategies to reduce greenhouse gas (GHG) sources and emissions and enhance greenhouse gas sinks, also called carbon sinks (European Environment Agency 2022)

CMD – California Military Department

CNRA – California Natural Resources Agency

Code of Federal Regulations (CFR) – an arrangement of the general and permanent rules published in the Federal Register by the executive departments and agencies of the federal government (National Archives 2021)

Community Development Block Grant (CDBG) – a program offering disaster recovery grants to rebuild affected areas and provide seed money to start the recovery process. These grants help cities, counties, and states recover from Presidentially declared disasters, especially in low-income areas, subject to the availability of supplemental appropriations (HUD 2022)

community lifeline – as defined by the Federal Emergency Management Agency (FEMA), a lifeline enables the continuous operation of critical government and business functions and is essential to human health and safety or economic security. There are seven lifeline categories: safety and security; food, water, shelter; health and medical; energy; communications; transportation; and hazardous materials (FEMA 2020)

Community Rating System (CRS) – a voluntary program under the National Flood Insurance Program (NFIP) that rewards participating communities through flood insurance premium discounts for exceeding the minimum requirements of the NFIP and completing activities that reduce flood hazard risk (FEMA 2022c)

Coronavirus Disease 2019 (COVID-19) – a highly contagious infectious disease caused by the SARS-CoV-2 virus

COVID-19 – Coronavirus Disease 2019

CPUC – California Public Utilities Commission

critical facilities – facilities and infrastructure critical to the population's health and welfare. These become especially important after any hazard event occurs. Typical critical facilities include hospitals, fire stations, police stations, storage of critical records, and similar facilities; however, what is identified as a critical facility varies by the community (FEMA 2020e). For the California SHMP, critical facilities included State-owned or -leased facilities (e.g., correctional facilities, development centers, hospitals, migrant centers, special schools), State bridges, State highways, State dams, and State water projects

CRS – see Community Rating System

CSAC – California State Association of Counties

CSTI – California Governor's Office of Emergency Services (Cal OES) California Specialized Training Institute

CSU – California State University

CTC – California Transportation Commission

CUPA – Certified Unified Program Agency

CVFPB – Central Valley Flood Protection Board

CVFPP – see Central Valley Flood Protection Plan

dam – any artificial barrier that has the ability to capture water, wastewater, or any liquid-borne material, for the purpose of storage or control of water (FEMA 2004a)

dam failure – an uncontrolled release of captured water due to a partial or complete breach in a dam (or levee) that impacts its integrity (FEMA 2004a)

DART – see Deep-Ocean Assessment and Reporting of Tsunami

debris flow – a moving mass of loose mud, sand, soil, rock, water, and air that travels down a slope under the influence of gravity. Debris flows (commonly referred to as "mudflows") are a particularly dangerous type of landslide with increased risk to life and property because they move quickly, destroy objects in their paths, and often strike without warning. They occur in a wide variety of environments throughout the world, including the majority of the states and U.S. Territories. Debris flows generally occur during periods of intense rainfall or rapid snow melt and usually start on hillsides or mountains. Debris flows can travel up to and exceeding 35 miles per hour (mph) and may carry large items such as boulders, trees, and cars. If a debris flow enters a steep stream channel, it can travel for several miles, impacting areas unaware of the hazard. Areas recently burned by a forest fire are especially susceptible to debris flows, including downslope and outside of the burned area (USGS 2022f)

Deep-Ocean Assessment and Reporting of Tsunami (DART) – systems to detect, measure, and report tsunamis in the open ocean in real-time

DFM – California Department of Water Resources Division of Floodplain Management

DGS – California Department of General Services

DIR – California Department of Industrial Relations

Disaster Mitigation Act of 2000 (DMA) – the latest federal legislation enacted to encourage and promote proactive, pre-disaster planning as a condition of receiving certain federal financial assistance (FEMA 2000)

diversity – physical, social, and psychological differences between people and groups with multiple subjectivities, perspectives, experiences, backgrounds, and socially constructed differences, such as varied racialized identities, ethnicities, genders, sexualities, disabilities, and other access or functional needs, mainstream language access, documentation statuses, Tribal Nation populations (federally recognized and non-federally recognized), Native or Indigenous origins, mental health, age ranges, socio-economic levels, countries of origin, cultural backgrounds, marital/parental statuses, thinking and communication styles, etc. (Cal OES internal definition)

DMA – see Disaster Mitigation Act of 2000

DOC – California Department of Conservation

DOF – California Department of Finance

DR – see Federal (or Presidential) Major Disaster Declaration

drought – based on impacts to water users, drought is a gradual phenomenon occurring slowly over time. Storage, whether in surface water reservoirs or groundwater basins, buffers drought impacts and influences the timing of those impacts. A single dry year is not a drought for most Californians because of the State's extensive system of water infrastructure and groundwater resources that help reduce the impacts (DWR 2022p)

DSOD – California Department of Water Resources Division of Safety of Dams

DTSC – California Department of Toxic Substances Control

DWR – California Department of Water Resources

EAP – see emergency action plan

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 (USGS 2022c)

Earthquake Brace + Bolt Program (EBB) – a program to support bolting older homes to their foundations and bracing cripple walls to reduce the likelihood that these homes will slide off their foundation during an earthquake. Retrofits must adhere to the California Existing Building Code. Since 2014 when the first EBB retrofit was completed, EBB grants have helped more than 19,000 homeowners retrofit their homes (CRMP n.d.)

EBB – see Earthquake Brace + Bolt Program

ecosystem services – ecological processes or functions having monetary or non-monetary value to individuals or society at large. These are frequently classified as: (1) supporting services such as productivity or biodiversity maintenance; (2) provisioning services such as food, fiber, or fish; (3) regulating services such as climate regulation or carbon sequestration; and (4) cultural services such as tourism or spiritual and aesthetic appreciation (EPA 2022j)

EDD – California Employment Development Department

EHP – see environmental and historic preservation

electromagnetic pulse (EMP) – an intense pulse of electromagnetic radiation, especially one generated by a nuclear explosion and occurring high above the earth's surface

EM – see Federal (or Presidential) Emergency Declaration

EMAP – see Emergency Management Accreditation Program

Emergency Action Plan (EAP) – a dam Emergency Action Plan is a written document that identifies incidents that can lead to potential emergency conditions at a dam, identifies the areas that can be affected by the loss of a reservoir, and specifies pre-planned actions to be followed to minimize property damage, potential loss of infrastructure and water resource, and potential loss of life because of failure or misoperation of a dam (ASDSO 2023)

Emergency Management Accreditation Program (EMAP) – is a voluntary accreditation process based on collaboratively developed national standards. The State will seek accreditation under this program for the 2023 State Hazard Mitigation Plan (SHMP). The benefits of having an accredited plan include: providing opportunities to assess preparedness programs against established national standards; demonstrating discipline and accountability in regularly reviewing, maintaining, and documenting compliance with standards and best practices; providing a common structure for review and analysis among state and local government programs nationwide; and offering residents evidence of their government's best efforts to comply with national standards and helps standardize the field of emergency management (FEMA 2004)

Emergency Management Performance Grant (EMPG) – the Emergency Management Performance Grant, as authorized by the Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended (42 U.S.C. Section 5121 et seq.) and Section 662 of the Post Katrina Emergency Management Reform Act of 2006, as amended (6 U.S.C. § 762), authorizes funding to assist state, local, Tribal Nation, and territorial emergency management agencies to implement the National Preparedness System and to support the National Preparedness Goal of a secure and resilient nation. EMPG enhances emergency preparedness by providing grants that build, sustain, or close gaps in capability as identified in the relevant Stakeholder Preparedness Review

emergency planning zone (EPZ) – a zone identified to facilitate a pre-planned strategy for protective actions during a defined emergency

EMP – see electromagnetic pulse

EMPG – see Emergency Management Performance Grant

environmental and historic preservation (EHP) – an element of the Federal Emergency Management Agency (FEMA) review of sub-applications for Hazard Mitigation Assistance (HMA) grants

EPA – U.S. Environmental Protection Agency

epidemic – the spread of an infectious disease beyond a local population, reaching people in a wider geographical area. Several factors determine whether an outbreak will become an epidemic, including the ease with which the disease spreads from vectors, such as animals, to people and the ease with which it spreads from person to person (Columbia Mailman School of Public Health 2021)

EPZ – see emergency planning zone

equitable outcomes – an outcome where every individual from every demographic has the opportunity to reach their full potential resulting in more economic opportunity for everyone (Dunbar 2021)

equity – California Governor's Office of Emergency Services (Cal OES) states that "equity means that all people are justly and fairly included in society and that everyone is able to participate, prosper, and achieve their full potential. It recognizes that everyone enjoys different advantages and faces different challenges and that everyone should be treated justly and fairly, according to their circumstances," socio-historical experiences, and structurally imposed barriers. Therefore, Cal OES prioritizes actions that promote equity, foster community resilience, and protect the most vulnerable and explicitly includes communities that are disproportionately vulnerable to climate impacts

equity priority actions – actions with an assigned priority emphasizing equity (Cal OES internal definition)

equity priority communities –populations that bear a disproportionate burden of California's emergencies, hazards, and disaster impacts because of a history of being systemically marginalized due to intersecting layers of discrimination, such as structural inequities relating to race, ethnicity, gender, sexuality, access or functional needs, mainstream language access, documentation status, Tribal Nation population experiences (federally recognized and non-federally recognized), Native or Indigenous origins, mental health, age, socio-economic status, countries of origin, religion, disability, etc. (Cal OES internal definition)

exposure – the number and dollar value of assets considered to be at risk during the occurrence of a specific hazard

extent – the size or location of an area affected by a hazard. For hazards that do not have a clearly defined extent, this definition expands to the hazard's strength or magnitude, also called the severity. For hazards in this Plan that do not have mapping, the severity discussion of the hazard profile addresses the extent

extreme cold – temperatures from winter weather associated with freezing rain, sleet, snow, and strong winds that may cause hypothermia or frostbite

extreme heat – temperatures that hover 10 °F or more above the average high temperature for a region and last for several days

Federal (Presidential) Emergency Declaration (EM) – emergency declarations supplement state and local or Tribal Nation efforts in providing emergency services, such as the protection of lives, property, public health, and safety, or to lessen or avert the threat of a catastrophe in any part of the United States. The total amount of assistance provided for in a single emergency may not exceed $5 million across the Public Assistance (PA) Categories A and B and Individual Assistance (IA) program for response and immediate recovery needs in an impacted area (FEMA 2022k)

Federal (Presidential) Major Disaster Declaration (DR) – declarations for events that cause more damage than state and local governments and resources can handle without federal government assistance. A federal disaster declaration puts into motion long-term federal recovery programs, some of which are matched by state programs, to help disaster victims, businesses, and public entities to jumpstart recovery efforts (FEMA 2022k)

Federal Fire Management Assistance Declaration (FM) – declarations for fire management assistance when the Federal Emergency Management Agency (FEMA) determines that a fire or fire complex on public or private forest land or grassland threatens such destruction as would constitute a major disaster (FEMA 2022g)

federal fire suppression authorization (FS) – authorization for a fire to qualify for the Fire Suppression Assistance Program; this program has been replaced by the Fire Management Assistance Grant (FMAG) Program and the FS declaration has been replaced by the Federal Fire Management Assistance declaration (FM)

FEMA – Federal Emergency Management Agency

FHSZ – see Fire Hazard Severity Zone

Fire and Resource Assessment Program (FRAP) – housed within the California Department of Forestry and Fire Protection (CAL FIRE), the Fire and Resource Assessment Program assesses the amount and extent of California's forests and rangelands using geographic information system (GIS) mapping, analyzes their conditions using data analytics, and identifies alternative management and policy guidelines through assessment reports. The program also provides Forest Health Research Program grants that support scientific studies that contribute to forest health and management (CAL FIRE 2023)

fire complex – two or more individual fire incidents located in the same general area which are assigned to a single incident commander or unified command (USDA 2006) (National Wildfire Coordinating Group 2006)

Fire Hazard Severity Zone (FHSZ) – the State Fire Marshal is mandated to classify lands within State Responsibility Areas (SRA) into Fire Hazard Severity Zones. The zones fall into three categories: moderate, high, and very high. The State's seasonally dry Mediterranean climate lends itself to wildfires. To better prepare, the California Department of Forestry and Fire Protection (CAL FIRE) is required to classify the severity of the fire hazard in areas of California. Maps are developed to represent these zones across the State using a science-based and field-tested model that assigns a hazard score based on the factors influencing fire likelihood and behavior (OSFM 2022)

Fire Management Assistance Grant (FMAG) – the Fire Management Assistance Grant Program is available to state, local, and Tribal Nation governments for the mitigation, management, and control of fires on publicly or privately owned forests or grasslands, which threaten such destruction as would constitute a major disaster (FEMA 2022e)

FIRM – see Flood Insurance Rate Map

FIS – see Flood Insurance Study

fiscal year (FY) – a set one-year period used for taxing or accounting purposes

flash flood – a flood that occurs with little or no warning when water levels rise at an extremely fast rate (National Severe Storms Laboratory 2022)

flood – the inundation of normally dry land resulting from the rising and overflowing of a body of water (National Severe Storms Laboratory 2022)

Flood Insurance Rate Map (FIRM) – the official map on which the Federal Emergency Management Agency (FEMA) delineates the Special Flood Hazard Area (SFHA). Maps for each county in the State can be accessed online: https://msc.fema.gov/portal/advanceSearch

Flood Insurance Study (FIS) – a regulatory mapping product developed by the Federal Emergency Management Agency (FEMA) that produces a detailed written account of a flood hazard mapping study including methodologies used, sources of data, and findings for watercourses, lakes, coastal flood, and localized flooding risks with a community. The FIS report usually includes flood profile charts with detailed Base Flood Elevation (BFE) information. All FIS reports within the State can be accessed online at: https://msc.fema.gov/portal/advanceSearch

Flood Mitigation Assistance (FMA) – Flood Mitigation Assistance is a competitive grant program that provides funding to states, local communities, federally recognized Tribal Nations, and territories. Funds can be used for projects that reduce or eliminate the risk of repetitive flood damage to buildings insured by the National Flood Insurance Program (NFIP) (FEMA 2022g)

floodplain – the land area along the sides of a river that becomes inundated with water during a flood

FM – see Federal Fire Management Assistance Declaration

FMA – see Flood Mitigation Assistance

FMAG – see Fire Management Assistance Grants

FRAP – see Fire and Resource Assessment Program

freeboard – an additional height above the Base Flood Elevation (BFE) used as a safety factor in determining the level at which a structure's lowest floor must be elevated or floodproofed to be in accordance with state or local floodplain management regulations (FEMA 2020c)

frequency – 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 in any given year. Frequency reliability varies depending on the type of hazard considered

frontline communities – neighborhoods or populations of people directly affected by climate change [and other hazards] and inequity in society at higher rates than people with more power in society. They are on the frontlines of the problem (NAACP 2018)

FS – see federal fire suppression authorization

Fujita tornado intensity scale – scale for rating tornado wind speeds, estimated based on damage sustained. 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; an F5 tornado (wind speeds of 261 to 318 mph) indicates severe damage (Storm Prediction Center 2022)

FY – see fiscal year

g – the acceleration associated with gravity; %g is an acceleration calculated as a percentage of the acceleration of gravity

General Plan – each local government's blueprint for meeting the community's long-term vision for the future (OPR 2022a)

geographic information system (GIS) – computer software that relates data regarding physical and other features on the earth to a database for mapping and analysis (ESRI 2022)

GHG – see greenhouse gases

GIS – see geographic information system

global positioning system (GPS) – a space-based radio-navigation system consisting of a constellation of satellites broadcasting navigation signals and a network of ground stations and satellite control stations used for monitoring and control

goal – 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 (i.e., by the actual benefits in terms of hazard mitigation)

GO-Biz – California Governor's Office of Business and Economic Development

GPS – see global positioning system

green infrastructure – refers to ecological systems, both natural and engineered, that act as living infrastructure. Green infrastructure elements are planned and managed primarily for stormwater control but exhibit social, economic, and environmental benefits (Environmental Finance Center 2008)

greenhouse gases (GHG) – methane, nitrous oxide, and other gases that trap heat and warm the Earth, as a greenhouse traps heat from the sun (Center for Science Education 2022)

ground shaking – the result of rapid ground acceleration caused by seismic waves passing beneath buildings, roads, and other structures (USGS 2022g)

hazard – a source of potential danger or adverse condition that could harm people and/or cause property damage

Hazard Groups – the 2023 State Hazard Mitigation Plan (SHMP) Hazard Groups provided guidance and subject matter expertise for the Plan. In addition, the Hazard Groups focused on specific hazard profiles and mitigation actions

hazard mitigation – any sustainable action that reduces or eliminates long-term risk to people, property, and the environment from future disasters. Mitigation planning breaks the cycle of disaster damage, reconstruction, and repeated damage (FEMA 2022h)

Hazard Mitigation Assistance (HMA) – a suite of grant programs that the Federal Emergency Management Agency (FEMA) sponsors that can fund proactive hazard mitigation plans and projects. These programs include the Hazard Mitigation Grant Program (HMGP), Building Resilient Infrastructure and Communities (BRIC), and Flood Mitigation Assistance (FMA) (FEMA 2022h)

Hazard Mitigation Grant Program (HMGP) – provides funding to state, local, Tribal Nation, and territorial governments so they can develop hazard mitigation plans and rebuild in a way that reduces or mitigates future disaster losses in their communities. When requested by an authorized representative, this grant funding is available after a Presidentially declared disaster (FEMA 2022i)

hazardous material – a substance or combination of substances (e.g., biological, chemical, radiological, nuclear, explosive, physical) that, because of its quantity, concentration, or physical, chemical, or infectious characteristics, has the potential to cause harm to humans, animals, or the environment, either by itself or through interaction with other factors

Hazus – a nationally standardized, geographic information system (GIS) based multi-hazard risk analysis tool developed and distributed by the Federal Emergency Management Agency (FEMA) (FEMA 2022j)

HCAI – California Department of Health Care Access and Information

HCD – California Department of Housing and Community Development

HHPD – see high hazard potential dam

High Hazard Potential Dam (HHPD) – High Hazard Potential is a classification standard for any dam whose failure or misoperation will cause loss of human life and significant property destruction (FEMA 2022n)

high-hazard dam – a dam whose failure or improper operation can cause loss of human life

HIRA – Hazard Identification and Risk Assessment

HIV/AIDS – Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome

HMA – see Hazard Mitigation Assistance

HMGP – see Hazard Mitigation Grant Program

HUD – U.S. Department of Housing and Urban Development

IA – see Individual Assistance

IBC – see International Building Code

ICARP – Integrated Climate Adaptation and Resilience Program

impact rating – the impact rating performed for the 2023 State Hazard Mitigation Plan (SHMP) is based on the fundamental definition of risk: Probability x Impact = Risk

inclusion – the California Governor's Office of Emergency Services (Cal OES) puts diversity into purposeful and meaningful action and builds a culture of belonging, respect, and connection by actively inviting the contribution and participation of all people

Individual Assistance (IA) – the Federal Emergency Management Agency (FEMA) provides assistance to individuals and families who have lost their homes due to a Presidentially declared disaster. It also helps with other needs such as disaster-caused childcare, medical expenses, or clean-up items (FEMA 2022m)

intensity – the measure of the effects of a hazard

International Building Code (IBC) – the foundation of the complete family of International Codes. It is an essential tool to preserve public health and safety that provides safeguards from hazards associated with the built environment. It addresses designing and installing innovative materials that meet or exceed public health and safety goals (International Code Council 2022)

inventory – the assets identified in a planning area. Inventories include assets that could be lost when a disaster occurs and community resources that are at risk. Assets include people, buildings, transportation, and other valued community resources

LAO – California Legislative Analyst's Office

LCP – see Local Coastal Program

levee – a man-made structure, usually an earthen embankment, used to contain, control, or divert the flow of water to try and reduce flooding risk (FEMA n.d.-c)

levee flood protection zone (LFPZ) – the maximum area that could be flooded if a levee under federal or state regulation were to fail while conveying flows at the maximum reasonable capacity

LFPZ – see levee flood protection zone

LGBTQIA+ – lesbian, gay, bisexual, transgender, queer or questioning, intersex, asexual, and more identities

LHMP – see local hazard mitigation plan

liquefaction – loosely packed, water-logged sediment that loses its strength in response to strong shaking, causing major damage during earthquakes (USGS 2022b)

LMP Unit – California Governor's Office of Emergency Services (Cal OES) Local Mitigation Planning Unit

Local Coastal Program (LCP) – local program for implementing California's Coastal Act policies

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 non-profit corporation under State law), regional or interstate government entity, or agency or instrumentality of a local government; any Tribal Nation or authorized Tribal organization, or Alaska Native village or organization; and any rural community, unincorporated town or village, or other public entity

local hazard mitigation plan (LHMP) – a local hazard mitigation plan assesses hazard vulnerabilities and identifies mitigation actions that jurisdictions will pursue to reduce the level of injury, property damage, and community disruption that might otherwise result from such events

Local Responsibility Area (LRA) – local responsibility areas are incorporated cities, urban regions, agricultural lands, and portions of the desert where the local government is responsible for wildfire protection. Wildfire protection is typically provided by city fire departments, fire protection districts, counties, and by the California Department of Forestry and Fire Protection (CAL FIRE) under contract (CAL FIRE 2022f)

LRA – see Local Responsibility Area

magnitude – the measure of the strength of an earthquake

MARAC – Mutual Aid Regional Advisory Committee

mitigation – a preventive action taken before an event to reduce or eliminate risk to life, property, or the environment

mitigation actions – specific actions to achieve goals and objectives that minimize the effects of a disaster and reduce the risk to life, property, and the environment

moment magnitude scale (Mw) – scale based on the total movement release of an earthquake. Moment is a product of the distance a fault moved, and the force required to move it. It is derived from modeling recordings of the earthquake at multiple stations. Moment magnitude estimates are similar to Richter magnitudes for small to large earthquakes (Michigan Tech 2022)

mph – miles per hour

Mw – see Moment Magnitude Scale

N/A – not applicable

NAHC – Native American Heritage Commission

NASA – National Aeronautics and Space Administration

National Earthquake Hazards Reduction Program (NEHRP) – a program to develop, disseminate, and promote knowledge, tools, and practices for earthquake risk reduction – through coordinated, multidisciplinary, interagency partnerships among the NEHRP agencies and their stakeholders – that improve the Nation’s earthquake resilience in public safety, economic strength, and national security (NEHRP 2022)

National Fire Danger Rating System (NFDRS) – a system that allows fire managers to estimate today's or tomorrow's fire danger for a given area. It combines the effects of existing and expected states of selected fire danger factors into one or more qualitative or numeric indices that reflect an area's fire protection needs. The system links an organization's readiness level (or pre-planned fire suppression actions) to the potential fire problems of the day (USFS 2022)

National Flood Insurance Program (NFIP) – provides flood insurance to property owners, renters, and businesses. This coverage helps them recover faster when floodwaters recede. The NFIP works with communities required to adopt and enforce floodplain management regulations to help mitigate flooding effects (FEMA 2022f)

nature-based solutions – sustainable planning, design, environmental management, and engineering practices that weave natural features or processes into the built environment to promote adaptation and resilience. These solutions use natural features and processes to combat climate change and reduce flood risk (FEMA 2023b)

NCEI – National Centers for Environmental Information

NEHRP – see National Earthquake Hazards Reduction Program

NFDRS – see National Fire Danger Rating System

NFIP – see National Flood Insurance Program

NGO – see non-governmental organization

NOAA – National Oceanic and Atmospheric Administration

NOFO – see notice of funding opportunity

NOI – see notice of interest

non-governmental organization (NGO) – typically non-profit entities that are independent of direct governmental influence

notice of funding opportunity (NOFO) – an agency's formally issued announcement that funding through a financial assistance program is available. A NOFO will include a description of activities and entities that are eligible to apply, as well as all other required criteria

notice of interest (NOI) – a sub-applicant's response to a notice of funding opportunity (NOFO) indicating an interest in applying for funding

NWS – National Weather Service

OAFN – California Office of Access and Functional Needs

OAL – Office of Administrative Law

objective – a measurable step you take to achieve a strategy

ODEI – California Office of Diversity, Equity, and Inclusion

OEHHA – California Office of Environmental Health Hazard Assessment

OPC – California Ocean Protection Council

OPR – California Governor's Office of Planning and Research

OSFM – California Office of the State Fire Marshal

OSHPD – California Office of Statewide Health Planning and Development

OSPR – California Office of Spill Prevention and Response

OTS – California Office of Traffic Safety

PA – see Public Assistance

pandemic – an epidemic of infectious disease that has spread through human populations across a large region, multiple continents, or worldwide (Columbia Mailman School of Public Health 2021)

particulate matter (PM) – particles of solids or liquids in the air

peak ground acceleration (PGA) – a measure of the highest amplitude of ground shaking that accompanies an earthquake, based on a percentage of the force of gravity (USGS 2019b)

PG&E – Pacific Gas and Electric Company

PGA – see peak ground acceleration

Plan or the Plan – used as a reference to the 2023 State Hazard Mitigation Plan (SHMP) within the document

PM – see particulate matter

PM_{10} – particulate matter consisting of fine particles that are 10 micrometers or less in diameter

$PM_{2.5}$ – particulate matter consisting of fine particles that are 2.5 micrometers or less in diameter

preparedness – actions that strengthen the capability of government, people, and communities to respond to disasters

probability of occurrence – 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 occurrence values is used to estimate the probability of occurrence (FEMA 2022p)

PSPS – see Public Safety Power Shutoff

Public Assistance (PA) – provides supplemental grants to state, local, Tribal Nation, and territorial governments and certain types of private non-profits so communities can quickly respond to and recover from major disasters or emergencies (FEMA 2022)

Public Safety Power Shutoff (PSPS) – an intentional shutdown of electrical power in an area because of hazardous weather conditions which could contribute to the possibility of wildfires

recurrence interval – a measure based on the probability that the given hazard event will be equaled or exceeded in any given year based on past occurrences (sometimes called the return period)

recovery – within emergency management, recovery focuses on restoring, redeveloping, and revitalizing the health, social, economic, natural, and environmental fabric of a community and often begins while response to a disaster is still occurring (FEMA n.d.-a)

redlining – a discriminatory practice in which services are withheld from potential customers who reside in neighborhoods that have significant numbers of racial and ethnic minorities and low-income residents

Regional Flood Management Plan (RFMP) – regional components of the Central Valley Flood Protection Plan (CVFPP) identifying and describing region-specific challenges, priorities, and accomplishments (DWR 2023)

repetitive loss (RL) property – any National Flood Insurance Program (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 $1,000; or two paid flood losses in excess of $1,000 within any 10-year period since 1978; or three or more paid losses that equal or exceed the current value of the insured property (NFIP/CRS 2015)

request for information (RFI) – a request from a grant funding review agency to a funding applicant asking for the submittal of any items missing from a grant application

resilience – the capacity of people, organizations, or systems to adapt to changing conditions and withstand and/or rapidly recover from disruption due to an emergency

RFI – see request for information

RFMP – see Regional Flood Management Plan

risk – the estimated impact a hazard would have on a community's people, services, facilities, and structures. 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 low, moderate, or high likelihood of sustaining damage above a particular threshold due to the 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 – the process of measuring the 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

risk ranking – process to score and rank hazards based on the probability that they will occur and the impact they will have if they do

riverine – of or produced by a river. Riverine floodplains have readily identifiable channels

RL – see repetitive loss property

Robert T. Stafford Act (Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 100-707) – the statutory authority for most federal disaster response activities, especially as they pertain to the Federal Emergency Management Agency (FEMA) and its programs. Signed into law November 23, 1988; amended by the Disaster Relief Act of 1974 (Public Law 93-288)

SB – see Senate Bill

sea-level rise – the average increase in the water level of the Earth's oceans

seiche – a standing wave in an enclosed or partially enclosed body of water, such as a lake, harbor, or reservoir (Pacific Northwest Seismic Network 2022)

SEMS – see Standardized Emergency Management System

Senate Bill (SB) – a draft of a proposed law introduced by a Member of the California State Senate

SEP – see State Emergency Plan

severe repetitive loss (SRL) property – any National Flood Insurance Program (NFIP) insured residential building that has incurred flood-related damage for which four or more claims payments have been made, with the amount of each claim exceeding $5,000 and the cumulative amount exceeding $20,000; or for which at least two claims payments have been made under NFIP coverage with the cumulative amount exceeding the market value of the building (NFIP/CRS 2015)

SFHA – see Special Flood Hazard Area

SGC – California Strategic Growth Council

SHMP – see State Hazard Mitigation Plan

significant hazard dam – a dam that can cause economic loss, environmental damage, or disruption of lifeline facilities or can impact other concerns, but not necessarily the loss of life

SLC – California State Lands Commission

SMGB – California State Mining and Geology Board

SMP Unit – California Governor's Office of Emergency Services (Cal OES) State Mitigation Planning Unit

SNC – Sierra Nevada Conservancy

SoCalGas – Southern California Gas

social vulnerability – as defined by the Federal Emergency Management Agency (FEMA), the susceptibility of social groups to the adverse impacts of natural hazards, including disproportionate death, injury, loss, or disruption of livelihood (FEMA n.d.-b)

Social Vulnerability Index (SVI) – an indicator of areas of vulnerability based on 15 factors ranging across household composition, minority status, and access to transportation (CDC 2022)

SPC – National Weather Service Storm Prediction Center

Special Flood Hazard Area (SFHA) – areas that will be inundated by the flood event having a 1 percent chance of being equaled or exceeded in any given year (FEMA 2020d)

Sperry-Piltz Ice Accumulation Index (SPIA) – a system for predicting the projected footprint, total ice accumulation, and resulting potential damage from incoming ice storms (SPIA Index n.d.)

SPFC – see State Plan of Flood Control

SPIA – Sperry-Piltz Ice Accumulation index

SRA – see State Responsibility Area

SRL – see severe repetitive loss property

SSC – California Seismic Safety Commission

stakeholder – business leaders, civic groups, academia, non-profit organizations, major employers, managers of critical facilities, farmers, developers, special purpose districts, and others whose actions could impact hazard mitigation efforts

Standardized Emergency Management System (SEMS) – the cornerstone of California's emergency response system and the fundamental structure for the response phase of emergency management. The system unifies all elements of California's emergency management community into one integrated system and standardizes key elements (Cal OES 2022)

State Emergency Plan (SEP) – the plan is a California Emergency Services Act (ESA) requirement and describes methods for conducting emergency operations. The State Emergency Plan details the process for rendering mutual aid and describes the roles and responsibilities of State government agencies during emergencies (Cal OES 2023a)

State Hazard Mitigation Plan (SHMP) – identifies hazards and associated vulnerabilities within the State and provides a comprehensive statewide strategy to reduce future disaster losses through sound mitigation projects (FEMA 2023k)

State Parks – California Department of Parks and Recreation

State Plan of Flood Control (SPFC) – a program of flood control projects developed under the Central Valley Flood Protection Plan (CVFPP)

State Responsibility Area (SRA) – State Responsibility Areas are areas where the state has financial responsibility for wildfire protection and prevention. Within these, the

California Department of Forestry and Fire Protection (CAL FIRE) is responsible for fire prevention and suppression (CAL FIRE 2022f)

subsidence – the caving in or sinking of an area of land (USGS 2022k)

surface fault rupture – an offset of the ground surface when a fault rupture extends to the Earth's surface (Pacific Northwest Seismic Network 2022a)

sustainability – refers to an overarching concept within which disaster management takes place. A well-known definition of sustainability comes from the World Commission on Environment and Development, which states that sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland Commission 1987). This vision was articulated at a finer level by the National Commission on the Environment, which suggested that sustainability is a strategy for improving the quality of life while preserving the environmental potential for the future, of living off interest rather than consuming natural capital (National Commission on the Environment 1992). For the purpose of this State Hazard Mitigation Plan (SHMP), the Climate Impacts Working group refined the term "sustainability" to include these previous definitions and the idea of preservation of resources, including physical, social, economic, environmental, historical, and cultural, for the benefit of future generations. One of the paths to sustainability is through investment in strong disaster mitigation

SVI – see Social Vulnerability Index

SWPC – Space Weather Prediction Center

TAWC – technical assistance working committee

THIRA – see Threat and Hazard Identification and Risk Assessment

Threat and Hazard Identification and Risk Assessment (THIRA) – a three-step risk assessment process that helps communities understand their risks and what they need to do to address those risks

tsunami – a series of waves in a body of water caused by the displacement of a large volume of water, generally in an ocean or a large lake, often caused by earthquakes or undersea volcanic eruptions

U.S. – United States

U.S. Drought Monitor – the U.S. Drought Monitor is a map updated each Thursday to show the location and intensity of drought across the country. The monitor uses a five-category system, labeled Abnormally Dry or D0 (a precursor to drought, not actually drought), Moderate (D1), Severe (D2), Extreme (D3), and Exceptional (D4) Drought.

Drought categories show experts' assessments of conditions related to dryness and drought, including observations of how much water is available in streams, lakes, and soils compared to usual for the same time of year (NIDIS 2022)

UC – University of California

UCERF3 – see Uniform California Earthquake Rupture Forecast

underserved/underrepresented communities – for the 2023 State Hazard Mitigation Plan (SHMP), this term has been defined to include rural communities, migrant and seasonal agricultural workers, individuals living in group quarters, and individuals living in mobile or manufactured homes

Uniform California Earthquake Rupture Forecast (UCERF) – a model providing authoritative estimates of the magnitude, location, and time-averaged frequency of potentially damaging earthquakes in California; UCERF3 is version 3 of the model

unreinforced masonry building (URM) – a building where load-bearing walls, non-load-bearing walls, or other structures, such as chimneys, are made of brick, cinderblock, tiles, adobe, or other masonry material that is not braced by reinforcing material, such as rebar in concrete or cinderblock. As these buildings were not constructed according to modern building codes, they are more likely to be damaged or collapse during a hazard event like an earthquake

URM – see unreinforced masonry building

USACE – U.S. Army Corps of Engineers

USDA – U.S. Department of Agriculture

USGS – U.S. Geological Survey

vulnerability – an assessment of how susceptible an asset is to damage based on its construction, contents, and the economic value of its functions

watershed – an area that drains downgradient from areas of higher land to areas of lower land to the lowest point

Watershed Emergency Response Team (WERT) – a team deployed to conduct post-fire assessments and identify types and locations of threats to life-safety and property from debris flows, flooding, rockfall, and surface erosion that are elevated due to wildfire

WCB – California Wildlife Conservation Board

WERT – see Watershed Emergency Response Team

West Nile Virus (WNV) – a virus transmitted by mosquitoes, usually between birds, but sometimes causing epidemics of disease (typically fever or encephalitis) in humans and horses

whole community – a term coined by the Federal Emergency Management Agency (FEMA) to support its preparedness initiatives. "Whole community" includes individuals and families from all aspects of society such as individuals with access or functional needs including people with disabilities, and people from various businesses, faith-based and community organizations, non-profit groups, schools and academia, media outlets, and all levels of government, including state, local, Tribal Nation, territorial, and federal partners (FEMA 2020a)

wildland urban interface (WUI) – the transition zone between unoccupied land and human development. It is the line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels (U.S. Fire Administration 2022a)

WNV – see West Nile Virus

Working Groups – the 2023 State Hazard Mitigation Plan (SHMP) Working Groups provided guidance and subject matter expertise for the Plan. The Working Groups evaluated overarching themes integrated throughout the 2023 SHMP

WUI – see wildland urban interface

Zone X – area determined to be outside the 1% and 0.2% annual chance floodplains (FEMA 2020d)

zoning ordinance – an ordinance that designates allowable land use and intensities for a local jurisdiction

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